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Centrality and Power in Organizations

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One need not be an expert on social networks to predict that the center node in a star configuration (position *D* in Figure 7-1a) will be the most powerful position. If presented with Figure 7-1a, few people would even ask whether the nodes represented individuals or groups, or whether the lines represented communications, friendship, or buy-sell transactions. Nor would anyone question whether the interaction was restricted, repeated, or symmetric. Most people would simply look at the diagram and declare position *D* the most powerful.

In addition, few people would be surprised to learn that a common finding in social network studies is that central positions are often associated with power and influence. Results consistent with this power/ centrality relationship have been reported in small laboratory work groups (Shaw 1964), within organizations (Brass 1984, 1985; Fombrun 1983; Krackhardt 1990; Burkhardt and Brass 1990), across organizations (Galaskiewicz 1979), in professional communities (Breiger 1976), and community elites (Laumann and Pappi 1976).

However, predicting the most central, powerful position becomes more problematic when the four-person Figure 7-1a network is embedded within a larger network, such as that depicted in Figure 7-1b. For example, Figure 7-1a might represent a work group, and Figure 7-1b might represent that same work group embedded within a department in an organization. Designating the most central position becomes even more complicated if we add further work groups within additional departments to represent an entire organization. The problem becomes one of identifying

(a)

(b)
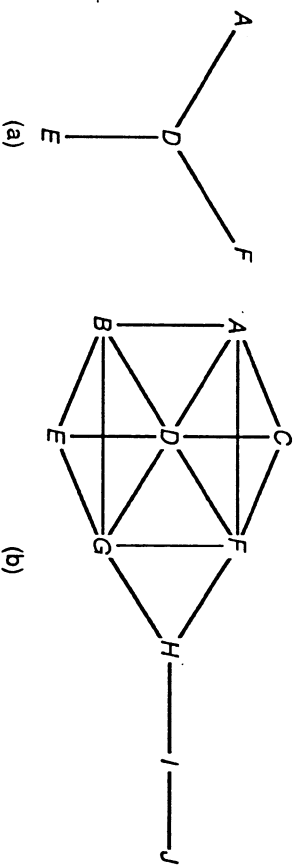
Figure 7-1

Adapted from Krackhardt (1990).

the appropriate unit of reference. In this case, should centrality within the work group, within the department, or within the entire organization be considered?

In addition to determining the unit of reference, determining the centrality of positions by simply looking at the diagrams becomes problematic as various combinations of nodes and links are considered. Even a small five-person network might produce differing opinions as to which position is most central (Freeman 1979). Of course, various remedies to this problem have been suggested in the form of mathematical formulas for calculating centrality. For example, one of the simplest calculations would involve counting the number of links connected to each position. However, this simple degree measure does not account for the system-wide properties of an extended network. Thus other centrality measures, which account for both direct and indirect links, have been offered (Freeman 1979).

The focus on system properties and indirect links led to the development of centrality measures that weight an individual's centrality by the centrality of those to whom he or she is directly connected. That is, one's centrality is increased by virtue of being linked to highly central others. If we assume that centrality and power are highly correlated, we can arrive at the conclusion that one's power is increased via links with powerful others. This proposition leads to consideration of additional units of reference within an organization. For example, direct links with top-level executives or with the dominant coalition in an organization may be positively related to power.

Connections to powerful others, however, may not increase one's power in certain situations. For example, while powerful others may provide useful information in a communications network, negotiating with powerful others in a bargaining network may produce negative results. Recent findings by Cook et al. (1983) suggest that under certain conditions ("negatively connected" networks) conventional measures of centrality do not relate to power. Two relationships in a network are said to be negatively connected when exchange in one diminishes or prohibits exchange in the other. These findings have led to attempts to define new measures

of centrality that apply to all types of networks. For example, Bonacich (1987:1170) has added a parameter to his measure that "reflects the degree to which an individual's status is a function of the statuses of those to whom he or she is connected."

The exceptional findings of Cook et al. (1983) point out the importance of considering the type of interaction described by the social network. Various types of networks exist within organizations—workflow, communications, friendship. Whether any "negative" networks exist within organizations is unknown.

This chapter will examine empirically the relationship between power and centrality within an organization. In doing so it will provide some limited evidence concerning the preceding questions. We begin with a theoretical discussion of power and attempt to describe various centrality measures from this theoretical perspective. We consider three measures of centrality (degree, closeness, and betweenness) across four units of reference (work group, department, organization, and dominant coalition) for three different networks (workflow, communications, and friendship). In addition, we consider the possibility of negative networks by relating an individual's power to the power of those with whom he or she is connected. Finally, we discuss the results in terms of the practical benefits of an organizational assessment of centrality and power.

Power

With the resurgent interest in power in organizations, a multitude of theories and approaches have been offered. Common to many of these approaches is a reliance on exchange theory, or a dependency framework such as that offered by Emerson (1962). The power of A over B is typically defined as the extent to which B is dependent on A (Marsden 1983). Building on this framework, the strategic contingencies and resource dependency approaches (Hickson et al. 1971; Salancik and Pfeffer 1977) posit that power (the inverse of dependence) derives from control of relevant resources. Control by one actor implies that another actor in the social relationship has few alternative sources for acquiring the resource. One actor controls or mediates another's access to the outcome or resource. A relevant resource is one that is in demand or in which another actor has a high motivational investment (Emerson 1962). Thus employees who are able to control desired resources increase others' dependence on them and, via the exchange process, are able to acquire the resources or bring about the outcomes they desire (Pfeffer 1981).

In addition to increasing others' dependence on them, actors seeking power must also decrease their dependence on others. This may be done by decreasing one's motivational investment in outcomes controlled by others, or by increasing the number of alternative sources available for acquiring the outcome (Emerson 1962). In other words, one must have access to relevant resources that is independent, not controlled or mediated by others.

