THE KNOWLEDGE IN THE NETWORK

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Luck is the residue of design. Branch Rickey

Below is an image of the network of connections among first year MPP students at the Kennedy School. This network is the circulatory system of the student body. Through this system flows information that is useful and sometimes vital to students. Where a student is placed in this network affects whether and when s/he receives information—and, in fact, centrality in this network is strongly related to grade performance (Lazer and Katz 2000). As a manager, you are also part of a useful and sometimes vital information flow, and your position in the network affects when and where you receive information, which, in turn, almost certainly affects your performance.

Further, if you are sufficiently high in the hierarchy, you can affect the shape of the network of individuals below you through a variety of policies. For example, at the Kennedy School students are divided into three "cohorts" that take their required classes during the first year together. This has a profound effect on the shape of the network in figure 1—students are twice as likely to know someone in their cohort as outside of their cohort. Similarly, as a manager you can adopt policies that affect the networks of individuals in your organization, and those networks can affect the performance of your organization (Flap et al. 1998).

[figure 1]

This essay examines a particular dimension of informational networks—the spread of information regarding innovations.[1] Innovation in the managerial setting involves either the development of a totally novel way of doing business, or, more typically, the synergistic recombination of old ways of doing business. Innovations face a number of challenges. First, individuals usually have a lot invested in the status quo—both psychologically and in (human and physical) capital. Second, developing an innovation and/or being an early adopter of an innovation typically involves risk—a leap into the unknown. From the individual point of view, there exists a much greater downside than upside to innovating. It will therefore often take a lot of evidence to dislodge the status quo.

Branch Rickey, certainly the greatest front-office innovator in baseball's history, once said, "Luck is the residue of design." This is as true in networks as in sports. The shape of an individual and organization's network creates "luck" (good and bad). Networks are the key to innovation in several ways. First, they affect our incentives to develop innovations; second, they create opportunities for synergistic recombination of old ways of doing business; and third, they augment the flow of information regarding innovations through a population. There is great variation in the structure of individual and organizational networks—and the shape of those networks affects individual and organizational success. Below we discuss the development of professional networks designed to facilitate information flow, and focus on two questions: (1) as an individual within the network (e.g., one of the points in figure 1), how do you structure your professional network to maximize the information you receive regarding other managers'

[1] See Baker (1994) for a more general discussion of the practical managerial lessons to be drawn from the academic work on networks.

experiences with innovations? (2) as an individual whose policies can affect the overall shape of the informal network in the organization, which policies will encourage the formation of ties through which useful innovations can be created and disseminated?

I The individual in the network

Imagine that you are confronting a managerial challenge—your organization is operating at the boundaries of its capacity; it's losing its best employees; etc. What is your first step in handling this challenge? Typically, you call others who have been in a similar position—e.g., if you are in a county government, you call peers in neighboring counties; if you run a job training program, you call others that run job training programs, etc. You implicitly recognize that while the optimal solution may be out of the range of your experiences, it may be within the range of the experiences of collective others. The innovation to address your problem may be new to your organization, but not to others. The key challenge for you, then, *is to use the experiences of <u>others</u> to help solve <u>your</u> problems*. There are two tools at your disposal to collect information on others' experiences. The first is to plug into central information sources— e.g., subscribe to specialized publications that contain useful information; upgrade your organization's knowledge base through executive programs, etc. This model of information acquisition, called "central source diffusion," is graphically depicted in figure 2 (Lave and March 1975).

