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J. Eng. Technol. Manage. 21 (2004) 51–81

Journal of
ENGINEERING AND
TECHNOLOGY
MANAGEMENT
JET-M

www.elsevier.com/locate/jengtecman

The meaning of success: network position and the social construction of project outcomes in an R&D lab

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Abstract

We analyze the social networks of project managers in an R&D lab of a Fortune 500 company to investigate how the extent and type of centrality shapes managers' perceptions of the success or failure of six technologically innovative projects. Managers asymmetrically discuss success more than failure, and the type of centrality they have influences how they talk about success. Interpretive flexibility in the meaning of success occurs among more central managers who have access to more information through their network ties. Not only do social ties affect information access, but also shape managers' perspectives on the outcomes of innovative projects.

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JEL classification: 032

Keywords: R&D projects; Network analysis; Innovation

1. Introduction

The study of innovation has by and large been the study of successful innovation. Failure tends to be hidden within organizations. Our focus is individuals' constructions of project success and failure within a Research and Development (R&D) context. This context is, in a sense, unusual in that gauging the success of innovation is more subjective than from a later vantage point when sales and margin figures are available. Without product sales figures, exactly what is meant by "success" is fraught with ambiguity. Thus, the social situation in which R&D personnel define the success and failure of their work lends itself more to sensemaking (Weick, 1995) and social construction processes rather than more

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straightforward calculation. Engineers make sense of the success or failure of their nascent products by constructing common narratives, not by conducting a routinized cost-benefit analysis (Bijker and Law, 1992).

We investigate the social network aspect of these narratives, examining how an individual's network position is related to his or her construction of project success and failure. The network ties that individuals maintain supply them not only with technical information vital to innovation, but also provide a cultural lens that shapes how they see their activities. The implications of our finding that network position shapes the social construction of innovative project success are twofold. For organizational theory, evidence outlining the social processes of project success would support the embeddedness perspective (Granovetter, 1985) according to which economic decisions are embedded in relationships rather than made by a hyper-rational "economic man" who weighs the costs and benefits of decisions independently of others. We seek to extend the embeddedness perspective to technologically innovative projects, where a dominant assumption is that technical aspects of decisions are emphasized over relationships. For technology management practice, our finding that network position shapes the assessment of project success would imply that project teams need to go beyond setting technical and financial goals and pay attention to how the social relationships between individual project members can affect the perceived outcome.

Our approach to studying the effects of network position on the perceptions of project success is inductive. The data are drawn from an R&D laboratory of a Fortune 500 multinational corporation. This company is dedicated to innovation in its product field, having established two new major R&D facilities in the last decade. We expected an individual's position in social networks to be related to how project success is constructed, and thus mapped the R&D lab's networks, finding a pattern of centrality for some individuals and not for others. Further, in coding qualitative interview data, we found differences among project leaders in how they talked about success. These narratives also show patterns—some project leaders discuss the big picture and social aspects of success, while others are more focused on technical success. We then matched our network data to the qualitative narratives used to construct success and failure of projects. In this paper, we analyze whether there are linkages between network positions and social construction processes in innovative projects.

2. Literature review

We are concerned with two key variables in technological innovation: the structure of network ties among R&D personnel and the project outcome as success or failure. To understand the connection between them, we review literature on the management of technological innovation, networks, and the social construction of technology. We conclude this section with our conceptualization of the linkage between network position and the social construction of project outcomes.

2.1. Managing innovation and the success of R&D projects

Innovation is a process by which individuals working in a particular organizational context generate and implement new ideas (Van de Ven, 1986). The success of innovation depends on

various factors related to the market, the technology, the environment, and the organization. The effects of these factors on innovation are not well understood, as studies often produce conflicting results (Balachandra and Friar, 1997; Damanpour, 1991; Kumar et al., 1996; Shenhar and Dvir, 1996). One plausible interpretation is that no single factor determines project success in all circumstances.

The inconsistent findings may be due in part to the lack of consensus on what success means. Innovation success is not merely difficult to attain, but also “multifaceted and difficult to measure” (Griffin and Page, 1996). For example, it has been defined as success in the market (Baker et al., 1986; Utterback, 1974; Griffin and Page, 1996; Ulrich and Eppinger, 1995; Freeman, 1982; Rothwell, 1985; Rothwell et al., 1974), the creation of new opportunities (Cooper and Kleinschmidt, 1987; Urban et al., 1986), technical advantage (Lipovetsky et al., 1997; Freeman and Beale, 1992; Pinto and Slevin, 1987) and customer satisfaction (Paolini and Glaser, 1997; Pinto and Slevin, 1988; Lipovetsky et al., 1997; Von Hippel, 1989). Pinto and Covin (1989) suggest three fundamental measures of project success: successful implementation, perceived value of the project, and customer satisfaction. Kumar et al. (1996) propose still other categories of project success: external, internal, marketing and product/process.

The definition of R&D project success is contextual (Olson et al., 1995), depends on the type of innovation (Green et al., 1995), and can be evaluated best by a combination of objective and subjective measures (Balachandra and Friar, 1997). A project’s success could depend on who measures it, by what criteria, when the measure is taken, and whether it is introduced to a new or existing market. This lack of clarity on how to define, and consequently measure, project success presents a concern to academics and practitioners as it creates space for different subjective interpretations. Therefore, a better understanding is needed of what project success means and how it can be best measured (Davis et al., 2001).

2.2. *Innovation and social networks*

Innovation has been the subject of numerous social network studies, however, many of them have been conducted at the level of interorganizational networks (e.g., Goes and Park, 1997; Powell et al., 1996). Studies that focus on intra-organizational social networks have found that central network positions and the ability to connect effectively to others in the organization provide access to knowledge and improve the ability to innovate (Hansen, 2002; Tsai, 2001; Ancona and Caldwell, 1992). However, this research at the business unit level does not capture the intensity and richness of interpersonal networks in which collaborative research takes place (Oliver and Liebeskind, 1998). Research at the level of the individual R&D project can produce useful understanding of what constitutes success or failure (Shenhar, 2001).

2.3. *The social construction of success*

Social construction is a sociological axiom—people seek to give meaning to the situations in which they find themselves (Berger and Luckmann, 1967). These constructions have implications for behavior. In organizations, the definition of a project as successful or not has implications for the distribution of resources such as budget and personnel. Science

and technology studies offer two useful concepts for investigating how innovation success and failure come to be perceived: symmetry and interpretive flexibility. Symmetry (Bloor, 1991) is the idea that both sides of a scientific dispute should be studied in the same way. For example, Martin (1991) approaches the controversy over whether fluoride should be added to public water supplies by investigating the psychological, economic, political, historical and social causes for why groups take either side of the debate. We apply the concept of symmetry to technological innovation: success and failure should be studied in the same way. For example, if one were to study the success of R&D projects only in terms of the technology working, and study failure only in terms of social conflict and organizational politics, the result would be unbalanced observation.

The literature on the social construction of technology provides useful leads on how and to whom definitions of successful innovation matters. One insight is interpretive flexibility—that technologies can mean different things to different people. Thus Bijker (1995) describes the history of the safety bicycle through the “interpretative flexibility” concept. In the 1880s, the bicycle with a chain drive on the rear wheel was viewed as: a market failure compared to the high-wheeled bicycles favored by risk-taking young men, a threat to blacksmiths’ horseshoeing livelihood, and as a source of moral degeneration through encouraging women to wear bloomers. This pattern of interpretive flexibility is most pronounced in the early stages of innovation, or prior to “closure” (Callon, 1980). By the 1900s, the bicycle had achieved closure—everyone interpreted the safety bicycle design as a success. Law and Callon (1992) report similar findings for the TSR.2 project—a British aircraft designed in the 1950s. Different actors (e.g., the Royal Air Force, Treasury, Labor party, Navy) brought different meanings to the project when defining its technical and budgetary goals. The aircraft became a working technology but the project was cancelled. Law and Callon (1992) argue that this resulted from members of the local project network failing to enroll key outsiders to their definition of success. In this case, the outcome was social construction of the project as a failure.