The relationship between power and dependence becomes more com-

plex when one considers the multitude or variety of outcomes that may be considered relevant or in demand in organizations. Thus A may control a particular outcome that is relevant to B, but B may control another, different resource that is desired by A. Thus, in order to acquire power in an organization, two conditions are necessary: actors must both decrease their dependence on others and increase others' dependence on them.

We use the terms "resources" and "outcomes" interchangeably and in the broadest sense to include both tangibles and intangibles. In addition, we do not assume that exchange relationships involve only one transaction, or that transactions occur at only one time. Nor do we assume that it is possible for any pair of organizational actors to exchange resources with one another (Marsden 1983). Exchanges are restricted by opportunities for contact, ideological similarity, or "social inertia" (Marsden 1983:690). In organizations, some exchanges are mandated by workflow procedures and the prescribed hierarchy of authority.

Centrality

The concept of centrality has been operationalized and measured in a variety of ways. For example, Freeman (1979) summarized three related measures of centrality (degree, closeness, and betweenness) and attempted to clarify them conceptually.

Degree The degree measure of centrality is calculated by simply counting the number of adjacent links to or from an actor. Based solely on direct connections, Freeman (1979) conceptualized it as a measure of activity. It is infrequently discussed, often entirely ignored, in most social network discussions of power because it does not capture the system-wide properties of the network (Cook et al. 1983). In Figure 7-1, position D has the highest degree centrality in both examples.

However, from our exchange perspective on power, the degree measure of centrality may represent the number of alternatives available to an actor. Increasing one's alternatives increases one's power. Cook and her colleagues (1983:288–289) caution against equating resource availability with number of alternatives, noting that it "makes no difference how many bad sources of supply a position has." However, we cannot logically assume that alternatives are "bad sources" any more than we can assume them to be "good sources." Absent additional information, we must assume that more alternatives, as represented by the degree measure of centrality, are better than fewer alternatives.

The degree measure may also be appropriate for capturing power-enhancing behaviors that occur via direct interaction, such as ingratiation and reciprocation. In addition, Murnighan and Brass (1991) note that coalition formation occurs one person at a time, in direct interaction between the founder and potential members. Direct links also represent the avoidance of relying on mediating positions for indirect access to resources.

Closeness Closeness measures of centrality account for both direct and indirect links in indicating how "close" a person is to all other persons in the network. It is generally calculated by summing the lengths of the shortest paths (geodesics) from a point to all other points. Direct links are counted as one step, with indirect links given proportionally less weight in the measure. In Figure 7-1a, position D is the most central. However, in Figure 7-1b, positions G and F are most central when using the closeness measure.

This measure can be interpreted to represent efficiency (extent to which an actor can reach all other actors in the shortest number of steps) or independence (being close to all other actors, a person is less dependent on intermediaries) (Freeman 1979). According to Freeman, it indicates the extent to which an actor can avoid the control of others.

In accounting for indirect access to others, the closeness measures allow for the possibility that an actor with only a few direct links may be central by virtue of those few links being to highly central others. For example, an employee who is connected to central employees in the communication network may have access to important information, a vital source of power in most organizations.

Betweenness Betweenness measures of centrality calculate the extent to which actors fall between pairs of other actors on the shortest paths (geodesics) connecting them (Freeman 1979). Following Freeman, this measure represents potential control over others. Thus, if persons A and C were connected only through person B, B would fall "between" A and C and would mediate the flow of any resources between A and C. In Figure 7-1a, position D mediates the flow between any two of the other positions. However, in Figure 7-1b, position H is the most central when calculating the betweenness measure.

Freeman (1979) suggests that this measure is particularly appropriate for assessing power in communication networks; a mediating person may withhold or distort information in transition. Whereas the closeness measure represents avoiding the control of others, the betweenness measure represents controlling, or increasing the dependence of others.

Other Centrality Measures In addition to the above three, numerous other measures of centrality have been offered. One of the most frequently used in research on interlocking directorates is the measure developed by Bonacich (1987). An actor's centrality is his or her summed connections to others weighted by the centrality of those others. The measure assumes that an actor's centrality is a function of the centralities of those actors with whom the actor has direct ties. Other measures based on similar assumptions include those developed by Hubbell (1965), Coleman (1973), and Burt's measure of prestige (1982). Stephenson and Zelen (1989) have proposed one of the few measures of centrality that is not based on geodesics, but takes into account multiple

shared paths between points. They argue that resources do not always flow along the shortest path, perhaps due to random fluctuations or actors who intentionally attempt to hide or shield the source of the resource, or avoid the flow of the resource through a particular intermediary. Still other measures of centrality have been suggested by Friedkin (1990).

Because it is impractical to include all these measures, we have chosen to consider degree, closeness, and betweenness based on their previously discussed theoretical implications. That is, closeness and betweenness represent the two necessary conditions for acquiring power: decreasing your dependence on others and increasing others' dependence on you. The degree measure most closely corresponds to Emerson's notion of alternatives. Together, these three best capture the dependency framework (Emerson 1962) used by many organizational scholars.

As illustrated in Figure 7-1b, the complexity of embedded relationships within an organization makes it possible for each measure of centrality to contribute unique variance in predicting power. While we expect some overlap among the measures, we hypothesize that each will be positively related to power and that each will add to the variance explained by the other two.

Units of Reference

The appropriate unit of reference for calculating centrality scores is often constrained by the method or level of analysis. For example, in laboratory studies there is only one unit of reference to consider, the small group created in the laboratory. At the group or organizational level of analysis, the small number of other units (departments, organizations, communities, etc.) restricts various combinations of subsets. Hence little attention has been given to unit of reference. However, at the individual level of analysis within an organization it is possible to consider centrality within a person's immediate work group, within departments or divisions, or within the entire organization. Likewise, an employee's power may depend on his or her connections to a particular group of persons, such as top-level executives.