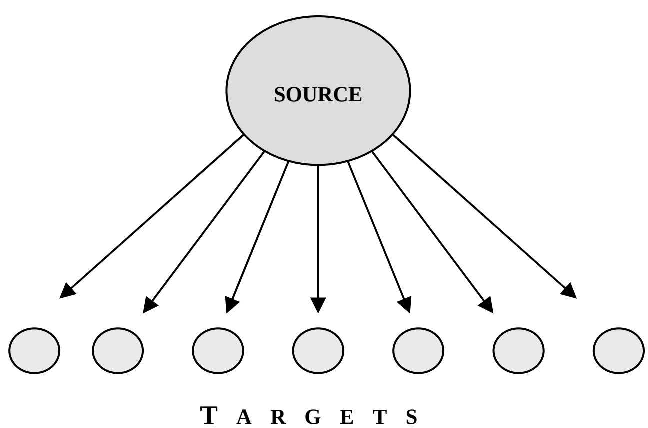

Figure 2

This essay focuses on the second tool managers use, but typically fail to exploit in a self-conscious, strategic, fashion: the "network." We define "network" as the connections amongst the population of individuals with experiences potentially relevant to you.[2] Research suggests (1) that very few individuals are willing to adopt an innovation without having spoken to people who have used and endorsed the innovation (Rogers 1995) and (2) informal networks are essential for information and resource exchange for innovation (Tsai and Ghoshal 1998). Individuals need to extract the collective experiences within the network to apply to their own challenges. The first principle of innovations is:

<u>*Principle 1.1*</u>*: Leverage the experiences within the network to find the solutions to your problems.*

A successful innovation will typically follow an "S" shaped diffusion pattern: a few early innovators/adopters, who then spread the word to the many non-adopters. Since there are only a few adopters to spread the word, the initial spread of an innovation will be slow. As an innovation spreads, it creates a larger body of experiences for non-adopters to draw from, resulting in an acceleration of the spread. At the point where most people have adopted an innovation, the spread decelerates as a few late hold outs adopt. Figure 3 illustrates the S-shaped spread process, plotting number of adopters over time. Notably, a key and repeated finding of diffusion literature is that individuals in the communication network who are well connected tend to be early adopters (e.g., Ibarra 1993).

[2]This is a slight oversimplification. In fact, central source and network diffusion sometimes operate together—in a "two-step" process (Lazarsfeld and Menzel 1963)—where some individuals receive information from a central source, and that information then spreads through the network.

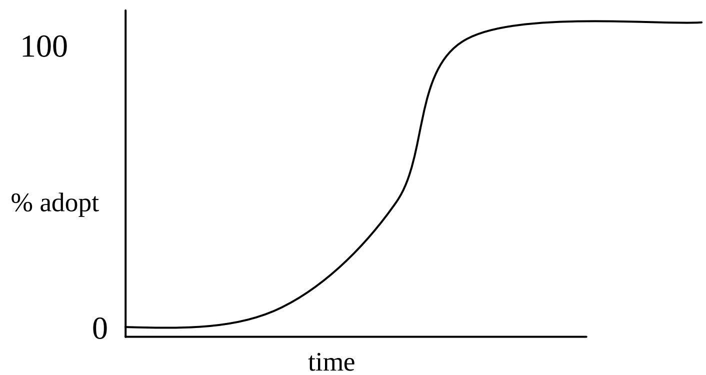

Figure 3

It can take many years for a useful innovation to spread (Rogers 1995). The challenge to the individual in the social system, therefore, is (1) to adopt "useful" innovations relatively early in their spread, especially in a dynamic world where an innovation may have a short shelf life, but (2) not to adopt innovations that are expensive and counterproductive (see section below on fads).

Self-evaluation 1: Do you regularly talk to other managers about problems and opportunities in your respective organizations? Using the first column in appendix 1, list people outside your immediate organization whom you talk to regularly. Next to each name list useful insights you have gained from that person (keep this list for future self-evaluations). Are you making optimal use of the experiences and knowledge of the people you talk to?