The questions of *how* interpretations reach closure and *who* has vested interests in finally defining the success or failure of an innovation are entangled. Vergragt’s (1988) case study of an R&D project at a chemical company points out this intersection. The lab he studied created a new synthesis of fatty acids with potential new applications, but in the course of the project, different definitions of what success meant coexisted. After a key researcher had left and no longer enrolled others to his perspective, other managers’ distaste for the low profile project, along with an organizational restructuring, resulted in the termination of the project. Thus, a project that could be called technologically successful reached closure as a failure, because it was socially constructed as such.

We take the perspective on social construction in organizations advocated by March and Olsen (1976) and Weick (1995). Under conditions of organizational ambiguity, sensemaking is likely to occur in a particularly strong form (Wagner and Gooding, 1997; Gioia and Thomas, 1996; Jelinek and Litterer, 1995; Harris, 1994). Early in the innovation process, R&D projects provide a context in which there is greater ambiguity about success and failure. This social situation provides a methodological advantage for studying the interpretive flexibility in how individuals make sense of project success.

The empirical literature on managers’ sensemaking of technological innovation tends to focus on their strategic perceptions of the organizational environment. The type of

technology (Griffith, 1999), innovativeness of the organization (Dougherty et al., 2000; Hill and Levenhagen, 1995), or empathy of managers (Wright et al., 2000) can affect managers' sensemaking and thus their strategies. We take a different approach: rather than focus on how technology managers interpret their organizational situation, we look at how their social network positions affect their sensemaking of a technical project as successful or unsuccessful. Investigating the structural context of sensemaking can provide important clues to how project managers come to understand what is innovative in their organization.

2.4. *Conceptual model*

The social construction of technology (and to some extent the sensemaking) literature concerns itself with the process—the “how”—by which technology comes to have meaning to relevant social groups. Lacking in this literature on subjective experiences of technology, however, is attention to social structure. Klein and Kleinman (2002, p. 34) note that in research such as Bijker's (1995) study of bicycle innovation, “we lack an explanation for why some groups' meanings had greater relevance than others.” They call for studies that combine a concern with social actors' structural positions as well as their processes of meaning formation, but conclude that “the empirical research. . . remains to be performed” (Klein and Kleinman, 2002, p. 47). In the sensemaking literature, Dougherty et al. (2000, p. 342) also note room for further study of the effect that structure has on meanings given to innovation in organizations. The problem with not taking structural positions into account is that research then implicitly assumes all actors are equal in the meaning construction process. We disagree with this assumption, and rely on the social network and management of technology literature, reviewed above, to better conceptualize how access to information influences social construction.

Since its origins in contingency theory (e.g., Burns and Stalker, 1961; Thompson, 1967), the management of technological innovation literature has examined various structural aspects of organizations and the way these influence innovativeness. Yet the qualitative process of how technology comes to be understood by R&D managers is largely missing from this literature (Brown and Eisenhardt, 1995; Bijker et al., 1994). The problem with paying little attention to process is that by glossing over important but messy details, accuracy about the innovation process in organizations is compromised. We take Barley's (1998) advice to “complicate the simple” by examining the nuances in how managers define the “success” of their R&D projects. By a close examination of the narratives that project managers weave around success and failure (rather than, say, having them check a survey box to indicate whether a project was successful or not), we can look for patterns in definitions to see how flexible interpretations are.

In our conceptual model, we combine an investigation of the process by which technological projects are given meaning with the study of the positions sensemaking managers hold in a network structure. Based on our readings of the social construction and network literatures, we expected to find that a manager's central position in the organization's social networks would affect the information to which he or she had access. Depending on the contacts to whom a manager talked in the different social networks, his or her narratives of what happened in projects would vary. By making sense of a project throughout its

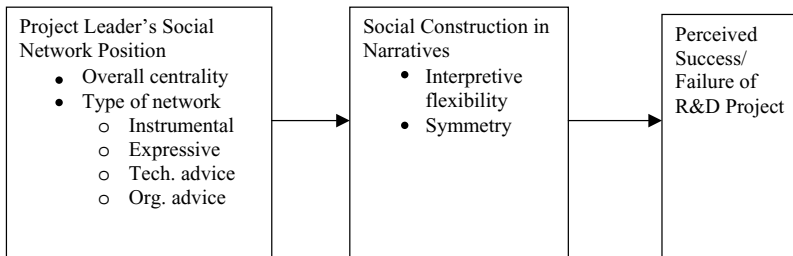


Fig. 1. Conceptual model.

development jointly with his or her network contacts, a manager comes to define a project's "success" or "failure."

Fig. 1 portrays what we expected to find in analyzing the qualitative interviews. For example, if a manager were central in a technical advice network, we would expect her idea of project success to revolve around technical matters. This kind of simple pattern in interpretation formed our basic expectations from which we built this study—that interpretive flexibility would be based on network positions. Different types of discussion networks would mean different definitions of success. Further, we expected symmetrical perspectives on success and failure. If a key player in the technical discussion network saw a project's success in the light of technical details, then that person would view project failure the same way. In summary, whether projects would be defined as successes or failures would be a function of managers' roles in the organization's social networks. At the same time, the effect of the social networks would not be direct, but rather mediated by a social construction process. We want to stress that we offer Fig. 1 not as a mechanistically determined model, but as a heuristic device to summarize our thinking about the connections between concepts. While our approach to the research question is qualitative, our analysis more closely resembles narrative analysis of themes than grounded theory (Stoddart, 1986). As will become apparent in the discussion of the findings, the narratives were rather more complex than a simple model can illustrate. For example, interpretive flexibility emerged in narratives in different ways—some discussions had depth in being used by most respondents but were narrowly talked about, in contrast to other narratives that were both deeply used and more broadly interpreted. Overall, the basic relationship portrayed in Fig. 1—a connection between network position and project success narratives—proved worthy of investigation.

3. Methods

3.1. Study setting

To explore the relationship between an individual's network position and his or her construction of project success, we collected data in an R&D laboratory of a Fortune 500 company, "Global East." Global East has been a world leader in its core business for the past 50 years and has over 100,000 employees in facilities in nearly 30 countries. The company

has a couple dozen R&D facilities worldwide which employ more than 2000 researchers. We studied six projects in the lab that serves the company's largest and most profitable business division. The facility employs about fifty scientists, engineers, technicians, student trainees, and management personnel, 10% of whom are women. The average age in the laboratory is 43. About 60% of the personnel hold an advanced degree.

The lab is headed by a director and consists of three major groups, each led by a group manager. The lab director assigns individuals to projects based on their expertise and as needs arise. A person may work on several projects at the same time. All lab members are directly involved in projects, regardless of position. Moreover, one's position within the formal structure does not determine one's role on a project. A group manager might lead one project and be a member of another project led by a subordinate. The atmosphere within the laboratory is rather informal.

We selected six projects, each of which met the following criteria: (1) employed at least five project members; (2) had either been completed within the past 2.5 years or was scheduled to be completed; (3) was initially estimated to last one year; and (4) represented either a successful or unsuccessful outcome. The lab director provided his evaluation of each of the six projects as either a "high success" or "low success." His assessment was based on whether or not, in his opinion, expectations had been met on: (1) potential financial returns, (2) satisfying the technical parameters, and (3) staying within budget constraints.¹ The six projects, which we have named *Alpha*, *Beta*, *Gamma*, *Delta*, *Epsilon*, and *Zeta*, are described in [Appendix A](#).

Over the span of eleven months, this lab was the site of extensive field study. We were sensitive to the fact that long-run personal interaction is essential for assuring the validity of field research ([Kirk and Miller, 1986](#)). During the field study, we conducted open-ended interviews with 42 people in the lab, including the director and project managers. Every staff member who was employed full time in the lab was interviewed. Tape-recorded interviews took place at the lab. In addition to exploring the topic of project success and failure, interview questions covered the projects' histories, time frame, leadership, and linkages to other parts of the company.

In two sessions, we interviewed the laboratory director about all six projects. The project managers were asked to discuss only the projects on which they participated as managers. As some of the projects have two managers, we collected a total of 10 project interviews. The interviews lasted 90 minutes on average. Tape recordings of the interviews were independently transcribed. To ensure consistency, each author thoroughly checked and re-checked the transcripts.