Although theory and one's research questions may designate some units of reference as more important than others, this does not seem to be the case when considering power in organizations. Given the possibility of multiple, different sources of power in organizations (Pfeffer 1981), considering multiple reference units may be important. Following this logic, we calculated centrality measures with regard to subunit (work group with the same immediate supervisor), department (groups of 30 to 50 employees as formally designated by the company), and the entire organization. In addition, we calculated centrality in reference to a small group of top-level executives that we refer to as the dominant coalition.

The utility of this multiple-reference-unit strategy may be limited by the size of the group in combination with the particular centrality measure. Assuming that an average employee may not be able to interact

effectively with more than 50 to 60 others, degree centrality scores will probably not be affected much by large size. For a large organization of 1,000 or more employees, the calculation of betweenness measures of centrality may be very time-consuming. In addition, using such a large number of employees may tend to homogenize the scores. For example, closeness scores may lose some meaning when calculated for very large numbers. In an organization of 1,000, every individual will probably receive the same path length for 500 to 600 employees who are not indirectly connected in paths shorter than three links. At the other extreme, everyone may receive the same closeness score within a small work group of five or fewer, provided that interaction is not restricted within the group.

In the organization under investigation, the departmental unit of reference seemed to represent the ideal size (30 to 50 employees) in relation to the preceding discussion. In addition, the five departments in this particular organization were relatively autonomous units, whereas the subunit workflow dependencies tended to cross subunit boundaries. That is, most of the subunits represented functional (homogeneous) groupings of employees whose workflow dependencies extended to other subunits within the department. Thus we hypothesized that centrality within the departmental unit of reference would be more strongly related to power than when using either the subunit or entire organization as the unit of reference. We expected centrality with regard to the dominant coalition to be a relatively strong and unique predictor of power, with little overlap with the other units of reference.

Types of Networks

This study considers the relationship between power and the centrality of organizational employees within three social networks: (1) workflow network, (2) communication network, and (3) friendship network. These networks correspond to three of the basic flows noted by Tichy, Tushman, and Fombrun (1979): (1) exchange of goods, (2) exchange of information or ideas, and (3) affect or liking. From our exchange-theory framework on power, these types of transactions form the bases for interdependencies among employees.

Workflow Network Although informal or emergent patterns of behavior can, and typically do, occur in a workflow, this network is formally prescribed. Even when accounting for informal modifications, the workflow represents a highly restricted interaction network. Within the workflow network, the basis for interdependencies among workers is established by the division of labor; as the overall organizational task is divided, workers performing parts are dependent on one another. As the work flows through the organization, workers exchange inputs and outputs. The relevant outcome is the performance of one's task, which continues the successful flow of work.

Having many alternative sources for acquiring inputs or distributing

outputs decreases a worker's dependence on others, and, conversely, should increase his or her power. Thus we would expect degree centrality to be positively related to power. Likewise, mediating the flow of work (betweenness) may also provide one with control. Because most work-flow transactions are dyadic in nature, closeness centrality may relate to power only to the extent that indirect connections provide other valued resources such as information. In addition, closeness centrality in reference to the entire organization may virtually eliminate any possibility that those on the boundaries of the organization can be considered central. However, boundary-spanning individuals in organizations are thought of as powerful because of their ability to reduce uncertainty for the technical core (Thompson 1967).

Communication Network   Interdependencies among people in communication networks are based on the exchange of information. Likewise, the relevant resource is information. Employees who are centrally located in the communication network have potential access to (closeness) and control over (betweenness) information and thus are potentially powerful (Pfeffer 1981; Mechanic 1962; Freeman 1979).

In addition to assessing communication network centrality in a person's subgroup, department, and the entire organization, we also used the dominant coalition in the organization as a unit of reference. We defined this coalition as a small group of high-level individuals who had the most influence and decision-making authority in the organization. Communication connections with this group may provide a person with valuable information and support. Likewise, mediating information to and from this top-executive group may provide control over important information. That is, centrality with regard to the dominant coalition will likely increase others' dependence on the central person with regard to information about "what's going on in the company."

Friendship Network   Employees in organizations are also linked together on the basis of social liking, or friendship. In such a network, the relevant resource, friendship, may not be the direct source of power. Rather, friendship may be instrumental in obtaining other relevant resources such as information or rewards. Friendships may also be the bases for forming coalitions, although it is equally likely that coalition partners may develop friendship. Regardless of the direction of this relationship, the overlay of friendship on work relationships may make it difficult for friends to withhold valuable information or join opposing coalitions. To the extent that friendships are instrumental in acquiring information, we would expect overlaps with the communication network and similar relationships between centrality and power.

Network Connections

Recent research by Cook and colleagues (Cook et al. 1983; Yamagishi, Gillmore, and Cook 1988) has pointed out the importance of considering

the concept of network connection—the nature of the link joining two or more dyads. The importance stems from the finding that under certain conditions centrality was not related to power (Cook et al. 1983). Among other things, these conditions include whether the connection is characterized as positive or negative.

In considering two exchange relations, A-B and B-C, they are defined as being connected at B (and forming the network A-B-C) only when the exchange between A and B in some way affects the exchange between B and C, and vice versa (Cook et al. 1983; Yamagishi et al. 1988). If the A-B exchange affects the B-C exchange positively, and vice versa, then the two relations are said to be positively connected at B. For example, B obtains information from A that allows B to help C solve a problem. A communication network is often used as an example of a positively connected network. Two relations are defined as negatively connected when exchanges in one diminish or prohibit exchanges in the other. For example, B's meeting with A forces B to cancel a meeting with C. In the negatively connected network, A-B-C, A and C are in competition for, or in conflict over, resources controlled by B. Competitive economic market structures, friendship networks, and dating relations are often cited as examples of negatively connected networks (Cook et al. 1983; Yamagishi et al. 1988). Yamagishi and colleagues also consider mixed networks—networks in which both positive and negative connections exist.