The trick of principle 1 is strategic execution. It is unrealistic to survey the experiences of everyone in the network with respect to particular issues for two reasons: quantity and quality. Most networks have too many people in them for you to get to know them all. Even a short conversation multiplied by a large number will result in a managerial gridlock of too much talk and too little action. Further, these conversations will usually not be short, for two reasons. First, descriptions of problems and solutions typically take time. Second, it is necessary to exchange information not just on problems and solutions, but contextual details around problems and solutions. A solution in one setting may not work in another setting. A human resources program aimed at addressing turnover in a government agency in an urban setting that is staffed largely by women may not fit the circumstances of a suburban agency staffed by men. How do you strategically shape your network so as to maximize the flow of useful information? Principle 2 is one almost everyone follows, although, as discussed below, it can backfire:

<u>*Principle 1.2*</u>*: Communicate with others who are socially and physically proximate to you.*

By socially proximate we mean individuals who are similar to you along socially relevant criteria—e.g., age, gender, race, etc. By physically proximate we simply mean spatially close.

Study after study indicates the *descriptive* accuracy of principle 2. Our personal networks are sharply delineated by race, age, gender, religion (e.g., Marsden 1988; Huckfeldt et al. 1995). Experimental studies that offer individuals a choice of discussion partners replicate this pattern (e.g. Miller and Suls 1977, Byrne 1971), and it is repeated in organizational settings (Ibarra 1993). In policy settings, Walker (1971) found that states paid especial attention to their neighbors and to states that were similar along a number of demographic and economic dimensions, and Kearns (1992) study of 127 Pittsburgh suburban communities found that managers disproportionately communicated with other managers with similar formal education and length of government experience. All in all, "birds of a feather flock together" and "birds close together flock together" are some of the most robust findings in social science.

There are multiple reasons why our networks are so socially and spatially constrained. The first two are simply serendipity and cost. We are more likely to *meet* people who are close to us. Meeting is a necessary (but not sufficient) condition to creating a relationship. We are therefore more likely to form relationships with people spatially close to us because we are more likely to meet them.[3] Similarly, we are more likely to intersect with people with like interests—because those interests will funnel

[3] Verbrugge (1977) calls this the meeting-mating process.

them to the same events, which then create opportunities to meet. Second, it is cheaper and more efficient to meet with people who are close. It is much easier to knock on a neighbor's door than a door on the other side of town.

In addition to serendipity and cost, there are deeper, informational reasons for this pattern. Socially and physically proximate individuals are more likely to have experiences relevant to you. Imagine you are moving to a new city. Who would be most useful to speak with? To the extent that the length of the commute matters to you, you want to talk to people who worked near you. If you have children, you want to talk to other people with children who would be sensitive to issues regarding schools, etc. Finally, you want to talk to people with a similar income—it wastes time to locate a child friendly neighborhood if the homes cost twice what you can afford.

In short, in house hunting, as in many informational settings, social and physical proximity predicts how useful an individual's experiences will be. It is not impossible that if you have kids and work in the north side of a city, that you would get useful information from someone with no children who works in the south side of the city for twice your salary—it is just less likely.

If you are a manager, you need to talk to people in situations similar to yours. Your strategic informational challenge is to accurately assess the relevant metric of similarity. Many of the criteria we unconsciously use in choosing people to interact with may not be so relevant to our managerial challenges—e.g., age, gender, etc.

An example: there has been a recent effort to create a national database of the DNA of convicted criminals. This effort is mainly occurring at the state and local level, with the FBI has been playing a critical coordinating role. Different state labs use different technologies. A lab may be locked into a particular technology—e.g. due to investments in expensive physical and human capital. Thus, the manager of that lab will be interested in innovations that maximize what the lab gets out of those investments. Ties to other labs using similar technologies would be more useful than ties to labs using different technologies. However, if a lab is in a position to update its technology, then having ties to labs using a variety of technologies will be more useful.

Self-assessment 2: Copy the names from appendix 1 into appendix 2. Use the first row of appendix 2 to draw up a list of characteristics that distinguish you—e.g., age, gender, years in organization, etc.— and distinguish your organization—e.g., size, type of clientele, type of employees, etc. Within these dimensions, how similar to you are the individuals you talk to, and how similar to your organization are the organizations to which the individuals on the first list belong? More generally, evaluate the extent to which the experiences these individuals have in their organizations can be effectively applied to you and your organization.