3.2. *Measuring the social networks*

We asked each of the respondents in the lab questions about his or her interactions with co-workers. We used the lab as the boundary of the network, consistent with both the

¹ In accordance with our focus on symmetry, we did not assume that just because the lab director saw projects as either "high" or "low" successes that the engineers' narratives necessarily would be all about success. There are always both positive and negative aspects of even the most wildly successful and abysmally failing projects. We wanted to know how R&D workers' perceptions of success and failure would be affected by their network positions.

realist and nominalist approaches of boundary delineation (Laumann et al., 1983). Research subjects indicated that this organizational unit is the most pertinent for their activities, and we were interested in the lab as the locale of innovation in the company.

As social networks are multiplex and operate on different levels depending on the type of relations individuals maintain (Burt, 1983; Tichy et al., 1979), we examined four different networks: instrumental, expressive, technical advice, and organizational advice. Instrumental ties refer to relations between individual actors that concern their work and include the transfer of physical, informational, or financial resources (Ibarra, 1993b; Tichy et al., 1979). We requested respondents to identify the co-workers in the lab with whom they “primarily talked about problems that arose in the course of the project.” Expressive ties include friendship and social support—attitudes and behaviors that are not prescribed by the requirements of work and indicate the presence of a social rather than work basis for a relationship (Ibarra, 1993b; Mehra et al., 2001). We asked respondents to name the people from this organization with whom they “felt comfortable discussing what is going on in the organization in general.” Following Sparrowe et al. (2001), this question was followed by verbal instructions to consider people with whom the respondent goes out for a drink after work or spends time with on weekends.

While most previous studies examine single advice networks of the contacts to whom members go for advice (Ibarra and Andrews, 1993; Salk and Brannen, 2000), respondents indicated in our preliminary interviews that advice on technical matters was different from advice on organizational matters. Thus, as suggested by Rizova (2002), we constructed two separate advice networks: technical and organizational. To measure the technical advice network, we asked respondents to whom they would go to, if they “need someone with technical competence and skills.” To measure the organizational advice network, we asked respondents whom they would contact if they “need someone with organizational competence and skills.”

3.3. Analyzing the qualitative interviews

After the qualitative data were gathered, we noticed that the project managers spoke at much greater length and presented much more interesting (and sometimes contradictory) information around the question of whether a project was successful than we expected. Thus the research question arose: is there a connection between the network data and how project managers talk about success? This inductive question led us to look systematically at discussions of success through qualitative coding. First we made broad, open categories, putting together interview text from transcripts that dealt with project outcomes, which we then separated into discussions of success and failure. We next began refining these broad groupings into more focused categories (Strauss and Corbin, 1990; Lincoln and Guba, 1985). Three coders separately found the same patterns of discussion about project success and failure, which we call narratives. Narratives are “how respondents in interviews impose order on the flow of experience to make sense of events and actions in their lives” (Riessman, 1993, p. 2). The narratives we analyze in this paper are respondents’ explanations of the meaning of project outcomes. To avoid biasing the results, the coding was conducted blindly; that is, coders did not know which manager was saying what. Our methodological innovation in this project was to link

the qualitative analysis of narratives to quantitative network data. After we had allowed the narratives to emerge from the data, we then matched managers' network positions to their accounts. The findings from this matching process are presented in the results section.

4. Results

4.1. The Networks

Based on the network questions, we compiled the instrumental, expressive, technical advice, and organizational advice networks. The networks are presented as directed graphs in Figs. 2–5, drawn in Krackplot 3.1 software (Krackhardt et al., 1994). On each of the network sociograms, we classified the 42 researchers who worked in the lab in nine categories. First, the seven project leaders are in the center and are listed with pseudonymous names. Most of them worked on multiple projects. Fred led or co-led projects Alpha, Gamma and Delta, and also worked also on Epsilon. Tonya co-led Beta and worked on Epsilon, Nick co-led Gamma and Delta, and Olga co-led Beta and worked on Zeta. Tom was the lab director and also co-led Zeta. The other two leaders, Natalie and Ted, worked only on the projects they led, Epsilon and Zeta, respectively. The second group of network actors consists of

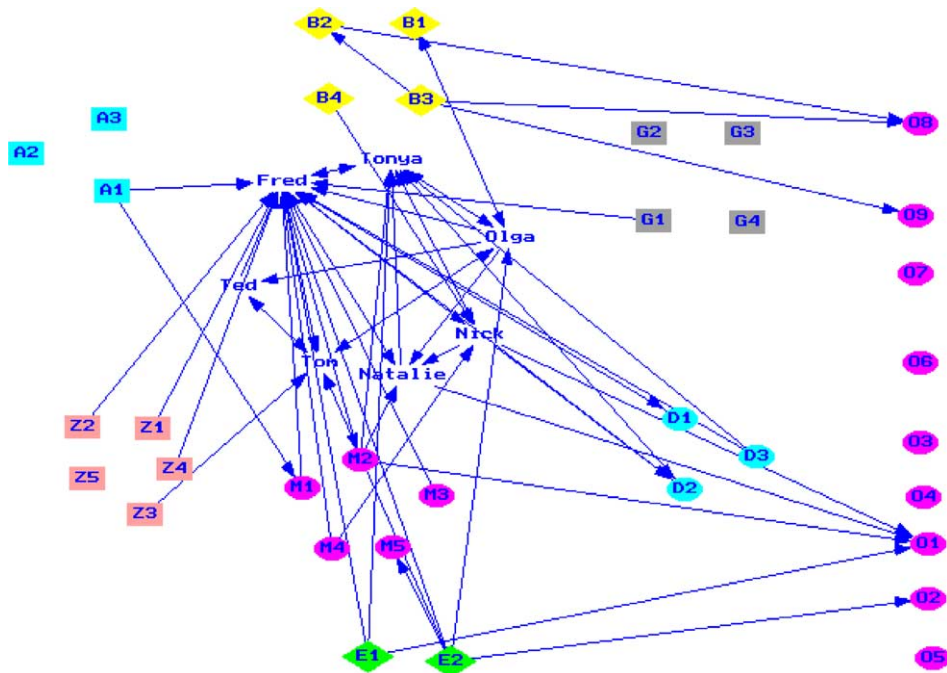


Fig. 2. Instrumental network.

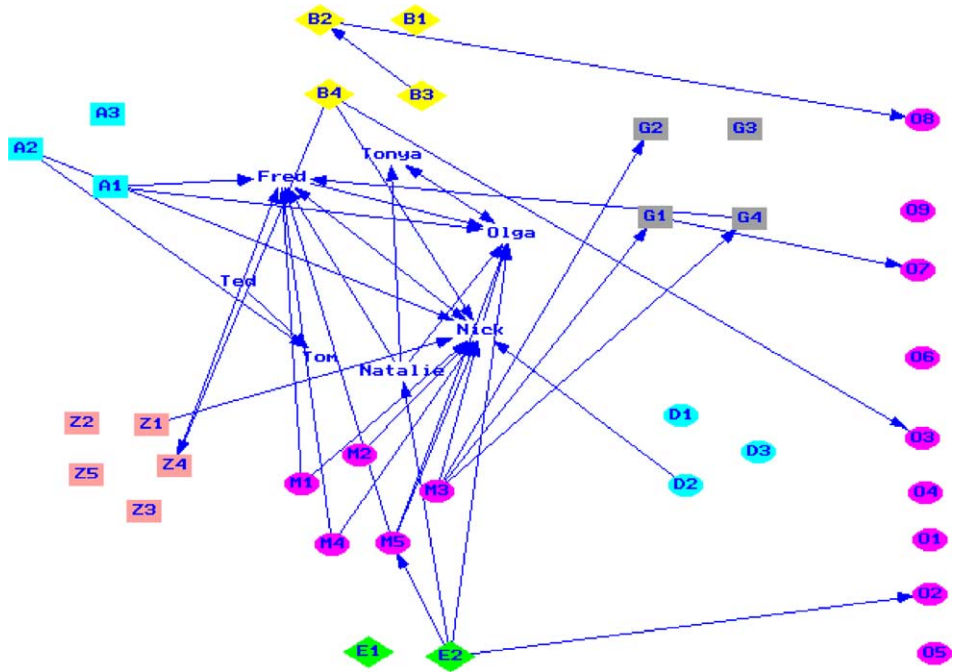


Fig. 3. Expressive network.

five people who worked on multiple projects. They are presented right below the project leaders as M1–5. Researchers who worked exclusively on one of the six projects are shown with a letter for the respective project and an identifying number, e.g., A1, B2, or Z5. The last group pictured in the network figures consists of nine people who worked in the lab but were not assigned to a project. These are presented on the right-hand side of the sociograms as O1–9.