Do negative networks exist in organizations? Can we expect to find evidence that centrality does not relate to power? Judging from previous studies (Fombrun 1983; Brass 1984; Burkhardt and Brass 1990), the answer is no. However, examples of negative connections are not difficult to find in organizations: A purchasing agent selects one supplier over another; a supervisor decides to promote one subordinate rather than another; a manager goes to lunch with one friend rather than another.

Of the networks studied in this research, the communication network is most often listed as an example of a positively connected network. On the other hand, the friendship network is often cited as an example of a negative network. However, as previously noted, friendship in organizations may be instrumental in acquiring other relevant resources, such as information. Thus the expected overlap between friendship connections and communication connections (people talk with their friends) may cancel out any of the negative connections associated with a friendship network. In addition, it seems intuitive that one person can have several friends without creating competition. Perhaps the negative connections would result only from specific facets of friendship, such as romantic or mentoring relationships.

The workflow network involves the flow of resources, such that B exchanges the resources obtained from A with another partner, C. Obtaining resources (inputs necessary for job performance) from A enhances B's exchange with C (outputs from B become C's inputs). This type of resource flow represents positive connections (Yamagishi et al. 1988). However, B may have alternative sources of inputs other than A. In receiving inputs from A, B may exclude other sources such as D.

Likewise, in distributing his outputs to C, B may exclude other recipients, such as E. Thus the A-B-C network is positively connected, but the A-B-D network and the C-B-E network are negatively connected. The result is that the A-B-C-D-E network is considered "mixed" (Yamagishi et al. 1988).

The analysis of mixed networks and the reasoning behind predictions of centrality/power relationships is somewhat complex, even for small networks (see Yamagishi et al. 1988 for details). We do not attempt it for the large, complex workflow network in the organization studied. However, the practical implications of these laboratory studies is distinctly illustrated by Bonacich (1987). He notes that the advantages or disadvantages of being connected to powerful others may depend on whether the network is positive or negative.

Connections to Powerful Others Following Bonacich (1987), whether one's centrality or power is increased by connections to high status or powerful others depends on whether the connections are positive or negative. In a positive communication network, the amount of information available to employees is positively related to the amount of information available to those with whom they have contact. Assuming that power derives from information, being connected to powerful central others should be positively related to power in the communication network.

However, in negatively connected bargaining situations, being connected to powerful others—those with many alternatives—puts one at a disadvantage. It is advantageous to bargain with others who have few options—those who are relatively less powerful. In bargaining situations, exchange with one partner precludes exchange with another. Some evidence of avoidance of powerful others is also found in the coalition-formation literature (Murnighan and Brass 1991).

We empirically explored the possibility of negative connections by calculating the power of those with whom an employee is connected. We expect this index to be positively correlated with individual power when considering the communication network. A positive relationship is also expected for the friendship network, to the extent that it overlaps with the communication network. However, the workflow network presents the possibility of a negative relationship. Being connected to powerful others in the work flow may place one in a position of dependence. From such a position it is unlikely that one would be able to place demands on powerful others concerning the acquisition of inputs or the distribution of one's outputs.

We also analyzed the relationship between one's own centrality and the power of those with whom one was connected. This analysis is necessary to the extent that one does not assume that centrality is equivalent to power. Rather, we are interested in the extent to which central employees are connected to powerful others. Because of the voluntary nature of the friendship network, we are also interested in the relative power of those whom one chooses as friends. Do employees choose friends who are more powerful, less powerful, or of similar power to themselves?

METHOD

Participants

One hundred forty nonsupervisory employees of a newspaper publishing company (87.5% response rate) participated in the study by completing a questionnaire administered by the researcher. The immediate supervisors of these employees completed a different questionnaire. In addition, 90% of the higher-level managers (above first-line supervisor) completed the same questionnaire as the nonsupervisors. In all cases, participation was voluntary and respondents were assured that their responses would be seen only by the researchers and be used for research purposes only.

Measures

Networks On the nonsupervisory questionnaire, respondents were asked to list the names of persons (1) who provided them with inputs to their jobs or to whom they distributed outputs from their own work; (2) with whom they talked frequently about work-related activities; and (3) whom they considered to be close friends. These listings provided the raw data for the centrality measures for the three networks: (1) workflow; (2) communication; and (3) friendship. Listings by the higher-level managers on this nonsupervisory questionnaire were used in part to identify the dominant coalition (details follow in this section). Reciprocation rates were 84% for the workflow network, 76% for the communication network, and 87% for the friendship network. Based on follow-up interviews concerning discrepancies, all links were treated as reciprocated.

The workflow network was also assessed via interviews and direct observation by the researcher. This independently derived network was compared with the network generated by the employee listings, and all discrepancies between the two were resolved via interviews following the questionnaire administration.

Centrality Three different measures of centrality (degree, closeness, and betweenness) were calculated for the sample of 140 nonsupervisory employees for each network (workflow, communication, and friendship) using three different units of reference (subunit, department, and entire organization). Subunits included all employees with the same immediate supervisor; departments corresponded to the five formally designated departments. In addition, the three centrality measures were calculated for the communication network using the dominant coalition as a unit of reference.

Following Freeman (1979), the degree measures of centrality were calculated by counting the focal employee's number of direct links. This number was divided by $n - 1$ (n = number of persons in the unit of reference) so that comparisons of degree centrality could be made across subunit and departments of different size.

The closeness measures of centrality were operationalized as the minimum distance between a focal employee and all other persons in the unit of reference (Freeman 1979). The sum of the lengths of the geodesic paths to all other persons in the reference unit was divided by $n - 1$. The closeness centrality measures were transformed by the formula $1 - [(d - 1)/(dmax)]$, where d equals the path distance and $dmax$ equals the largest observed value of d (Lincoln and Miller 1979; Brass 1984). This transformation does not change the magnitude of the relationship between closeness and other variables, but reverses the sign such that higher scores reflect greater closeness centrality.

