

Network Conditions for Organizational Change

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Understanding the overall network structure of organizations can help managers to support change. This article describes three different network theories of change, exploring the underlying assumptions and implications of each model. First, the E-I model predicts that cross-departmental friendship ties will help generate positive response to change in organizations by fostering trust and shared identity. The viscosity model predicts that introducing controversial (not clearly good or bad) change into the periphery of an organization and carefully regulating the interaction of innovators and nonadopters provides the best chance that it will diffuse successfully. Finally, the structural leverage theory presents a mathematical model that supports broad diffusion of clearly superior change, informing as many people as possible about the change.

Keywords: social networks; change; diffusion; innovation

Networks are a natural focus for change agents. We often look for central opinion leaders to be the leverage points for change (Baker, 1994; Rosen, 2000). Once we have identified them, we focus our change efforts on them, and according to the theory, the rest of the organization follows (e.g., Krackhardt, 1992). But one issue that has often been overlooked is the nature of the network as a whole and how that affects change efforts. That is, what is the shape of the network as a whole, and how does that shape affect the speed or even probability of a successful change?

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To address this, we draw on three opposing theories, each of which makes some sense, yet each predicts very different conditions for successful change. Just as organization development specialists often present differing perspectives on organizational change strategies (Alderfer, 1977), we suggest that there are different and occasionally conflicting network conditions for change.

The network models we will discuss here have some assumptions in common. First, they assume change is an ideational process. That is, one must first change people's awareness, attitudes, and beliefs about the change (e.g., Argyris & Schon, 1978). Second, they assume that change is a dynamic process of social influence. Change does not occur overnight but instead often involves a long process of convincing a string of people, who in turn convince others, of the feasibility of the change effort (Rogers, 1995).

But beyond these integrating assumptions, there are deep differences among these models suggesting very different preconditions for organizational change. In the following sections, we present three models for change, discussing their preconditions and the conditions for change that they suggest.

MODEL 1: DENSE INTEGRATION THROUGH EXTERNAL TIES

The first model suggests that change is more likely to be successfully implemented when the social network in the organization is strongly connected (Krackhardt, 1994a; Krackhardt & Stern, 1988). The line of reasoning behind this is that diffusion of innovative ideas happens along network paths. If an idea is successfully installed or adopted at one seed location, the extent to which it carries to other parts of the organization is a function of the paths of network ties to those distant locations.

Krackhardt and Stern (1988) go one step further to state that the conditions for successful implementation of radically new changes include an abundance of ties that cut across formal organizational subunit boundaries (departments, divisions, etc.). Their argument can be summarized as follows:

1. Change often is threatening to people because of the uncertainty it causes about the future.
2. This perceived uncertainty will result in conflict among various subunits in the organization.
3. This conflict leads to increased commitment to the local subunit and to reduced cooperation with other subunits.
4. Yet to successfully implement the change, more cooperation, not less, is required across these subunits.

Thus, unfortunately, this reduced cooperation comes at exactly the time when adaptation to change requires cooperation among subunits. Krackhardt and Stern (1988) suggest a counter measure to this logical pessimism:

1. Increased cooperation is enhanced when individuals trust each other.
2. Strong friendship implies trust.

3. In times of change, then, organizations in which friendship links exist between subunits will be more effective than those in which strong friendship links exist only within subunits.

Krackhardt and Stern (1988) suggest an additional benefit that such interlocking patterns of friendship ties will have for the organization undergoing change. They argue that friends influence people's general motivations through identities. If a person has friends only within the department, then one identifies with the subunit (department, team, division) alone. On the other hand, if one has friends spread throughout the organization, then one's identity becomes tied to this larger entity, the organization as a whole. That is, these friendships influence the part of the organization that one is trying to protect in the change process. As one's individual friendship ties are spread more widely throughout the organization, one identifies more with the larger organizational entity and is more willing to engage in cooperative and altruistic behaviors necessary to make the change work for the organization.

Krackhardt and Stern (1988) propose a simple and direct measure of this structural feature, which will facilitate change. This measure, called the E-I index, indicates the extent to which the overall organization is characterized by interunit, as opposed to intraunit, strong ties. The E-I index is calculated as follows:

$$EI = \frac{E - I}{E + I},$$

where E = number of ties that cut across subunit boundaries, and I = number of ties that connect people within the same subunit.

When adaptation to change is necessary, organizations in which members maintain friendship ties with others outside their own unit are likely to perform better because their members will be making decisions to benefit the organization overall, not just their own subunit.