Individuals face a trade-off in the quality and quantity of their ties. If you invest a lot of time in getting to know just a few people, those people, if they possess any useful information, are especially likely to pass it on to you. However, what you gain in depth of informational resources you lose in breadth. Four factors dictate whether you want to invest in a few "strong" ties or many "weak" ties: (1) the *complexity* of the information being transmitted (Hansen xx); (2) the *competitiveness* of your informational environment (Uzzi xx); (3) the *perishability* of the information being transmitted (Kraatz xx) and (4) the *riskiness* of the potential decisions you are discussing with your ties (Albrecht and Ropp 1984; Krackhardt 1994). If the information is complex, then a larger pipeline—a strong tie—will be necessary to convey it. Thus, if you are dealing with a complicated policy area, strong ties are relatively more valuable. If you are dealing with a dynamic competitive informational environment—where information is time-sensitive and highly perishable—then strong ties are more valuable, because people tend convey information to their strong first.[4] If the potential decision is risky, then having a trusted friend convey a recommendation counts for far more than having a passing acquaintance convey that same information.

Principle 1.3: The more complex, competitive, and dynamic an informational environment, the greater the value of strong ties relative to weak ties.

[4] For example, in a study of lobbying networks in health policy, Carpenter et al. (2000) found that the more lobbyists were interested in a particular policy, the more they invested in strong ties relative to weak ties. Information regarding legislation, federal rules, etc., is highly perishable, and potentially very competitive.

Self-assessment 3: The people you listed in self-assessment 1 are your strong ties. Now do the same exercise for your weak ties. List your professional acquaintances—people outside your immediate organization who you would recognize, and have a discussion regarding professional matters, but do not regularly interact with. People typically have a large number of weak ties— thus use directories, conference listings, etc., to help recall them. What useful information have you gotten from these people? Are you making optimal use of your weak ties? How do you maintain this set of weak ties to keep them viable sources of information?

Also: how complex, competitive, and dynamic is the managerial environment you work in? Does your balance of strong and weak ties match your managerial environment?

In a landmark study of social networks, "The Strength of Weak Ties," Mark Granovetter (1974) found that individuals disproportionately found out about jobs through their "weak" ties—e.g., through acquaintances—rather than through "strong" ties—close friends and family. This was not the result of some perverse reverse-favoritism of acquaintances over friends. Rather, it was a reflection of the *structure* of the strong-tie vs. weak-tie networks. Your close friends and family have a much higher probability of knowing each other than your acquaintances. This has a very important implication—strong ties tend to provide the same information that other strong ties are already giving you. Weak ties are more likely to provide novel information.

The point here is not about making friends versus making acquaintances—it is about the structure of your informational network. The people that you know are not simply passing along information about their experiences, they also act as a conduit for information about other people's experiences ("I've heard that xx is a good restaurant." "People say that xx is a good school." Etc.). If you are talking to people who know each other, they will often convey only information you have already received. Thus, you need to be sensitive to the groups that an individual will plug you into.

Imagine you talk to individuals A and B, who both talk to individual C. Further, individuals E, D, and F talk to each other, but not to anyone else. Who would it make the most sense to talk to, if you had a choice, individual C or individual E (figure 4)?