The betweenness measures of centrality were calculated using the formula developed by Freeman (1979). To determine betweenness centrality, the probability of a focal person falling on the geodesic (shortest path) connecting any two other persons is summed over all unordered pairs of persons. The value is then divided by $(n^2 - 3n + 2)/2$, the maximum value when n equals the number of persons in the unit of reference. In calculating the betweenness centrality scores in the workflow network, direct connections with persons outside the organization were included. Without including these connections, all boundary-spanning employees would receive scores of zero on the work-flow betweenness measures because their positions represent the first or last link in the workflow network.

Power Two independent reputational measures of power were obtained. Nonsupervisors were asked to "list the names of persons whom you consider to be influential at the newspaper. That is, list persons who seem to have pull, weight, or clout in this company. List as many or as few as you think necessary." The mean number of nominations received by each employee in the nonsupervisory sample was 1.37, with a standard deviation of 1.85.

The second measure of power was obtained by asking the immediate supervisor of each employee to rate that employee on a seven-point Likert type scale (1 = very little influence; 7 = very great amount of influence). Instructions were the same as noted previously, with modifications appropriate to rating rather than listing the names. The mean score was 2.80, with a standard deviation of 1.49. The correlation between supervisors' ratings and number of nominations received from nonsupervisors was .70 ($p < .01$), indicating substantial agreement between supervisors and nonsupervisors.

These immediate first-level supervisors were not asked to list workflow, communication, or friendship interactions in order to avoid the possibility of method-variance contamination in their power ratings. The names of all the immediate subordinates of each supervisor were listed on the rating form so that there would be no bias in the recollection of names.

Dominant Coalition Considered in identifying the dominant coalition were the communication and friendship patterns of the ten persons in the

organization who received the most listings as powerful on the nonsupervisory questionnaire. Based on the relative number of listings and the interaction patterns, four of these ten persons were selected as representing the dominant coalition. These four individuals indicated reciprocated communication and friendship connections, and were ranked first, second, third, and fifth in the nonsupervisory listings of power.

Power of Others Each of the nonsupervisory employees was assigned six indices representing the average power of those other persons with whom the focal employee was connected. The six indices represented supervisor ratings of power and nonsupervisors' listings of power for workflow, communication, and friendship connections. For the supervisors' ratings of power, the means and standard deviations were as follows: workflow 2.41, .63; communication 2.92, .95; and friendship 2.61, 1.11. For the nonsupervisory listings, the means and standard deviations were as follows: work flow 1.19, .52; communication 1.79, 1.19; and friendship 1.30, 1.21.

RESULTS

Means, standard deviations, and intercorrelations among the workflow network centrality measures are presented in Table 7-1; Table 7-2 indicates the same for the communication network centrality measures. The intercorrelations between the work flow and communication network measures are presented in Table 7-3.

Due to the large number of variables in this study, the friendship network results were not included in the tables, except in reference to the

Table 7-1
Means, Standard Deviations, and Intercorrelations for Workflow Measures

	MEAN	S.D.	1	2	3	4	5	6	7	8
Subunit										
1. Degree	.61	.61								
2. Closeness	.90	.07	.57							
3. Betweenness	.35	.08	.18	.08						
Department										
4. Degree	.24	.28	.15	.43	-.26					
5. Closeness	.76	.16	.03	.13	-.08	.59				
6. Betweenness	.04	.07	.48	.54	.28	.32	.49			
Organization										
7. Degree	.04	.02	.25	.44	.17	.27	.20	.36		
8. Closeness	.65	.12	-.28	-.29	.09	-.13	.27	.18	-.02	
9. Betweenness	.01	.02	-.01	.14	.15	.06	.16	.15	.32	.27

$p < .05$ for all $r > .14$; $p < .01$ for all $r > .20$

Table 7-2
Means, Standard Deviations, and Intercorrelations for Communication Network Measures

	MEAN	S.D.	1	2	3	4	5	6	7	8	9	10	11
Subunit													
1. Degree	.55	.46											
2. Closeness	.87	.12	.63										
3. Betweenness	.07	.06	.31	.26									
Department													
4. Degree	.19	.18	.22	.34	.04								
5. Closeness	.77	.11	.27	.57	.05	.71							
6. Betweenness	.05	.03	.18	.23	.24	.58	.32						
Organization													
7. Degree	.04	.02	.27	.41	.26	.59	.54	.73					
8. Closeness	.63	.07	.16	.44	.17	.26	.63	.38	.65				
9. Betweenness	.01	.04	.08	.19	.26	.37	.26	.78	.82	.54			
Dominant Coalition													
10. Degree	.16	.40	.11	.19	.27	.44	.28	.44	.44	.23	.51		
11. Closeness	.71	.11	.14	−.11	.13	.51	.12	.34	.48	.12	.36	.59	
12. Betweenness	.03	.07	.09	.16	.25	.36	.22	.68	.69	.40	.85	.71	.49

$p < .05$ for all $r > .14$; $p < .01$ for all $r > .20$

power of others. This was done because preliminary analyses of the correlations between corresponding measures in the communication and friendship networks indicated substantial overlap (rs from .60 to .97). Correlations of the friendship network measures with the power measures produced virtually the same results as obtained when using the communication network measures. When controlling for the communication measures, the friendship measures did not add significantly ($p < .05$) to any of the relationships studied. However, in some cases the partial correlations between the communication measures and power measures were significant when controlling for the corresponding friendship measures. Thus including the friendship measures in the tables would have been a redundancy.

As indicated in Table 7-1, the department betweenness measure correlated significantly with all the other workflow centrality measures. The department closeness measure was strongly correlated with the subunit degree and betweenness measures, but was negatively correlated with the subunit betweenness measure and the organization closeness measure. Degree and closeness measures were highly correlated, with the exception of organization measures. Subunit betweenness was negatively related to department degree.