Krackhardt and Stern (1988) are quick to point out, however, that exhibiting a high E-I index is not that simple. Indeed, E-I indices tend to be negative; that is, informal ties tend to occur among people within subunits. This happens for two reasons. First, people tend to be collocated within these subunits. The "law of propinquity" (Allen, 1977; Krackhardt, 1994b) states that people who are physically closer together are more likely to interact and form stronger relationships among each other. Therefore, we naturally expect and observe more and denser ties among people within a subunit than among people of different subunits. Second, even if they are located across large spaces, people within the same subunits often are forced to interact with each other because of the task dependencies that occur within subunits (Krackhardt, 1994b). Over time, these interaction patterns (or at least some subset of them) become the foundation for friendships. Therefore, it may be posited that a high E-I index will facilitate the cooperation necessary for change, but it also is unlikely that an organization will naturally emerge with such a structure without purposeful and strategic intervention on the part of management to encourage and produce such a structure.

Krackhardt and Stern (1988) put their theory to an empirical test. They set up a series of experiments as part of a course exercise. The protocol for the experiment was

as follows. As part of the requirements for a course, all the students participated in an organizational simulation exercise over a weekend. The class was divided into two organizations, and each organization was divided into four departments. The organizational exercise required the four departments to define a role for themselves as well as figure out how to make "money," the rules for which were stipulated in the exercise manual. Some methods for making money required cooperation across departments; some did not. Overall performance, a formula that also was given in the exercise manual, combined financial performance with other objective indicators of efficiency and human resource issues.

Each organization played independently. Unbeknownst to all the participants, the only difference between the two organizations was the way in which the students were assigned positions within the organizations. A week before the start of the exercise, students were asked to fill out a friendship questionnaire in which they indicated which of the students in the class were their personal friends. In one organization (the "natural" organization), groups of students who were friends of each other were assigned to the same departments, and there were relatively few friendship ties between departments. This natural organization, therefore, had a low (negative) E-I index value. In the other organization (the "cross-tied" organization), students were assigned to roles such that they had few friends within their department, mostly their friends were scattered among the other three departments. This gave the cross-tied organization a high E-I index value.

The exercise administrators punctuated the exercise with mini-crises. For example, at one point they announced a recession that required the organizations to lay off 10% of their work force; at another, they changed the payoffs for successfully completing a task. These new problems gave the participants the opportunity to respond creatively, to deal with the resulting uncertainty, and to plan and implement a change effort to address the mini-crisis. As with most change, dealing with the specific problem imposed by the administrator was not the real dilemma; it was dealing with the political fallout from the implementation of the attempted solution.

Both the natural and its paired cross-tied organization were subjected to identical crises at the same time. This design allowed direct comparisons between the two organizations' responses to these imposed crises. This exercise was replicated six times over several years of offering this particular class in three different schools. As Krackhardt and Stern (1988) report, in all six trials, the results were the same: The cross-tied organization—the organization with the higher E-I index—performed better than its natural counterpart with the low E-I index. They suggest that high E-I index structures always will facilitate successful response to change efforts in conditions of uncertainty.

MODEL 2: VISCOSITY AND ISOLATION

The second model predicts almost the exact opposite from the E-I index model above. Borrowing from the literature on the genetics of altruism in biology (Boorman & Levitt, 1980), Krackhardt (1997) proposed a model that suggests successful change

is more likely when organizational subunits are not well connected with each other, when interaction between these subunits is minimal, and when the seed for change is planted at the periphery, not the center, of the network. But before we understand the different predictions of this model, we must first clearly outline the differences in the assumptions this model makes.

This model considers the diffusion process of change. That is, it assumes that some small fraction of organization members propose and support a change or innovation in the organization, and that the problem they face is convincing the rest (the majority) of the organization members that such a change is a good idea. We can think about such proposed innovations in three broad categories: innovations that clearly are superior to the status quo, innovations that clearly are inferior to the status quo, and innovations that are controversial—that is, not clearly superior or inferior, but rather having value influenced by other people's perceptions.

Everyone will adopt clearly superior innovations once people are made aware of them. Clearly inferior innovations will not be adopted. But in the case of controversial innovations, successful diffusion depends on the ability of adopters to establish a critical mass of support for the innovation. The likelihood of adoption for the innovation depends not only on the nature of the innovation but also the process of diffusion, which in turn is influenced by the structure of interaction among organization members.