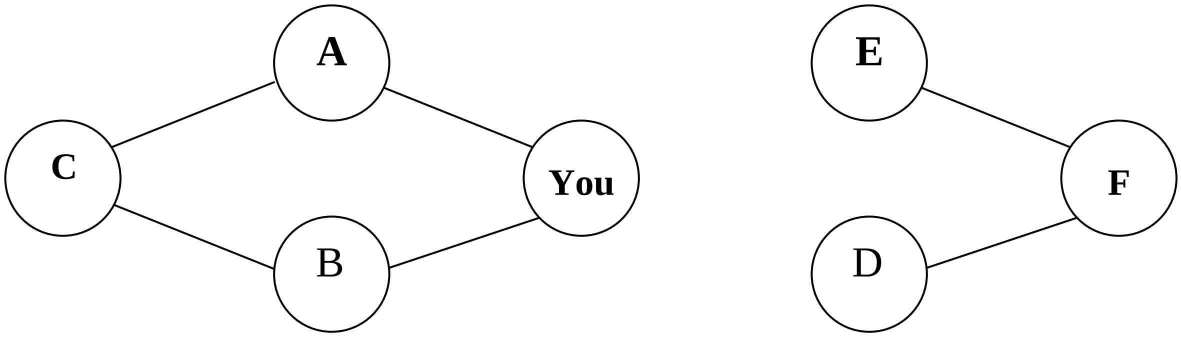

Figure 4

Clearly, all other things being equal, individual E. You are already getting the benefit of C's experiences, to a certain extent, because you hear about them through individuals A and B. You are not receiving any information about the experiences of D, E, and F. Thus, by talking to E, the information regarding E's experiences is novel, plus you get novel information about D and F's experiences.

The general lesson of the above discussion is that you need to assess how "in-bred" your personal advice network is:

Principle 1.4: Minimize the redundancy in your informational network.

Of course, all other things tend not to be equal. You will typically have a lot in common with A and B, and C will have a lot in common with A and B. Thus, it is likely that you have a lot in common with C. Second, the fact that A and B know C greatly increases the likelihood that you will be introduced to C. In fact, generally, if you followed principle 2 with respect to the people that you "happened" to meet, you would very likely have gathered around you a set of similarly situated, like-minded individuals who know each other. Informationally, this is not a healthy situation. In an ideal world, you would be exposed to a diverse set of viewpoints and sources (principle 3) from individuals who face similar challenges (principle 2). In the real world, you need to balance the need for diversity with the need for similarity. In fact, there are potentially great benefits to making ties to a different network of managers, who face some of the same challenges that you do, because it is likely that different communities, because of accidents of history, converge on different solutions to similar problems. There may be also groups that approach similar issues from a very different perspective that would have useful information for you. In the DNA database case, relevant outside communities include academia and industry—where individuals from those sectors clearly have different orientations than the managers of the DNA labs, but might provide useful information regarding potential innovations. More generally, by communicating with even one person in that community, you may get entrée to a whole different set of approaches to the same problems you confront.

> Self-assessment 3: Write in the list of strong ties in the inside circles in appendix 3. Draw lines between the people who you believe communicate with each other. How many of the people you talk to also talk to each other? In the outside circles, write down the groups from which that individual acts as a conduit of information to you. From your experience, to what extent is the information you are receiving from one individual the same information are you already receiving from other individuals? To the extent it is possible, compare how in-bred your strong ties are relative to your weak ties.

Imagine the following scenario. In your judgment, a potential innovation is not worth adopting. However, you observe someone else adopting that innovation. This might give you to pause—perhaps they know something you don't know. Then you observe another person adopting this innovation, and you jump on the bandwagon—figuring that they cannot both be wrong. Unbeknownst to you, someone else is watching all 3 of you, and concludes—all 3 of you couldn't be wrong—and also adopts. The question is—how much more information does that 4^{th} person have than you did? It would appear to be 50% more—observing 3 adoptions vs. 2. However, in reality, your decision conveys no information to the 4^{th} individual. You adopted—despite your reservations—because of the first 2 adoptions. The information your decision conveys is completely redundant with the information that the first adoptions convey. Nevertheless, at this point, the bandwagon is moving—all because a few people adopted this innovation. This phenomenon is known as an "information cascade" (Bikhchandani et al. 1998), and the resulting problem as the *information aggregation problem* (i.e., the problem is that information regarding an innovation is not aggregating after the first couple of adoptions).

In fact, fads, manias, bubbles, "mass hysteria," have a long history (e.g., see MacKay 1841). Management ideas are particularly good candidates for the subject of fads. Management is fraught with ambiguity, and social signals are a way of resolving that ambiguity (indeed, that is the point of this essay). However, fads are particularly dangerous when you have redundant informational networks, because it may seem like you are receiving information from more sources than you really are.