Using UCINET 5.1 software (Borgatti et al., 1999) and following Brass and Burkhardt (1993), Hansen (2002), Salk and Brannen (2000), we computed indegree centrality (Freeman, 1979) for all 42 people in each of the four networks. Indegree is a simple yet powerful measure that captures a node’s position in the network by summing up how many times that node has been cited by alters.² Indegree centrality is an indicator of social status (Wasserman and Faust, 1994), and thus appropriate for our analysis of interpretations made by influential individuals.

Descriptive statistics for these measures are presented in the top part of Table 1. As the central concern of this paper is the interpretations of project success and failure, we focused on the structural positions of the project leaders—key individuals in the network who are

² We also considered other measures of centrality such as (symmetrical) degree, betweenness, closeness, and eigenvector centrality (Bonacich, 1987; Freeman, 1979) but chose indegree for parsimony. The description of the structural position of project leaders does not change if alternative measures are used.

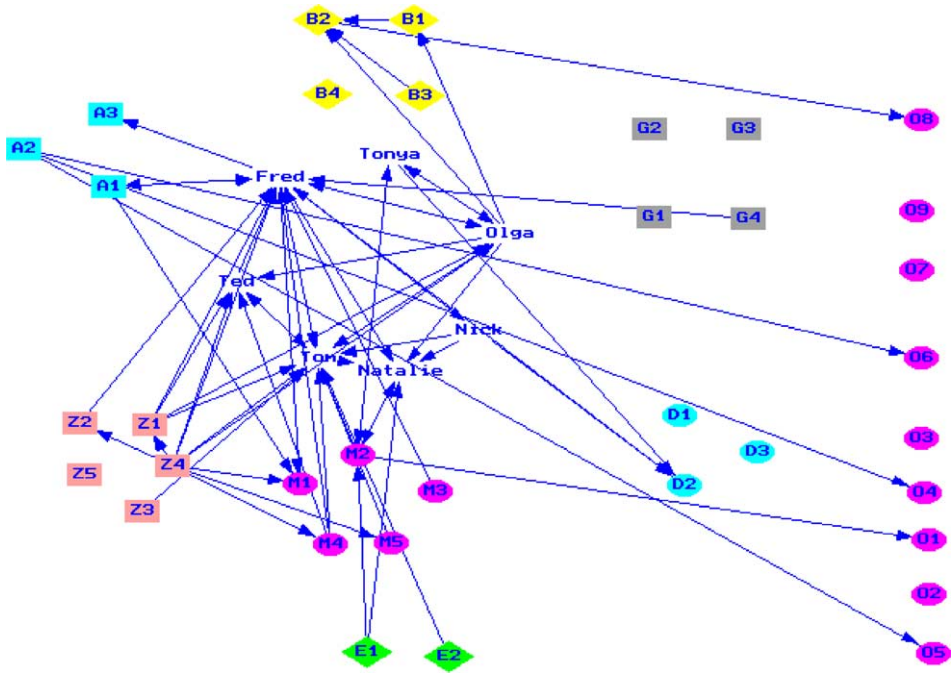


Fig. 4. Technical advice network.

in a position to evaluate the performance of projects. The lower part of Table 1 reports the descriptive statistics for the indegree centralities of the seven project leaders. The mean centrality for the seven leaders is well above the mean centrality for the whole lab; more precisely, it is between 1.53 and 1.65 standard deviations above the mean, or between the

Table 1
Network centrality: project leaders and other lab employees

	Descriptive statistics	Instrumental network	Expressive network	Technical advice network	Organizational advice network
Whole network ($N = 42$)	Mean	1.45	0.95	1.55	0.88
	S.D.	3.04	2.17	2.62	2.38
	Min	0	0	0	0
	Max	17	10	11	11
Project Leaders ($N = 7$)	Mean	6.29	4.29	5.86	4.57
	S.D.	5.06	3.95	3.93	4.35
	Min	2	0	1	0
	Max	17	10	11	11
Z score ($\text{mean}_{WN} - \text{mean}_{PL}$)		1.59	1.53	1.65	1.55
t -Value, one tailed test (PL vs. others)		6.56***	6.09***	7.08***	6.23***

*** $P < 0.001$.

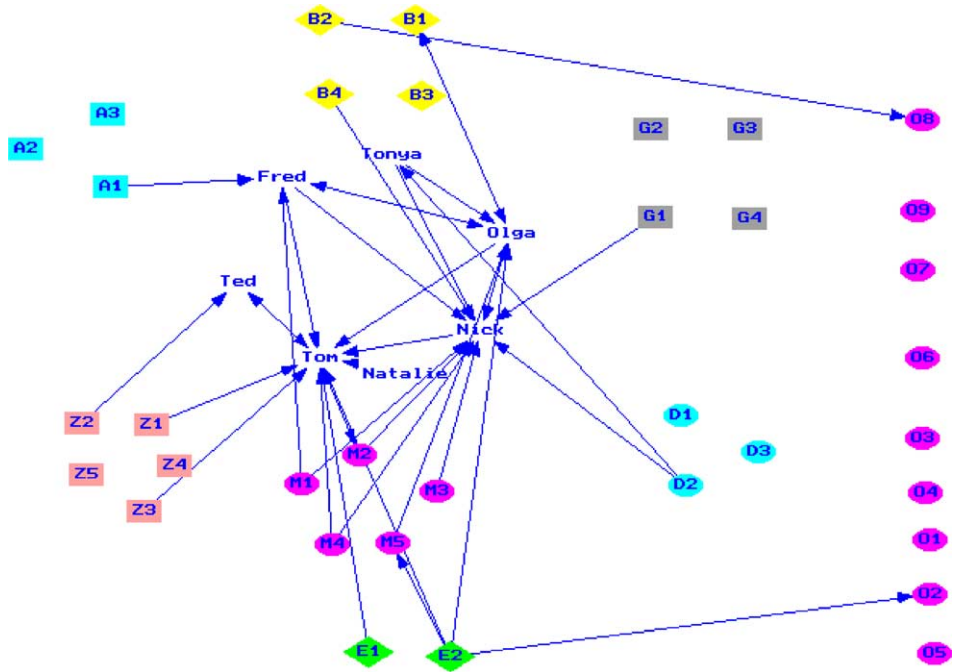


Fig. 5. Organizational advice network.

87th and 90th percentile, demonstrating the highly central position leaders have in the lab’s social network in general. *T*-tests demonstrate that the project leaders have significantly higher centrality than their coworkers in all four networks. Still, there is variance among the leaders’ centralities in the different networks. While the most central people in the network are always some of the project leaders, not all project leaders are central in all networks. In fact, a couple of project leaders have centrality of 0 in individual networks (Natalie in the organizational advice network and Ted in the expressive network). In Table 2, we classify the project leader’s central positions in the networks as high, medium (i.e., about the mean for the project leaders’ group), or low (i.e., below the leaders’ group mean). Following Ibarra (1993a), we present an aggregate measure of project leaders’ position across networks at the bottom of Table 2. The centralities of the project leaders in the four networks are visually presented in Fig. 6.