For the communication network measures (Table 7-2), intercorrelations between measures within subunits were highly correlated. The organization degree measure was strongly correlated with all the other measures. In general, the intercorrelations for the communication net-

Table 7-3
Intercorrelations Between Communication and Workflow Network Measures

	WORKFLOW								
	Subunit			Department			Organization		
Communication	*Deg.*	*Close.*	*Betw.*	*Deg.*	*Close.*	*Betw.*	*Deg.*	*Close.*	*Betw.*
Subunit									
1. Degree	.56								
2. Closeness	.24	.19							
3. Betweenness	.07	.05	.09						
Department									
4. Degree	.13	.37	−.19	.49					
5. Closeness	.21	.37	−.17	.28	.21				
6. Betweenness	.04	.21	.08	.12	−.12	.08			
Organization									
7. Degree	.13	.27	.11	.02	−.17	.11	.21		
8. Closeness	.11	.08	.04	−.15	−.06	.09	.20	−.01	
9. Betweenness	.06	.18	.09	.01	−.17	−.08	.16	.06	.06
Dominant Coalition									
10. Degree	.26	.39	.01	.38	.02	.25	.21	−.16	−.02
11. Closeness	.22	.28	.02	.21	.04	.24	.27	−.12	−.03
12. Betweenness	.12	.26	.11	.09	−.15	.18	.23	.05	.04

$p < .05$ for all $r > .14$; $p < .01$ for all $r > .20$

work measures were higher than those for the workflow network. Correlations across networks (Table 7-3) were moderate to low. The subunit degree measures correlated highly, as did the department degree measures.

Centrality Measures

Table 7-4 presents the zero-order correlations for the centrality measures and the supervisors' ratings of power. All of the degree measures and most of the closeness and betweenness measures correlated significantly with the supervisors' power ratings. In addition, Table 7-4 shows the standardized betas when all the degree, closeness, or betweenness measures were simultaneously entered into a regression equation. The adjusted R^2 for each set of measures is also presented. Two significant negative betas occurred; closeness in the workflow for the entire organization, and betweenness in the communication network for the entire organization. Most of the betas for the workflow measures were not significant. As separate sets, the degree measures and the closeness measures explained the most variance in supervisors' ratings of power.

Table 7-4
Relationships Between Centrality Measures and Supervisors' Ratings of Power

MEASURE	DEGREE		CLOSENESS		BETWEENNESS	
	r	beta	r	beta	r	beta
Communication						
Subunit	.23**	.013	.17*	.167	.06	-.014
Department	.51**	.562**	.35**	.366**	.33**	-.358**
Organization	.29**	-.145	.12	-.239*	.22**	-.195
Dominant Coalition	.35**	.183*	.46**	.458**	.26**	.152
Workflow						
Subunit	.25**	.159	.17	.017	.11	.055
Department	.21**	-.152	.23**	.029	.24**	.214**
Organization	.16*	.013	-.08	.103	-.19*	-.223**
Adjusted R²	.29**		.30**		.17**	

*p < .05; **p < .01

Table 7-5
Relationships Between Centrality Measures and Nonsupervisors' Listings of Power

MEASURE	DEGREE		CLOSENESS		BETWEENNESS	
	r	beta	r	beta	r	beta
Communication						
Subunit	.24**	-.012	.18*	.085	.13	.019
Department	.50**	.358**	.35**	.186	.46**	.444**
Organization	.42**	.066	.25**	.030	.35**	-.246
Dominant Coalition	.49**	.292**	.39**	.323**	.41**	.275**
Workflow						
Subunit	.31**	.214	.39**	.285**	.08	-.039
Department	.22**	-.186	.06	-.049	.33**	-.286**
Organization	.15*	-.043	-.06	.127	-.04	-.075
Adjusted R²	.35**		.28**		.29**	

*p < .05; **p < .01

Table 7-5 presents the zero-order correlations, betas, and adjusted R² for the centrality measures and the nonsupervisors' listings of power. Most of the measures were significantly correlated with power. However, as in Table 7-4, the subunit betweenness measures for both networks did not relate significantly to power. The set of degree measures explained the most variance in the nonsupervisors' listings.

Continuing the analyses of the measures of centrality, Table 7-6 presents the results of hierarchical regressions with each set of measures being entered first in the regression equation, followed by each of the

Table 7-6
Hierarchical Regression Analyses for Measures of Centrality

MEASURE	Adjusted R² Supervisors' Ratings	Adjusted R² Nonsupervisors' Listings
Degree	.29	.35
add closeness	.34*	.36
add betweenness	.30	.37
Closeness	.30	.28
add degree	.34	.36**
add betweenness	.36*	.34**
Betweenness	.17	.29
add degree	.30**	.37**
add closeness	.36*	.34*

*significant (p < .05) change in R²
**significant (p < .01) change in R²

Table 7-7
Relationships Between Units of Reference and Supervisors' Ratings of Power

MEASURE	SUBUNIT		DEPARTMENT		ORGANIZATION		DOMINANT COALITION	
	r	beta	r	beta	r	beta	r	beta
Communication								
Degree	.23**	.053	.51**	.589**	.29**	.447**	.35**	.181
Closeness	.17*	.091	.35**	-.081	.12	-.044	.46**	.378**
Betweenness	.06	.004	.33**	.012	.22**	-.144	.26**	-.015
Workflow								
Degree	.25**	.115	.21*	-.132	.16*	.201*		
Closeness	.23**	.121	.14*	.032	-.08	.068		
Betweenness	.11	.074	.24**	.187*	-.19*	-.310**		
Adjusted R²	.05*		.27**		.14**		.22**	

*p < .05; **p < .01

other two sets of measure. Overall, the results in Table 7-6, taken in combination with Tables 7-4 and 7-5, point out the strength of the degree measures of centrality.