How does one avoid being swept up in a fad? Part of the answer is following principle 1.4—the more diverse your informational sources, the more reliable your informational base. The other part is delving into the experiences of adopters with an innovation:

<u>Principle 1.5</u>: Critically evaluate other people's experiences with an innovation.

If you simply adopt an innovation because other people have, you are adding to the information cascade. If you stop and evaluate other people's experiences, you might find that those experiences are not positive. This suggests the need to ask about how much an innovation has cost, how much it has contributed to performance, etc. In doing so, not only are you reducing the risk of adopting an undesirable innovation, but also you are reducing the likelihood that an undesirable innovation will spread further.

II The organizational view

There are system-wide policies that can facilitate the fruitful spread of innovations. It is in fact generally easier to create and spread information within organizations than between organizations. In fact, there is an emerging view among organization theorists that "organizations have some particular capabilities for creating and sharing knowledge that give them their distinctive advantage over other institutional arrangements, such as markets." (Nahapiet and Ghoshal 1998: 242). The formal structure of an organization has a strong impact on the shape of the informal networks within an organization—ties tend to be within divisions, between peers, with advice between levels of hierarchy generally unidirectional (e.g., Lazega and Van Duijn 1997; Hans 1996).

These structural tendencies sometimes create organizational disfunction— for example, creating isolated cliques between which there should be, but is not, communication. Organizations have a variety of mechanisms to foster intra-organizational ties where they would be useful. How should managers go about creating an organization through which beneficial innovations will easily flow? The overarching first principle is:

<u>Principle 2.1</u>: create an organization where people have access to each other's experiences.

<u>Organizational diagnostic 1</u>: Conduct a "network survey" of your organization (see appendix 4 for a simple example). To what extent are people who should be talking to each other actually talking to each other? Randomly select a number of pairs of people in the organization. The number of degrees of separation between two people in a network is simply the smallest number of lines between two people. How many degrees of separation between them? Typically, people who are more than two degrees of separation apart are "socially invisible" to each other (Friedkin 1980).

This is the systemic analog of principle 1.1. An organization needs to understand the value of its internal informal network. Policies should create opportunities for members of the organization to interact. This might be called the *water cooler strategy*—creating social focal points at which people can meet and talk. In particular, it is valuable to stimulate interactions among people who would have useful experiences to share with each other. Potential alternatives include:

- Occasional formal organizational gatherings—e.g., dinners, lunches, etc. There is a value in some of these to "assign" seating so that people do not simply interact with the same individuals every time.
- An organizational directory—on-line and paper versions—with phone #'s and e-mails.
- An ongoing on-line conference for individuals to post queries. [5]

Nohria (1992) offers a striking example from the Route 128 high technology corridor in the Boston area. The 128 Venture Group convenes once a month, and involves many of the high technology players in the area. It allows for the creation of new business ventures—innovations of a sort— through a synergistic combination of relationships among venture capitalists and people with potential ventures. 56% of the participants that Nohria followed found significant leads through the meeting.

In the DNA database case, the FBI has taken on the role of facilitating the creation of communication within this community of primarily state and local labs. It does the following: it circulates a directory with a listing and contact information for all of the labs that do DNA forensic work. It sponsors a once a year conference on the use of the database software. This conference, while useful for its stated purpose of directly spreading information about the database program, is also valuable for the connections it creates within the DNA community. Finally, it is in the process of adding an electronic conference to the central database that all labs are connected to. The conference will facilitate communication among the labs regarding the technical and managerial challenges they face.

<u>Organizational diagnostic 2</u>: what does your organization do to facilitate interactions among its members? Write up a list. Could your organization facilitate more useful interactions than it does now? Write a list of additional measures your organization could take.

[5] We would view electronic communication as a good complement to face-to-face communication, but not as a substitute (e.g., see Nohria and Eccles 1992).