4.2. Narratives on success and failure

In presenting the results of our analyses, we describe the patterns that emerged from the open-ended interview questions about project outcomes and connect these narratives about success and failure with the network centrality of the project managers who construct them. In all conversations, project managers did not separate the causes of success from successful outcomes. No one spoke in clear linear terms about “X must be done first, then

Table 2
Project leaders' network positions

	Tom	Nick	Fred	Tonya	Olga	Natalie	Ted
Instrumental network centrality	Medium (5)	Low-medium (4)	High (17)	High (8)	Low-medium (4)	Low-medium (4)	Low (2)
Expressive network centrality	Low (2)	High (10)	High (8)	Low (2)	High (7)	Low (1)	Low (0)
Technical advice network centrality	High (11)	Low (1)	High (11)	Low (2)	Medium (5)	Medium (6)	Medium (5)
Organizational advice network centrality	High (11)	High (11)	Low (3)	Low (1)	Medium (5)	Low (0)	Low (2)
Total centrality	High (29)	High (26)	High (39)	Low (13)	Medium (21)	Low (11)	Low (9)

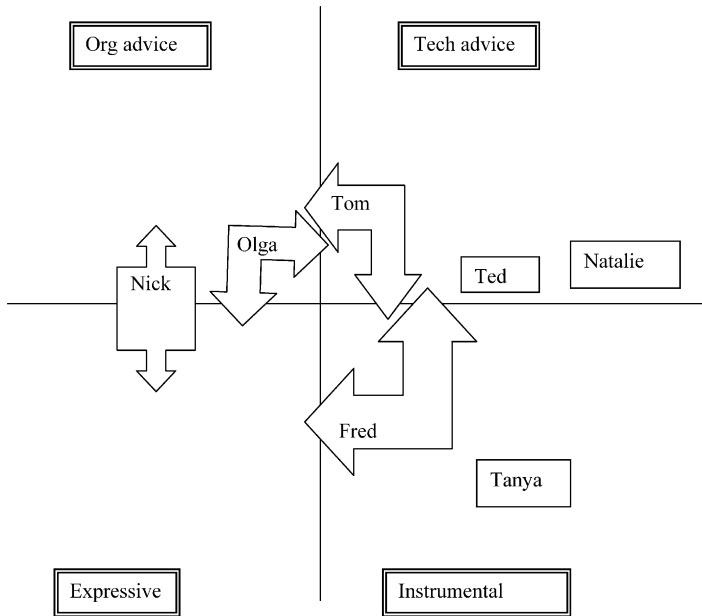


Fig. 6. Four types of centrality held by project managers. Note that individuals must have medium or high centrality to be listed as having that type of centrality. Also note that this figure is not using *x-y*-axis quadrants, but rather is meant to show where there are overlapping domains of centrality for the different actors.

Y must follow in order to create successful outcome Z.” Instead, the means and ends of success and failure were intertwined in these narratives.

Six patterns³ in the social construction of project success and failure emerged from the qualitative data: (1) general reflections on the “big picture” of project success, (2) social and cultural criteria such as reputation, (3) organizational factors including support from upper level management, (4) market concerns, (5) efficiencies, i.e., in time and costs, and (6) technological success.

4.3. Matching network centrality and the social construction of success

To connect the narratives about project success to their speaker’s network position, we first consider the extent of project manager’s total centrality (low to high) in the R&D lab networks. Then we turn to their centrality in the four distinct social networks: (1) instrumental, (2) expressive, (3) technical advice, and (4) organizational advice, and describe how centrality in these networks shapes managers’ narratives. Finally, we assess the evidence in light of the key concepts of symmetry and interpretive flexibility.

³ Although by coincidence six narratives emerged from the data and six projects met the criteria for study, there is no direct relationship between the narratives and the projects. Common narrative themes run through all projects.

4.3.1. Extent of centrality

From Table 1, we can see that project managers have greater average centrality than others in the R&D lab. There is variation among project managers, however. The most central individuals, shown in Table 2, are Tom, Nick, Fred and Olga. There is a direct relationship between centrality and the amount of talking respondents do on the subject of project success and failure. Tom has the most to say, next Fred, then Nick and Olga. The less central managers—Tonya, Natalie and Ted—have much less to say. Both the length of commentary and the diversity of narratives used to socially construct the success of projects are greater for those who are more central. Tom, one of the most central individuals overall, is the only respondent who employed all six narratives to talk about project success. This trend supports the idea from the networks and information literature that central individuals have access to more information (Useem, 1984; Burt, 2000). Project managers also provide bridges between the less connected, unnamed project members (see Figs. 2–5), thus they have access to more useful, non-redundant information. We turn now to which of the six narratives are employed by people holding different kinds of centrality.

4.3.2. Types of centrality

We organize our discussion of the connection between the type of network centrality and the emergent narratives by the content of the narratives. This presentation facilitates comparison of the amount of interpretive flexibility and symmetry within these accounts in the analysis that follows.

4.3.2.1. Narrative 1: general reflections on success and failure. The sole project leader who discussed the “big picture” of project success and failure—Tom—occupied a formal organizational position as lab director that required him to coordinate all of the projects. He argued, “Success cannot be evaluated by a single criterion. It varies from project to project.” No other respondent made a general statement about all R&D projects, instead they restricted their comments to the success and failure of projects in their own experience. In describing “low success,” Tom rhetorically embraced the “learning opportunity” provided by projects that were, in his terms, not “extreme successes.” Tom’s greater access to organizational information affords him this broader perspective on success. Beyond Tom’s formal authority, his centrality in instrumental, organizational and technical advice networks (Table 1 and Fig. 6) is also a source of power and information. His centrality in the expressive network, however, is low: people in the lab go to Tom for organizational and technical advice and to solve problems, rather than because they feel comfortable doing so. Still, his formal authority is perhaps the major reason why his construction of project success includes the big picture.

But were his general reflections on project outcomes symmetrical? Tom generally defined failure as projects that did not survive: “We had projects that never saw the light. When we stopped working on them we did not have a solution, so in this regard they were failures.” These two sentences were nearly all he had to say on failure. While Tom discusses both success and failure in this general narrative, he spent much more time expanding on the variety of successes than on failures—an asymmetry that continued throughout the other narratives.

4.3.2.2. Narrative 2: social and cultural criteria for success. The only project managers who include social criteria in describing successful and unsuccessful projects are those highly central in more than one kind of network (see Fig. 6). Nick, Olga, Tom and Fred garner more social capital through their network positions, and correspondingly can see the social elements of innovation. The kind of network centrality a project manager has also shapes how he or she views social criteria. Fred explains the lack of success of Project *Delta* as due to cultural differences:

There was a lot of concern about the quality of the machine, because it was being made in [a developing country]—whether it would be pieced together with rubber bands and paper clips, or whether it would be a really quality machine. Generally machine equipment that comes from that part of the world is not very good.

The technical failure is due to social problems, in this interpretation. Fred's perspective from his central position in technical advice, instrumental, and expressive networks is that social organization is something that explains failure, not success. If Fred had also been the lab's nexus for advice on organizational issues, he may have been more likely to see the social elements of success as well.

Those who have organizational advice centrality seem to have more appreciation for the social factors that lead to project success. For example, Tom describes the importance not only of human capital on R&D projects, but also of social capital:

People like Fred are respected quite a bit. These people [in a business unit of the company] come to him and that makes this place more successful. This way they utilize us. Success here depends on how much the engineer or the chief scientist makes himself indispensable to the needs of this group [the business unit], his expert power. And then, people talk about it.

Tom points out that the opportunity for success is provided through the social recognition of expertise. Similarly, Olga's comments illustrate how reputation is a criterion that spans the organization and the market:

A goal was to give the company more of an engineering, technical image and bring it up in technological prestige. [The divisional VPs] were ready to back us no matter what because they wanted something new, different, something that is a showcase where they can bring customers, that is a high-tech product, has a high-tech image and has a high-tech manufacturing facility.

Discussions about the social aspects of success are not easily categorized into either organizational or market concerns alone, in fact, these concerns constitute two of the other narratives.

4.3.2.3. Narrative 3: organizational criteria for success. The four most central individuals in the lab—Tom, Olga, Fred and Nick—in addition to discoursing on the social elements of projects also talk about ways the larger company contributes to the success or failure of projects. Among the less central managers, only Ted mentions organizational success. Ted describes Tom's role in garnering organizational success for his project: "Tom got the VPs interested in what we do and this way we got a lot of support for developing the program."

Organizational success for R&D projects also means being able to solve problems for other groups in the company, as Nick's comments illustrate: "We designed and built a machine that can be used to generate data on other projects as well. This is extremely important for the manufacturing people. Now they can make changes in the process." Mostly though, organizational success means enrolling the upper level management in your interpretation of the project. Tom assesses the success of a project by "the number of VPs interested in it." Olga described the outcome of having the attention of the divisional VPs fixed on her project: "This is very good for the [R&D] facility. This is how we get high profile projects and not just scut work." Having the criteria for organizational success—VP attention—leads to further organizational success—better project assignments. Budget is another indicator of organizational success. As Tom puts it, "Success is also political, not just technical. You understand what I am saying. On this project for instance, we started with a very small budget. Now, because of the corporate commitment to it, we got a budget ten times higher than [5 years ago]."