The key that Krackhardt (1997) explored was the extent to which successful diffusion of such controversial innovations was affected by particular features of the social structure under very reasonable assumptions of social influence. He built a dynamic computer model to simulate the diffusion process to understand how controversial innovations might diffuse through organizations. In each time period, people (adopter or nonadopter) would seek out a set of others within the local part of the organization that they currently found themselves in and confer with those others on their beliefs about the innovation. They would retain their original belief that either the innovation is a good idea and should be supported or it is a bad idea and should not be implemented if they found anyone who agreed with their original beliefs about the value of the innovation. If they were surrounded by people who disagreed with them, they would tend to convert to the other belief (in other words, change from being a nonadopter to being an adopter or vice versa).

To be specific, Krackhardt (1997) specified the following set of assumptions:

1. Each adopter searches randomly through L_a others to find a likeminded individual. Each nonadopter searches randomly through L_n others to find another likeminded individual. Adopters are more likely to proselytize the status quo-oriented nonadopters than the converse; therefore, $L_a > L_n$.
2. If in the process of the search, individuals find at least one other individual who agrees with them, then they retain their current belief. This assumption acknowledges the work of Asch (1951) who found that it required only one person to agree with the participants of his experiments to allow them to retain their beliefs, no matter how many confederates disagreed with the participants.
3. If an adopter fails to find at least one other adopter in the course of his or her search, then the adopter will convert to being a nonadopter with probability α . This is the probability of conversion from adopter to nonadopter for those who find themselves isolated.

4. If a nonadopter fails to find at least one other nonadopter in the course of his or her search, then the nonadopter will convert to being an adopter with probability τ . This is the probability of conversion from nonadopter to adopter for those who find themselves isolated.

This set of drivers for the model was a reasonable way to capture the micro decision-making process as to whether any individual would become an adopter of the innovation. Krackhardt (1997) further stipulated a macro structure that constrained people from interacting with just anyone else in the organization. He posited that interactions were a function of two structural features: (a) clusters of individuals in the organization permitted free and random interactions among people within a cluster and (b) interactions between people in different clusters was restricted (probabilistically) by a viscosity parameter v . On occasion, individuals could "visit" or "migrate to" some subset of other clusters. When they did, they would be confronted with a new subpopulation of people who may be adopters or nonadopters or (most likely) a mix of the two. Depending on this mix, this individual then would either be converted or not depending on whom they interacted with and the parameter values in the assumptions of the model above.

Krackhardt's (1997) computer simulation of this process allowed him to explore how sensitive the adoption of the innovation or change was to the various parameters in the model. What was most intriguing about his results was that the long-term survival of the change was relatively insensitive to the particular parameters in the micro part of the model relating to individual characteristics of how far actors search to find likeminded individuals and how likely they are to change, to convert from one position to the other when isolated (L_a , L_n , α , τ). Instead, the success of the change was a function of three features of the overall structure of the organization: (a) the location of the original proponents of the innovation within the structured arrangement, (b) the permissible bridges between clusters that described which clusters different people could visit or migrate to, and (c) the rate v at which people were likely to visit these other clusters. Across a wide range of structures and parameter values, Krackhardt discovered that the following general principles held:

Principle of Peripheral Dominance: It is more likely that a change will be adopted throughout the organization if the adopters occupy a cluster that is at the periphery and has relatively few bridges to the organization than if they occupy a position at the center of the organization's structure.

In contrast to the E-I model, this result suggests that if the innovation is controversial, the change agent is better off focusing on a relatively secluded island or cluster to begin the change process. This peripheral location is less likely to attract a backlash from the nonadopters who, because of their superior strength in numbers originally, can overwhelm the adopters. Similarly, controlling the amount of movement between the cluster containing the original adopters and the clusters of nonadopters allows the innovation to become established among the adopters before being introduced to nonadopters within the organization. This leads to Krackhardt's (1997) second general principle:

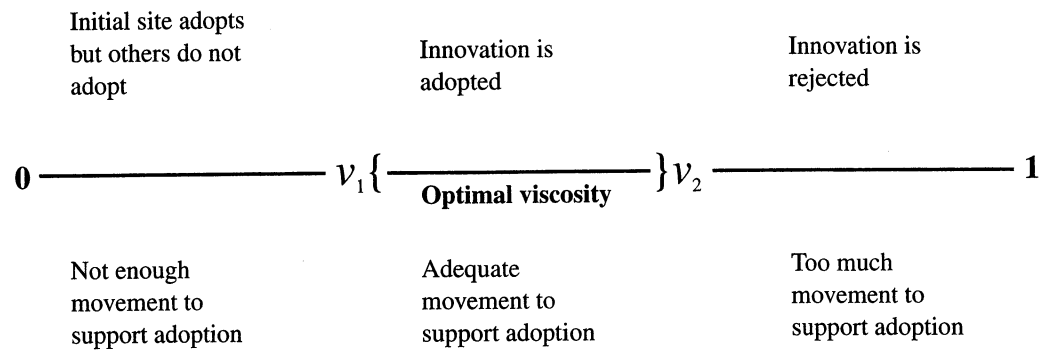


FIGURE 1: Range of Optimal Viscosity

Principle of Optimal Viscosity: The degree of viscosity, v , the rate of migration from one cluster to another, has two threshold values, v_1 and v_2 , such that $0 < v_1 < v_2 < 1$. As Figure 1 shows, if v lies below the first threshold v_1 , then the migration rate is so slow that very little conversion occurs at all. In this case, in the long run the organization will forever have a small group of adopters and a majority of people in the rest of the organization who remain nonadopters. If on the other hand, v lies above the second threshold, v_2 , then the larger group of nonadopters will invade and dominate the adopters, yielding in the long run an organization returning to the status quo state. However, if the migration rate v lies in the narrow range between v_1 and v_2 , then the adopters will convert nonadopters at a greater rate than the converse, and in the long run the entire organization will successfully adopt the innovation.

Again, this result contrasts with the E-I model. The E-I model suggested that strong, dense, and bridging ties across organizational boundaries were the prerequisite to successful change in cases where response to change required common identity and trust. In this case, where the innovation is controversial and where the nonadopters are as likely to convert adopters as vice versa, strong interconnecting ties tend to give the advantage to the status quo so that the innovation is squashed. But as shown in Figure 1, there exists a narrow window of opportunity between v_1 and v_2 wherein the adopters can focus their efforts on a few adjacent clusters, can slowly convert them, and then once they build a base, can carefully move forward through the rest of the organization. With a slow, steady infusion of adopters into "foreign" cells, the nonadopters are not mobilized to invade back into the adopters' territories. It is a delicate balance, but Krackhardt's (1977) simulation suggests that there is a possible path using this strategy.

This viscosity model emphasizes that change is threatening to some and may involve institutional and cultural changes that are difficult and not clearly all good or all bad. If change agents spread themselves out too quickly and too thinly, they can inadvertently mobilize this backlash, which could diminish the prospects for change. On the other hand, if change agents are completely isolated from the rest of the organization, then the innovation will not diffuse. However, if the innovators are located on the periphery, with some limited contact and exposure to the rest of the organization, they can safely establish the change, demonstrate its effectiveness, and then spread the

word to one neighboring subunit at a time. Thus, the predictions of this model differ substantially from the predictions of the Krackhardt-Stern (1988) E-I model, which argues for maximally bridging ties across different groups to facilitate cooperation required for change. This model suggests that success is dependent on a low degree of bridging, slow movement in the direction of change, and a focus on not introducing change too quickly as this might mobilize substantial opposition.

MODEL 3: VARIANCE IN TIES AND STRUCTURAL LEVERAGE

A third model for the overall structural conditions for change stems from a mathematical principle of networks that has seen some attention in sociology and marketing. It sheds a different light on the structural features that facilitate or hinder change. Although the basis of the principle is mathematical, it has strong implications for social influence processes, so we will take time here to clarify the principle and its implications.

Suppose that you are an organizational outsider in charge of getting a large organization to adopt a change. Suppose further, you recognize that the acceptance of the change is largely a social process, that is, friends convince friends it is a good idea. As an outsider, you have limited knowledge of who the key opinion leaders might be. But you are confident that a seminar you have developed will convince any participants of the value of the change and convert them into supporters of the change. Your resources limit you to 20 people at the seminar. Which 20 people do you invite?

Unlike the previous model where change was controversial, in this case it is clearly superior. Therefore, change is likely to result from diffusion of information about the change. Rogers (1995) defines *diffusion* as the process of communicating information about an innovation among the members of a social system (p. 5). And studies of opinion leaders' roles in the diffusion of innovations suggest that individuals are able to influence the adoption decisions of their friends and contacts (Coleman, Katz, & Menzel, 1957; Rogers, 1995; Rosen, 2000). In this case, the managers who learn of the new change are likely to adopt it and likely to tell their friends about it. Once their friends know about the change, they also are likely to adopt the change with some positive probability.