Principle 2.2: *Facilitate ties between people who have mutually relevant experiences.*

Following principle 1, use the mechanisms listed above to bring together individuals who have mutually relevant experiences. Thus, if you have a series of organizational gatherings, it might be useful to invite subsets of the organization with mutually relevant experiences. Information technology can be especially useful as acting as "traffic cop" for useful communications—e.g., listservers allow for sending out mass e-mails to targeted audiences; electronic conferences allow individuals to go directly to the topics most relevant to them. One might also imagine creating a database, linked to directory information, of who has tried what innovations, who faces what challenges—e.g., having everyone in the organization list key descriptors of their corner of the organization, what innovations they have tried, evaluations of particular innovations etc.[6] Such databases would also help eliminate the information aggregation problem by creating a repository for experiences regarding innovations. The idea of such a database would be to make it as cost and time efficient as possible for someone make useful ties. The objective is to create a design that increases the likelihood of positive synergies among the members of an organization.

Principle 2.3: *Facilitate ties between people who would not "naturally" interact.*

As noted above, networks tend to spatially and socially constrained. Typically a network breaks down into a number of cliques, within which there is a lot of communication, and between which there is very little communication. From the individual point of view, this increases the informational benefit of bridging those cliques. From the organizational point of view, there is also particular value in creating links among those cliques to enhance the flow of information. In fact, just a few cross-clique linkages can have a disproportionate impact on how much information flows within an organization.[7] Thus, those efforts that have a particular impact on the

[6] Note that there need to be sufficient institutional incentives for people to contribute to such databases. Otherwise, they will evolve into empty—and useless—vessels.
[7] See Watts (1999) for a formal demonstration of this.

likelihood of two people meeting that otherwise would not are especially valuable, for example: organization-wide conferences, cross training exercises (where an individual from one office cross trains at another office).

This also points to value of what might be labeled a *network matchmaker*—an individual or set of individuals in an organization who knows everyone, and whose job it is to connect people who might usefully talk to each other. In fact, we all play that role to a certain extent—"I think Mark Smith tried that—give him a ring—tell him I told you to call…." Organizationally, this only works well if the person in this role (1) has the time to talk with a lot of people; (2) bridges many of the cliques within the organization; and (3) actively seeks to connect people who could benefit from meeting.[8]

> <u>Organizational diagnostic 3</u>: Are there any obvious "holes" in the organizational network you have produced? Are there any isolated groups in the organization? To what extent are ties simply spatially determined? In your organization, how might you encourage more interactions among people who are not physically proximate?

<u>*Principle 2.4*</u>*: Reward experimentation, not just success.*

Innovation requires risk taking—especially if you are the initial innovator. It is important to reward risk taking, even if it does not pay off, because every risk taken creates information for the organization about what works and what does not work. Paradoxically, there is a major possibility of under-investment in innovation in the public sector because <u>what one person finds produces payoffs for *other* people</u> (Dutton and Freedman 1985; Levitt and March 1988).[9] The organization should want the potential innovator to take into account the positive impact of his behavior on third parties in the organization. This will not happen automatically, however. Imagine the private market

[8] Notably, people may have an incentive not to play matchmaker—because in connecting two people who have information that is valuable to one another, this decreases the value of the erstwhile matchmaker as an informational source to those two individuals (Burt 1992).

[9] See Strumpf (1999) for a nice application with respect to decentralized government. Strumpf analyzes innovation in centralized versus decentralized governance as applied to innovation, finding that there is a danger that in decentralized governance there is a danger of under-experimentation because local governments will not take into account learning externalities. Also see Rose-Ackerman (1980) for an analysis that concludes that local governments will tend to underinvest in innovation.

analog— when an individual produces an innovation their first step is to patent it. Why? So they can receive the profits from the development of that innovation by themselves or others.[10] If it were impossible to patent inventions, innovation in the private sector would be vastly decreased.[11] In the public sector, there is no analog to patents. Once an individual has discovered a better way to do something, that information becomes public.

Ironically, by increasing the efficiency of the flow of information through an organization, one increases the "publicness" of the information and decreases the incentive to experiment. If the informational flow in an organization is so efficient that everyone rapidly finds out about a successful experiment elsewhere in the organization, then it would be tremendously tempting not to try something new until someone else tried it first. If someone else tries it and it works, then you adopt—a little later, but at much less risk. At the opposite extreme, where everyone operates in isolation in an organization, there is no temptation to wait until someone else has tried the innovation.