Fred's infectious excitement about a machine resulted in management support, though notice the technical bent even in his discussion of organizational criteria for success. He reports, "To have it in here and running, everyone was fascinated with it—including management, including Tom. So they thought it was quite an accomplishment to build a machine from scratch." Nick, who is more central in the organizational advice network than Fred, has a greater variety of ways of talking about success as due to organizational factors. The teamwork between Nick and Fred, for instance, Nick counts as a factor in success:

We understand one another and we save a lot of time going back and forth. [Fred] tells me what the technical issue is and I find the person with the right skills and I make sure this person is not going crazy working on 10 other projects. In other words, I made sure that Fred got [the person's] mind and his hands 100%.

Having specialized skills and matching specialists to jobs is another one of the organizational criteria for successful projects.

Organizational explanations are also given for failed projects. Tom defines cancelled projects as failures:

Several years ago the company's senior management changed. New people were brought in; new criteria for success were established. We had a project that made perfect sense under the previous management strategy, but did not under the new strategy and that is why it did not come to fruition. There was no longer a clearly identifiable business unit that was pulling for it, championing it.

In this narrative, project failure has little to do with technology or market, and everything to do with organizational politics. While top management's reactions to projects were deemed a cause of failure as well as success, the overwhelming focus of conversation was on gaining support from executives.

4.3.2.4. Narrative 4: market criteria for success. The same project managers who construct organizational narratives also talk about market criteria. The market narrative is interesting in that project managers devote a large volume of commentary to it, but really only talk about the market in two ways—in terms of sales and customer satisfaction. Thus, this

narrative is deep, but narrow (i.e., in contrast to the organizational narrative which includes a wide range of interpretations). Listen to the respondents on the topic of commercial sales. Fred, “The market has recognized [the product]. It had a huge effect on sales and profits. I would say we probably have 90% of that market.” Olga, “A success is to be able to go out to the field in a targeted way, succeed and grow the sales as rapidly as [possible].” Tom, “The criteria for success were met, yes, they were commercially successful.” Interpretive flexibility is reduced when talking about quantifiable sales.

Customer satisfaction is somewhat more open to interpretation, but still linked to market outcomes. Fred views a less successful project as lacking customer satisfaction: “On this project there was concern how much effort will be required to satisfy the customer. I think that it met technical expectations. Financially [meeting expectations], that is to be seen.” Tom relates, “Our customers are not just looking for lots of data but for analytical support and conclusions. Your effectiveness is judged based on how much they ask for your product and the services you provide.” Ted echoes, “Your performance depends on the acceptance of what you have to offer.”

In both this narrative and the one discussed above, Ted is the outlier. He brings up the ideas of market and organizational success but has lower total network centrality and only medium technical advice centrality. Ted’s somewhat sycophantic relationship with Tom perhaps influenced his statements. In his interview, Ted was very brief in his remarks and was the only project manager apprehensive about being tape-recorded. He seemed to be concerned with what Tom would find out about his opinions on projects, despite assurances of confidentiality by the researcher. In rating Tom, Ted gave only the highest marks. Thus, we infer that Ted’s responses were (very abbreviated) paraphrases of what he had heard Tom stress about project success. In this mimesis, Ted includes organizational and market narratives to define project success.

4.3.2.5. Narrative 5: efficiency criteria for success. All project managers except Ted referred to efficiency as a criterion in project success. Most commonly, projects were seen as successful if they saved on costs and time, and failing if they did not. Additionally, machines were viewed as more efficient if they were smaller in size or if they allowed customers to employ fewer skilled workers. Natalie considered her project successful in efficiencies of product size: “Size was important. We had to make the unit smaller because it needs to be transportable.” Being able to complete a project with fewer members was also described as a success.

4.3.2.6. Narrative 6: technological criteria for success. Every respondent cited technological reasons for successful projects. These project leaders, however, did not view technical success in exactly the same way. Within the narrative there was interpretive flexibility. Natalie, who had medium centrality in the technical advice network and little centrality in the other networks, discussed technological success differently from Nick, who was central in organizational advice and expressive networks but not technical advice. Natalie describes technological success as meeting stated goals: “The project had two purposes, to analyze data in the lab, and to be able to take the equipment in the field and run tests in the field—to analyze processes and products. We are successful on both.” Nick views real technological success, in contrast, as going beyond stated goals: “It was a huge success because we were

able not only to achieve our technical goals, but beyond. We can do other testing procedures with the machine now. They were up and above the scope of the machine.” Nick does not cite meeting goals in talking about technological success. He links technological failure with the organization: “It was very difficult because we had something that we did not design. We had to re-build it and make it work.” Technology that is not designed in-house is more likely to fail, in Nick’s opinion. He frames technological failure in organizational terms, not surprisingly given his network position. This comparison between Natalie and Nick demonstrates a broader pattern across all the respondents: the kind of centrality a person had shaped the direction of their interpretation of success. Even within a narrative that might seem to be more straightforward on the surface, Nick talked about technological success more organizationally from his central position in the organizational advice network while Natalie talked about technological success more narrowly from her position of more limited technical advice contacts.

Fred discusses a less successful project by constructing the consistency of the technology as meaningful:

Personally, I think part of the success is also the satisfaction of seeing an in-house test duplicate what the customer believed was the performance of a product on his real machine; that duplicated the field test results in the customer’s eyes. Technically, I would have been happier if we had done a greater amount of testing to evaluate that the process repeats better, that the products we tested were consistent.

The ability to replicate results, not just whether the technology works or not, is another part of the technological narrative. The interpretive flexibility in how these project managers speak about technological success demonstrates there is room for social construction in a seemingly straightforward question of whether a new technology “works” or not.

4.4. Symmetry

We analyzed the above six narratives to see whether the discussions of successful and unsuccessful aspects of R&D projects were symmetrical. We found that all six narratives were used to talk about success and failure, but that the discussions had clear asymmetries. Perhaps not surprisingly, people volunteered more information in talking about success than failure, though they were asked the same interview questions for each project. For instance, out of 301 pages of transcript on project outcomes, 242 record discussions devoted to success and only 59 to failure. Within each of the six broader narratives, there was a greater range of discussion on successful projects. For example, in talking about success using social criteria, respondents described the importance of the projects’ “prestige,” “reputation,” “visibility,” and cross-cultural applicability. On the other hand, in discussions of failure employing the social/cultural narrative only one idea arose: that locating the project in a developing country led to an unsuccessful outcome.

Another asymmetry in discussions of success and failure was evident in the intensity of emotion respondents demonstrated. For the project they saw as the most successful, slight changes in tone of voice and facial expression showed the pride and happiness individuals felt in discussing Project Beta. In contrast, one respondent became visibly upset discussing the project he saw as the most unsuccessful: “Should have thrown it away the day we got

it!” The respondent ended his remarks on the project with a loud exasperated sigh. He then folded his arms forcefully across his chest, scowled, and in an agitated tone remarked, “Never mind.” After a pause, he exclaimed, “Next project!” to indicate he wanted the interview to move on to other topics. No one showed as strong an emotion in discussing success.

The asymmetry we found in narratives of project success and failure had four emergent dimensions: (1) the variety of the six different narratives used to discuss success tended to be greater than to discuss failure; (2) the total amount of information on success was much greater than on failure; (3) within each of the six narratives, project managers’ discussion of success was much broader ranging than of failure; and (4) the negative emotions toward failure were displayed more prominently than were positive feelings about success.

4.5. Interpretive flexibility

The concept of interpretive flexibility, that project success and failure mean different things to different people, was supported in two ways here. Project leaders’ interpretations of project success differed both within the common narratives we identified, and in their definitions of particular projects as more or less successful. Within the narrative of technological success, for example, some respondents focused on meeting stated goals, some on exceeding technical goals, and some on being able to meet technical goals consistently. The most widely varying accounts of success and failure occurred in descriptions of organizational criteria and technological criteria. We saw the least amount of interpretive flexibility in efficiency and market narratives.