Clearly, given the assumptions about the success rate of the seminar and the assumption about diffusion through friends, you could invite anyone, as long as they had some friends, and they would help move the organization closer to adoption of the change. You might randomly select managers within the organization, and they would then go forth and spread the word to their friends and so on until everyone has adopted the change. But also clearly, you are better off inviting people who have more friends than people with fewer friends. The question is, short of conducting an expensive organization-wide survey to find out how many friends everyone has, can you do better than randomly choosing 20 participants?

The deceptively simple answer to this question is, yes. What you can do is randomly select your 20 potential participants, then ask each of those potential participants to

randomly nominate one of their friends. The crucial step here is that you then invite these 20 randomly nominated friends to the seminar and leave the originally selected 20 potential participants at home. The mathematical fact behind this strategy is that it can be shown that these 20 randomly nominated friends will virtually always have more friends than the originally selected potential participants.

Feld (1991) and Krackhardt (1996) independently discovered the mathematical feature that led to this influence strategy. Feld's context was sociology, and he showed mathematically "why your friends have more friends than you do." Krackhardt applied the same idea to marketing, showing that diffusing a new product into a population could be more efficiently done through giving free samples to friends nominated by a set of randomly selected members of the population. He called this strategy structural leverage.

How much more efficient the structural leverage strategy is than the random selection of seeds was not discovered until later when Feld and Krackhardt (1999) joined forces. They show that if you randomly choose seeds for change in an organization, this is the "direct seeding method," you will get diffusion at some rate K through the friends of your randomly selected seed. But if you ask the potential seeds to nominate one of their friends at random and then use that nominated friend as the seed for change instead of the originally nominated person, the structural leverage strategy, you can expect a rate of diffusion of $K+\Delta$. It turns out that Δ is always nonnegative, virtually always positive, and can be as high as K , meaning that the successful diffusion happens twice as fast as would happen if one relied on direct seeding for change.

Feld and Krackhardt (1999) showed that one could ascertain the expected advantage (the size of Δ) in using the structural leverage method through a relatively simple sampling of network ties in the overall structure. What Feld and Krackhardt demonstrated is that the indirect seeding method for change will be dramatically more efficient at diffusing the change when the number of friendships maintained by organization members varies significantly. If a social network is characterized, on the average, as having high variance in numbers of friends, then the Δ approaches K and the payoff for using the structural leverage method is maximized.

DISCUSSION

We have discussed three models that describe how network structures might affect change in organizations. The first model, the E-I model, suggests that successful change is enhanced by a thick network of strong bridging ties. The second model, the viscosity model, suggests that success in getting an organization to change is enhanced by a reduced number of cross-group ties and that change is more likely to be successful if it is introduced slowly and from the periphery. The third model, the structural leverage model, suggests that rapid change is enhanced through the use of secondary contacts rather than a group of randomly chosen primary contacts.

Can these diffuse and somewhat contradictory models be used to inform a change agent on how to go about implementing a change in the organization? Before we can

answer this question directly, we should discuss how much confidence we have in each model. Each of these models is a theory, an explanation that allows us to make some predictions about change. Although each theory was crafted from reasonable assumptions and built on prior social science findings, each remains largely untested in the real world. Of the three, only the E-I index has been put to any empirical test. First, Krackhardt and Stern (1988) conducted the experiment using students in a university setting. In addition, Nelson (1989) demonstrated that high E-I index values were related to reduced conflict and more cooperative attitudes between divisions in a church setting.

The viscosity model makes predictions based on a computer simulation. This, however, does not constitute a test of the model. Rather, computer simulations allow the theory builder to deduce a theory from a set of explicit assumptions about a complicated (social) process (Krackhardt, 2000). To the extent that these complicated dynamic assumptions are true and complete, we can expect this theory to match the real world closely. But theories are never complete and their assumptions are (almost) never true. That is what science is about: testing whether the necessarily simplified explanations embedded in theories are "true" in that they are reflected in real world data. The viscosity model helps us to understand how change might be fostered within organizations by the potentially counterintuitive action of positioning the potential innovation away from the core of the organization and limiting interaction. Although we can think of examples that are consistent with this model, we do not have systematic scientific evidence that allows us to conclude much beyond the logical consistency of the statements embedded in the theory.