Units of Reference

Zero-order correlations, standardized betas, and adjusted R² for the four units of reference in relation to supervisors' ratings of power are presented in Table 7-7. Similar analyses for nonsupervisors' listings of power are presented in Table 7-8. For both measures of power, centrality

short

Table 7-8
Relationships Between Units of Reference and Nonsupervisors' Listings of Power

MEASURE	SUBUNIT		DEPARTMENT		ORGANIZATION		DOMINANT COALITION	
	r	beta	r	beta	r	beta	r	beta
Communication								
Degree	.24**	-.035	.50**	.346**	.42**	.432**	.49**	.316**
Closeness	.18*	.093	.35**	-.005	.25**	-.011	.39**	.193
Betweenness	.13	.091	.46**	.218*	.35**	-.007	.41**	.116
Workflow								
Degree	.31**	.120	.22**	.008	.15*	.107		
Closeness	.39**	.313**	.06	-.142	-.06	.026		
Betweenness	.08	.027	.33*	.326**	-.04	-.135		
Adjusted R^2	.15**		.35**		.16**		.26**	

*$p < .05$; **$p < .01$

measures for department and dominant coalition accounted for the most variance. In particular, the degree measures for the department, organization, and dominant coalition in the communication network were strong. Negative betas resulted for the organization-wide betweenness measures for both networks.

Table 7-9
Hierarchical Regression Analyses for Units of Reference

	Adjusted R^2 Supervisors' Ratings	Adjusted R^2 Nonsupervisors' Listings
Subunit	.05	.15
add department	.28**	.34**
add organization	.15**	.24**
add dominant coalition	.25*	.30**
Department	.27	.35
add subunit	.28	.34
add organization	.26	.33
add dominant coalition	.32**	.38**
Organization	.14	.16
add subunit	.15	.24**
add department	.26**	.33**
add dominant coalition	.28**	.29**
Dominant Coalition	.22	.26
add subunit	.25	.30*
add department	.32**	.38**
add organization	.28**	.29

*significant ($p < .05$) change in R^2
**significant ($p < .01$) change in R^2

Results of hierarchical regression analyses (Table 7-9) were consistent with these findings. In Table 7-9, each set of centrality measures for a particular unit of reference was entered into the regression equation first. That set of measures was then followed in the regression equation by the set of centrality measures for one of the other units of reference. Only the set of centrality measures for the dominant coalition added significantly to the variance explained by the centrality measures for department. In all cases the centrality measures for department added significantly to the variance explained in power.

Power of Others

Correlations between individual power and the power of those with whom the individual was connected in the workflow, communication, and friendship networks are presented in Table 7-10. The power of those with whom one was directly connected in the communication and friendship networks was positively and significantly related to one's own power. However, this was not the case for workflow connections. The power of those with whom one was connected in the workflow was not related, or was negatively related to one's own power.

Do employees choose more powerful persons as friends; or, do they prefer affiliation with persons less powerful than themselves? Based on the strong positive correlation between one's own power and the power of friends, the answer is neither. That is, people tend to choose friends who are relatively similar to themselves in terms of power.

Are central employees connected to powerful others? The answer tends to be no. Due to the large number of possible relationships, we

Table 7-10
Correlations Between Individual Power and Power of Others

	INDIVIDUAL POWER	
	Supervisors' Ratings	Nonsupervisors' Listings
Power of Others		
Workflow		
Supervisors' Ratings	-.17*	.03
Nonsupervisors' Listings	.01	.11
Communication		
Supervisors' Ratings	.37**	.19*
Nonsupervisors' Listings	.32**	.24**
Friendship		
Supervisors' Ratings	.50**	.35**
Nonsupervisors' Listings	.36**	.31**

*$p < .05$; **$p < .01$

summarize the results of this analysis rather than present several tables. Of the 180 possible correlations, only 65 were significant at $p < .05$. Of those, 32 were significant at $p < .01$, and only 20 of those were greater than .25, the highest being .41 (departmental workflow betweenness with supervisors' ratings of power of others). In general, the communication and friendship centrality measures were negatively and not significantly related to the power of others in the workflow. Department closeness in both the communication and friendship networks was positively related to power of others in the communication and friendship networks. The closeness measures of friendship were all negatively related to the power of others in the workflow. Also, department measures of degree and closeness in the workflow were positively related to power of others in the workflow. With these few exceptions, the overall results were weak and inconclusive.

DISCUSSION

Overall, the results of this study indicated that centrality was positively and significantly related to power in an organization no matter which measure of centrality or unit of reference was chosen. The exception to this was the betweenness measures of centrality within the subunit and organization for both communication and workflow networks. However, departmental betweenness was strongly related to power. As with the departmental betweenness measures, the departmental measures in general accounted for the most explained variance in power.

Unit of Reference

Thus it appears that the department is the most applicable unit of reference for calculating centrality measures in this organization. This finding emphasizes the importance of accounting for embeddedness in an organization. With a few exceptions, subunit measures of centrality were not highly correlated with department or organization measures. In some workflow cases, the correlations were negative. This may be due to the functional, homogeneous task groupings within many subunits in our sample. That is, employees within the same subunit performed the same task, with primary workflow connections crossing subunit boundaries. With communication and friendship links likely "shadowing" the required workflow links, these connections across subunits may be an important source of power. Results might be different in an organization composed of relatively autonomous product (heterogeneous) subunits.

There may be a size limit on the relevance of embeddedness. Considering a nonsupervisory employee's centrality within the entire organization may effectively homogenize the scores. That is, within a large organization there will be many persons who are far removed from any one employee. In relation to these far-removed persons, every focal will

receive similar centrality scores, thus decreasing the variance in scores. The standard deviations reported in Tables 7-1 and 7-2 tend to support this notion. With a few exceptions, the organization centrality measures have lower standard deviations than the department or subunit measures.

Another related possibility is that these far-removed persons, outside one's department but in the organization, are of little importance in establishing one's power. That is, one's power reputation may depend primarily on contacts with one's more immediate reference group. This may also suggest that there are power centers within organizations. For example, there may be relatively large clusters or cliques of individuals within which one establishes one's power base.