Interpretive flexibility in defining the success or failure of a particular project appeared most clearly in Project Delta, the project that was initiated in a developing country and then brought to the R&D lab that we studied. Tom, the lab director defined the project as a success, though not a “high success.” Nick and Fred, who were clearly told that this was a “low success” in Tom’s book rather than a failure, seemed to have a different interpretation than Tom. Tom’s view of Delta’s success:

What came out of it was a range of capacities for product development for a range of products. Along with this, now [the developing country] has a capability for testing [the product], which they would not have had without participating in this project. Essentially what we are trying to do is leverage the capability of not only site-specific development, but integrate it, leverage it to develop other sites.

Tom’s optimism on the project outcome was not shared by Nick, who was upset by the priority given to this project:

It took a lot of time, it tied up a lot of resources. I had to assign people to deal with all the technical problems. Their expertise could have been used on other projects. It took a long time to get this machine to demonstrate what it could do, and I think people just kind of gave up on it. Yes, it was a very [draws out word] long and arduous process.

If Nick’s emphasis was the waste of time and people, Fred’s was the waste of money on this “low success” project:

Financially, it was a lot of money for this machine. I mean there was a budget for this machine—there was an estimated budget, which was exceeded because of the manufacturer in [the developing country]. And that is why it was re-built here, because it was thought to be able to be built for a certain price. Now, because it required that we do some redesign in [the developing country], it exceeded that price by some amount, maybe by twenty percent. And then when it got here, it needed to be rebuilt, it probably exceeded it by another hundred percent.

Fred also uses the social/cultural narrative to account for Delta's lack of success, in pointing to why cost overruns were so high. Because Tom is the lab director, however, his greater access to budgetary resources and information flow to upper management meant that his interpretation was given greater weight. Although they described it as such, neither Nick nor Fred used the word "failure" to define this project. The laboratory director had clearly told everyone involved, including the interviewer, that this was a successful, albeit less successful, project.

4.6. Patterns in network centrality, narrative symmetry and interpretive flexibility

To summarize the main findings across the six narratives in terms of our conceptual model, we compare the symmetry and interpretive flexibility in the discourse of the most central project manager (Fred) and the least central (Ted) in [Table 3](#). Project managers with less centrality, like Ted, talked less symmetrically about success and failure, and less flexibly within the fewer narratives they used. As [Table 3](#) shows, Fred used four narratives to discuss success and five to discuss failure; Ted employed three narratives to talk about success, but refused to discuss failure. Within discussions of technological success, Fred has a much more nuanced interpretation than Ted, as the quotes in [Table 3](#) illustrate.

The type of network centrality shapes the direction of R&D managers' interpretations of success and failure of projects as well. Tom, for example, is highly central in the organizational advice network and has a broad ranging discussion of success using all six narratives, but asymmetrically spends much less time talking about failure. Fred, who is very central except in the organizational advice network, is more symmetrical in his remarks, but does not talk about the big picture. Additionally, Fred only refers to socio-cultural criteria when discussing failure. His central position in networks that are technical, instrumental, or friendship based means that he sees both success and failure of lab technology but misses out on the broader social organizational picture.

5. Discussion

5.1. Caveats

We begin our discussion of the implications of the findings by acknowledging the caveats of this study. In particular, we note four limitations of this research. First, we cannot impute causality because our data are comprised of interviews and measures of networks at one time point. For example, we cannot rule out the possibility that idiosyncratic aspects of

Table 3
Comparing two project managers on their symmetry across narratives and interpretive flexibility within the technological narrative

	Social networks in which the respondent is central	Narratives the respondent used to explain “high success”	Narratives the respondent used to explain “low success” or failure	Interpretive flexibility in how the respondent uses technological narrative	Illustrative quotes employing narrative 6—technological criteria
Fred	Expressive, instrumental, technical advice Highest total centrality score of all project managers	3. Organizational 4. Market 5. Efficiencies 6. Technological	2. Social/cultural 3. Organizational 4. Market 5. Efficiencies 6. Technological	Elaborate explanation of what constitutes technical success on a project. Uses a number of different themes to exemplify technical success: technical complexity, uniqueness, technical superiority of the product; discusses technical characteristics such as speed and precision; draws a connection between technical and market success	<ul style="list-style-type: none"> ● “It was quite an accomplishment to build a machine from scratch and to have it running” ● “It was a very technically complex project. No one had done anything like ● fSpeed, precision, repeatability . . . You need to do a repeated testing to make sure it works properly. The more testing the better but you need to be concerned about time and cost as well” ● “One thing that contributed to the success of this projects is that we . . . agreed on the concept and specified the technical objectives quite clearly. This is always a good thing” ● “What we offer is so much better than the competition, it is hard for [our customers] to justify buying something else that is so inferior”
Ted	Technical advice Lowest total centrality score	3. Organizational 4. Market 6. Technological	None—clear asymmetry in discussing success/failure	Cursory discussion of what constitutes technical success. Focused entirely on the technical performance of the product	<ul style="list-style-type: none"> ● “Technical success is taking a theory and then proving that it really works”

particular projects are affecting the social construction of meaning. Or perhaps, individually, project managers' work experience influences their interpretations more than their network centrality, in a manner that was unobservable to us. We also cannot control for other individual characteristics like gender.

Second, our findings may not be immediately generalizable to other companies. For example, at Global East the lab director initially chooses project teams. Companies that use other means of selecting R&D teams might have different patterns of network positions or accounts of success. Third, although we did not focus on the effect of formal structural positions on interpretations of success, not surprisingly, this authority does matter. As we report, Tom's influence on the social construction of Project Delta as a "low success" rather than "failure" seems in large part due to his formal position as lab director. More systematic analysis of the interacting effects of formal and informal structures on project outcomes is needed (Rizova, 2002). Lastly, we do not compare the socially constructed narratives of success to what might be considered the more objective measures of the projects that the lab director gave us. We did not want to privilege one voice over others, and instead allowed all of our interlocutors to bring up criteria that seem like more objective measures of success to them. For example, Fred discusses the increased costs of Project Delta, a quantifiable outcome that contradicts the lab director's assessment of that project.

5.2. Conclusions

With the above limitations in view, we revisit the main findings of this study and discuss what they mean for organizational theory and technology management. The following narratives of success and failure emerged from the interviews with project managers: (1) general reflections on the "big picture" of project success; (2) social and cultural criteria, such as reputation; (3) organizational factors, including support from upper level management; (4) market concerns; (5) efficiencies, for example, in time and costs; and (6) technological success, i.e., does it work. Project managers' construction of complex definitions of success implies that R&D project outcomes must be measured on multiple dimensions, supporting the movement in this direction in the innovation management literature (e.g., Davis et al., 2001; Olson et al., 1995; Biemans, 1992).

Interpretive flexibility in the narratives occurs when people carry different meanings of technology (or project success). We found more interpretive flexibility in the narratives employing social, organizational and technological accounts of success, and less flexibility in interpretations of market and efficiency criteria. The exact opposite might be expected—that technological criteria would be subject to less interpretive flexibility and market discourse to more. This unexpected finding implies that there may be a connection between which aspects of project success are interpreted more flexibly, and where a work group is located in the product stream. Among these R&D managers, technological criteria are subject to debate, while market factors seem more straightforward; but in a marketing department the reverse might be true. Our research implies that R&D management presents unique challenges not just because of its functional task of working with uncertain outcomes, but also because the meanings that R&D people bring to their work differ, based on their social network contacts.

Our research question comes from the perspective that organizational behavior is embedded in webs of social relations (Granovetter, 1985; Powell, 1990). Managers make decisions in the context of their network ties. Network structures affect access to information (Useem, 1984; Burt, 1992; Haunschild and Beckman, 1998) and norms for behavior (Fine and Kleinman, 1979; Galaskiewicz, 1985). Recent network analyses have tended to focus on formal alliances, not as much study of the informal side of organizations and the cultural meaning of ties has been conducted (Smith-Doerr and Powell, 2004). To employ either quantitative structural analysis or qualitative cultural analysis alone, however, misses the connections between organizational structure and culture. We contribute to the embeddedness perspective in linking our quantitative study of informal organizational networks and qualitative study of cultural meanings of work. A manager's network position shapes not only the information and norms he or she holds, but also how he or she constructs the success of an innovative project. This construction process is not an individual calculation about technical merit, but rather a socially mediated perception.