The third model has both a stronger underpinning and a weaker claim to the real world: It is based on a mathematically proven relationship. And the math proves something that is counterintuitive: It is *always* the case that the average number of friends of friends will be greater than or equal to the average number of friends. But whether this mathematical relationship can be translated to action, in the form of faster diffusion of change, remains an empirical question.

Each of the theories uses networks of relationships within the organization to address different types of organizational change. As Table 1 shows, the theories address change using different methods and mechanisms. Each theory likely applies best to support particular types of change in particular types of organizations. Beginning with the E-I model, we see emphasis on cooperation resulting from trust and shared identity that is induced through the interplay of informal friendship ties across formal organizational boundaries. This is particularly useful when the change is organization-wide and requires cooperation across subunits.

The viscosity model puts less emphasis on cooperation and more on the conditions that lead an individual actor to change his or her mind in the face of social influences. In the case of controversial change, one in which there is no obviously dominant and correct alternative and one in which people are likely to influence each other in both directions (for the change vs. for the status quo), paying attention to the network features of relative isolation and low visibility/viscosity may be levers that the change agent should consider.

TABLE 1
Comparing Network Models of Change

<i>Model</i>	<i>Type of Change</i>	<i>Method</i>	<i>Mechanism</i>	<i>Type of Organization</i>
E-I model	Organization-wide change	Strong ties across departments	Trust, Identity	Departmentalized structure
Viscosity	Adoption of controversial innovation	Peripheral seed, limited contact between clusters	Individual's decision to adopt	Dispersed units, physical or geographical separation
Structural leverage	Diffusion of clearly superior innovation	Social process—friends of friends	Broad awareness of innovation	Dispersed, low level of structure

Finally, the structural leverage model focuses on the relative impact and speed of diffusion for different strategies of selection of change agents. If the situation is not controversial (not likely to generate resistance), if the goal is maximum impact in a relatively short period of time, and if the question is, "Who should propagate the change?" then this model can help make that selection.

Each of these theories could prove to be a powerful tool for individuals who are managing change because each allows managers to benefit from insight about the structure of networks within an organization and their relationship to change even in the absence of complete information about the precise structure of those networks. This is important because people are not always very good at "seeing" the informal network structure within their own organization. For one small company, the managers could accurately identify the presence or absence of slightly less than half of the advice relationships that existed and could accurately identify the presence or absence of one third of the friendship relationships that existed (Krackhardt, 1990). Bringing someone in from outside to map out the networks that exist within the organization can also be costly and time consuming.

Table 2 outlines what managers need to know and how they can act on it to facilitate change within their organizations. The E-I model requires managers to be aware of the structure of departments within the organization, which should be readily available information. Then to be sure that the organization is prepared to respond to organization-wide change successfully, managers should encourage the development of ties across departments. For the viscosity model, managers need to know the structure of departments, or clusters, within the organization and the degree of interaction among departments. Then to foster innovation, managers need to be sure that the department in which the innovation is first introduced is at the periphery of the organization and that the interaction that occurs between the adopting site and other sites in the organization is carefully regulated to avoid isolation or dilution. This action is very different from the action recommended by the E-I model in which interdepartmental interaction is always encouraged. Finally, to use the structural leverage model, managers need to

TABLE 2
Information and Action Necessary to Support Change

<i>Model</i>	<i>What Managers Need to Know</i>	<i>Managers' Actions to Facilitate Change</i>
E-I model	Structure of department	Encourage development of ties across departments
Viscosity	Structure of departments, Degree of movement across departments	Introduce innovation at periphery of organization and regulate flow of movement across departments
Structural leverage	List of friends of randomly selected organization members	Contact a friend of randomly selected organization member to introduce change

know the list of friends within the department for a randomly selected set of organization members, but do not require complete information about all of the friendship relationships that exist within the organization. Then managers may choose one friend to be the seed for diffusion of change. Managers also may use the lists to compare the number of friends maintained by different members of the organization to estimate the benefit of using the structural leverage strategy rather than the direct seed strategy for diffusing change.

Thus, in the end we suggest that these theories are less contradictory than they are complementary, each being most useful under different contingencies. Putting these three models together suggests that part of the dialogue in organizational change should be around the shape and characteristics of the overall network before deciding on any strategy for change. In other words, although many in organizational studies have focused on structural holes (e.g., Burt, 1992), perhaps we should move to a focus on structural wholes.

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