The appropriate unit of reference with regard to centrality/power relationships may depend on the density, or desired density of connections in an organization. For organizations requiring rapid change to environmental fluctuations, the organizational unit of reference may be of crucial importance. That is, the survival of the organization may depend on communication across departments. To discover that the strongest relationships between centrality and power occur at the departmental unit of reference may suggest that changes are needed. In addition, an organization interested in rapid change might attempt to decrease the mean score for closeness centrality for the entire organization. Thus the assessment of power and centrality in regard to unit of reference can have practical implications for the organization. Discouraging relatively isolated "fiefdoms" and rewarding connections across departments and divisions may be necessary.

Measures

Perhaps the least-expected result of this study was the strength of the degree measures of centrality when compared to the more elaborate closeness and betweenness measures. The degree measures did as well or better than the others in relating to power. It may be that degree reflects alternatives, and increasing alternatives increases one's power in exchange relationships (Emerson 1962). Regarding the communication network, direct contacts avoid the unreliability of information mediated through others. Direct contacts may also be necessary for coalition formation (Murnighan and Brass 1991), and may be the best source of information in learning the network (Krackhardt 1990).

Stronger results for the betweenness measures might have been obtained if supervisory personnel had been included in the sample. Organizations typically structure their hierarchies so that supervisors mediate communication from the top down and vice versa. A manager who does not score well on betweenness, especially in relation to the dominant coalition, may not be performing his or her liaison role effectively. We might also expect managers to score higher than subordinates on centrality within the entire organization, as coordination of activities across departments is often considered a managerial responsibility.

For an organization that prides itself on easy access (an "open-door" policy), a strong correlation between degree measures of centrality and power may provide an indication that the policy is working. However, direct access may not always be the most efficient way to transmit information. If the degree measures totally dominate the closeness measures, or the betweenness measures, it may indicate that designated channels of communication are not being followed or that information obtained through them is unreliable. However, that was not the case in this study. Both the closeness measures and the betweenness measures within the department and in relation to the dominant coalition were strongly related to power.

Networks

Some of the negative correlations and betas for organization-wide work-flow measures may reflect the reliance of the organization studied on organization boundary-spanning personnel. For a newspaper publishing company, advertising, reporting, and circulation tasks are crucial to success. Because of the nature of their tasks, these employees operate on the boundaries of the organization, which effectively prevents them from obtaining high scores on closeness and betweenness within the organization. For these employees, centrality may not be a primary source of power. Rather, they may acquire power by effectively coping with environmental uncertainties (Salancik and Pfeffer 1977).

Likewise, the strong correlations between the communication network measures and power may reflect the importance of information to a newspaper publishing company. In addition, the findings indicated that centrality in the friendship network was not significant when controlling for centrality in the communication network. Contrary results (i.e., dominance of the friendship centrality measures over the workflow or communication measures) would be cause for concern. An organizational assessment that showed that friendship by itself was the primary source of power would signal a need for change.

Network Connections

Although not directly assessed, results of this study indicated some evidence of negative connections within the workflow. Being connected to powerful others in the workflow was not positively related to power, as was the case in the communication and friendship networks. This finding may reflect a greater number of alternative sources, the focal being just one alternative, for the powerful other in the workflow. That is, the power of the person with whom the focal is connected may be the result of his or her having many alternatives to the focal. This would decrease the focal's power while increasing the power of the person to whom the focal is connected. It may also indicate that competition and bargaining, rather than the sharing of information, is occurring in the workflow.

Although the friendship network has often been offered as an example of a negatively connected network, we found no evidence of this. In relation to power, the friendship network apparently operated as a source of information, much the same as the positively connected communication network.

Conclusions

Although this research provides some empirical answers to questions concerning centrality and power in organizations, other questions remain. For example, we did not attempt to measure subunit or departmental power in relation to individual power. Membership in a powerful department may increase individual power, especially when reputational measures of power are used. Brass (1984, 1985) found that departmental membership was significantly related to individual power. More cross-level research is needed to investigate possible interactions between individual, subunit, and departmental power. Relational "frog pond" effects are also possible. That is, does one acquire more power by being a relatively powerful frog in a relatively small pond (powerless department), or by being a relatively powerless frog in a large, powerful pond?

Because of the cross-sectional nature of this study, we cannot determine the causal relationship between power and centrality. Does centrality lead to power? It is equally likely that powerful employees are sought out by others, thus increasing their centrality. In one of the few longitudinal studies of networks and power, Burkhardt and Brass (1990) found evidence supporting the notion that centrality preceded power following a technological change.

The need for longitudinal network studies is also apparent when considering the very practical question of how you change a network. While we have endorsed the utility of an organizational assessment of networks and power, few suggestions for changing the network have been offered. Results have shown changes in communication network patterns and power following the introduction of a new technology (Burkhardt and Brass 1990). Absent a radical jolt, such as a change in technology, Pfeffer (1981) has noted the stability of the distribution of power within an organization. Commitment to previous decisions, institutionalization of attitudes and behaviors (Burkhardt 1991), and the ability of those in power to generate additional power, all contribute to stability. Those in power are unlikely to relinquish their power. Very little is known about how networks form, how stable they are, or what is needed to change them.

In addition, more research is needed to determine the interrelationships between personal characteristics, strategies, and tactics, and network positions. While we take the position that network structure will provide constraints on personal strategies, Brass and Burkhardt (1992) found that assertiveness and coalition building were related to degree and closeness measures of centrality. Their results indicate that both network position and behavioral strategies were related to power.

Caution must be exercised in generalizing the results of this study to other organizations. As we have noted in the discussion, characteristics of the sample and the organization may have directly affected the findings. The selection of measures and units of reference, as well as the types of networks addressed, must be guided by theoretical and practical considerations. These measures, units of reference, and networks should be viewed as complementary rather than competing alternatives. Each provides a different theoretical perspective and application. In combination they can provide useful insights for both research and practice in organizations.

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