In general, the project managers who were more central in advice networks spoke at greater length about project success and failure. Further, the nature of a project manager's centrality affected how he or she constructed the success of projects. We measured centrality in four networks: instrumental, expressive, organizational advice, and technical advice. Fig. 6 summarizes who was central in each kind of network. The manager with centrality in all networks except the most informal, expressive network, (Tom) was the only one to look at the big picture and generally reflect on how to think about R&D project success or failure. Only the project managers who had multiple kinds of centrality, and thus not surprisingly, greater overall centrality, (Tom, Nick, Olga and Fred) introduced social/cultural, organizational and market aspects of project success to the discussion. The most commonly cited accounts of project success were the efficiency and technological success narratives. All project managers constructed their definitions of project success with these two narratives (with one exception). In particular, project leaders who had centrality only in instrumental or technical advice networks (Tonya, Ted, Natalie) focused on efficiency and technological narratives. Put differently, the type of centrality closely matched the content of the narratives particularly well for the more technical and utilitarian side of projects. A possible implication of this finding is that project managers with access mostly to narrow technical and cost-cutting information are less likely to have a nuanced, multifaceted view of what makes for a successful project.

Further study is needed on how informal organizational culture in turn affects the power structure, i.e., the link between interpretations of success and the allocation of R&D budgets. Perhaps central individuals who have more influence on flexible interpretations of success and failure are also more likely to have their future projects funded. In other words, their social capital may help them garner additional financial capital for their projects.

Social capital is the opportunity to receive greater returns for human capital (Bourdieu, 2001). In this paper, the four discussion networks represent different kinds of social capital. Individuals have the chance to use their abilities based on why people go to them. For example, people go to Natalie for technical advice—she is central in the technical

network—thus, she has the social capital to use her technical expertise. She does not, however, have social capital to develop her organizational expertise. Her perceptions are also shaped by what kind of access she has information to in her network position. People talk to her about technical details, and she sees project success in terms of meeting technological goals. Social capital also means that an actor has credibility; a centrally connected person is one whose interpretation of success and failure is given more credit. Thus, our research expands the idea of social capital as resulting in success for individuals (Burt, 2000), to demonstrating how advantageous position in an organizational structure affects the social construction process, which in turn may affect the success of innovative projects.

Our commitment to symmetry in this study meant that we analyzed whether success and failure were discussed in the same way. Were the same narratives used to talk about the successful and unsuccessful aspects of R&D projects? We found that project managers talked more about success than failure, and used a greater variety of narratives in discussing success. Thus, symmetry characterized our approach, but not our data. This lack of symmetry in discussing failure has potentially disastrous implications for organizations, particularly those dealing with risky technologies. In Vaughn's (1996) study of the Challenger disaster, she carefully documents the culture of the engineering work group at NASA. The engineers did not provide adequate warning about the shuttle's O-ring problems not because they were overruled by amoral managers, but because in their informal culture of viewing risky technical deviation as normal, O-ring failure became socially constructed as routine. If failure becomes so routine that it is no longer seen as remarkable in R&D organizations, disaster, as with the Challenger, can result.

The results of this study show the importance of knowing *who* is interpreting project success and failure. We found that if engineering work groups included multiple managers who are centrally located in different kinds of networks, they may have conflicting interpretations of the project outcome. One project we studied was particularly subject to interpretive flexibility in definitions of its outcome. Various, Project Delta was considered a success, a "low success," and an unsuccessful project. Our research findings suggest that the social structural context can provide an important addition to understanding interpretive flexibility. A technology, or a technical project, is more likely to achieve "closure" in its interpretation when only one key participant has network centrality. When multiple actors have centrality in different networks, as in Project Delta, there is a greater likelihood of conflicting constructions of meaning. But this difference in meaning given to a project by diversely connected R&D workers actually increases the overall symmetry in the team's attention to aspects of success and failure. An extrapolation of this finding is that having an R&D team with diverse backgrounds and social ties may lead to more conflict (Morrill, 1995), but also can help provide a more balanced view of projects.

The informal structure and culture of project teams should be viewed symmetrically by technology managers who want their organizations to learn from failure. For building an R&D team, awareness of the different kinds of social ties and informal information flows to which personnel have access will improve the likelihood of a balanced view of technological success and failure. A good team would have a mix of people—i.e., some central in organizational advice networks and others more relied upon for their technical

expertise. Another implication for the management of technological innovation lies in the importance of being aware of when social construction processes may lead to less effective organization. In the early phases of R&D, project members who are more powerful in both formal and informal structures may simultaneously have disproportionate sway over interpretations of success and a vested interest in continuing unsuccessful projects. As Henderson and Clark's (1990) study of printer manufacturers demonstrates, constructing a less than successful project as a success may be dangerous to organizational health. If company leaders cannot see projects as failures, even organizational survival may be at risk. Similarly, Lewis (2001) shows that a project socially constructed as unsuccessful can ultimately have better sales than one participants construct as successful. Managers of technological innovation should be aware of how the human tendency to give meaning to ambiguous situations may result in less effective organizational outcomes. Awareness of which narratives are being used to make sense of R&D projects, and whether enough attention is being given to failure might mitigate possible distortions. R&D project teams with diverse social network ties that engage in interpretive flexibility may be more difficult to manage than projects whose success is assessed more straightforwardly, but creative learning often comes from uncertainty.

Acknowledgements

The study was made possible by NSF grant #9714058. We thank Miro Radoynovski for his help in transcribing interviews.

Appendix A. Project histories

A.1. Alpha

The project was requested by one of the company's business units. The project started with a clear technical objective—to modify an existing product and improve its performance characteristics. Time constraints were a serious managerial concern as the identified market opportunity was beginning to narrow. The technical outcome of the project was a new product. The commercial impact of the technical outcome cannot yet be determined.

A.2. Beta

The objectives of the project were the development of a new product, its successful testing and commercialization. The technical outcome of the project was three-fold: development of a new product, a new measurement methodology, and a training component. In addition to its intended use, the product is widely used by the salespeople. The project is judged as highly successful both technically and commercially. It led to the establishment of a new manufacturing business. The Vice President of the Division took a personal interest and personally rewarded project members.

A.3. Gamma

Gamma was “blessed by the President of the company” and had no strict budgetary constraints imposed. The business unit was the customer. The Division’s VP participated as a project sponsor and took an active part in the decision-making process. The technical outcome of the project was a new product and process platform. The product represented a significant change in the way an industry was operating, and Global East captured about 90% of its market. The corporate commitment to the project is reflected in the size of its budget which was twice as high as the budget of typical project for the laboratory.

A.4. Delta

The objectives of the project were to design a low cost equipment and process methodology which could be afforded worldwide. Because of the low cost requirement, the equipment was initially designed, built, and implemented outside of the US. As the project progressed, a second project manager was assigned to the US team because of the poor quality of the equipment, which was designed and built in another country. The technical outcome of the project was a new piece of equipment that proved to be instrumental in new product development in the laboratory of another business division. However, the equipment has not yet been used for its intended purpose.

A.5. Epsilon

Epsilon involves designing and building an instrument (“R&D tool”) for speedy and reliable data collection. The technical specifications involved reducing the size of the equipment, improving the speed of operation and increasing the degree of user-friendliness. The project’s success is measured by the feedback of the users.

A.6. Zeta

The objective was to develop a new technological process to increase sales to technical customers. A team of twelve R&D laboratory members worked on this task. The initial application was limited to the geographical location of the R&D facility but several years later its use began spreading across the company’s core business divisions. A second phase of the project has developed as a response to the customers’ needs for technical support, equipment modifications, and training. The project’s success is reflected in its budget increases over time.

Appendix B. Summary of projects

Project	Number of members	Number of respondents	Project manager(s)	Project duration	Technical outcome
<i>Alpha</i>	5	4	Fred	9 months	New product. Impact is not clear
<i>Beta</i>	7	7	Tonya and Olga	1 year	New product and a new measurement methodology
<i>Gamma</i>	8	6	Fred and Nick	2 years 3 months	Radically new test equipment and testing methodology
<i>Delta</i>	7	6	Fred and Nick	3 years	An unintended range of product development capabilities for another business unit
<i>Epsilon</i>	10	8	Natalie	3 years 6 months	Product engineering and methodology utilized in many geographical locations
<i>Zeta</i>	12	11	Ted and Tom	3 years	Technology platform used across the corporation

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