Imagine an innovation made in an organization that is 90% likely to produce the same amount of service for more money (say $10,000), and 10% likely to save the organization about the same amount of money. Is this a good experiment? If this was the only location where this innovation could be attempted, then this is clearly a bad bet. However, if this experiment offers definitive information on whether this innovation works, and if there are many other offices where this might be replicated, then this could be an excellent investment for the organization. To extend this scenario, imagine there are 100 offices where this innovation might be replicated. Then the innovation becomes a 90% bet to lose $10,000, and a 10% bet to gain $1,000,000—overall, a pretty good bet from the organization's perspective. However, if the manager of the office in question gets rewarded only on his/her bottom line, then the innovation seems like a terrible choice—90% likely to fail.

[10] The private sector story is somewhat more complex than this, since in sectors where there is a lot of innovation, often firms will enter into a network of agreements to share inventions. While such information sharing seems anathema to profit maximization in a competitive market, they are maintained in part by the benefits of the long run relationships that discourage parties from taking advantage of each other in the short run, and in part through a compensation system where one firm provides more useful inventions than the other receive compensation (Baumol 1991).

[11] Note that since there are no property rights within an organization, private sector organizations confront the same incentive within their organizations as public sector organizations. It is between private sector actors that, unlike the public sector, there are property rights.

What is therefore necessary is to (1) allow subunits of the organization enough discretion to experiment; and (2) to reward the subunits, in part, for the information they create for the rest of the organization.

<u>Organizational diagnostic 4</u>: Would members of your organization take the above bet? How much discretion do managers of your organization's subunits have? How much are they rewarded for taking risks that pay off from the organization's point of view?

<u>Principle 2.5</u>: Reward communication—especially asymmetric communication.

Communication is typically a give and take—e.g., peers talk to peers about their experiences. This reciprocity, in part, sustains a relationship. Thus, in figure 5, Joe and Diane each provide the other with about the same amount of information—and both gain equally from the relationship. They both have an incentive to continue providing the other with information in order to guarantee future reciprocity from the other.

Joe $\rightleftarrows$ **Diane**

Figure 5

Now consider figure 6. The information flow is just one way—from Diane to Joe. Why would Diane continue this relationship? There are a number of possible reasons why she might. First, Diane may expect reciprocity in other forms—e.g., respect, obedience, etc. Second, Diane may benefit from Joe's success.

Joe $\longleftarrow$ **Diane**

Figure 6

This is less likely to be the pattern where Joe is not a linear subordinate of Diane's—e.g., if Joe were a peer, or in a different division of the organization altogether. In fact, if Joe were a peer and Diane's performance were being measured against her peers, then she has an incentive not to share information with Joe.

In short, where there is naturally a symmetric information flow, individual incentives to exchange information generally align with the organization's interest. Where potential information flow is asymmetric, there will often be a mismatch between the individual's interest (not to share information) and the organization's interest (for the individual to share information). This is a major problem since many potentially useful communications are asymmetric, because some people have more experience than others. Unsurprisingly, a common organizational disfunction is the lack of asymmetric relationships where they would be functional (Weiss 1999).

This raises the more general point that not everybody in the network has the same influence on the system. For reasons of organizational position, personality, or conscious strategy, some individuals in a network end up being far more connected than other individuals. For example, in the network of MPP students, while the median number of ties a student had was 22, some had as many as 48 ties, and some as few as 2 ties. As noted earlier, more central actors are likely to be especially early adopters of innovations. From the systemic view, central actors play an essential role—they act as key arteries in the flow of information through an organization. They are disproportionately important in facilitating the spread of information regarding innovations. Thus, if there is a particular innovation that needs to spread through the organization, getting "buy in" from these opinion leaders is especially important—a blockage of a major artery in organizations, as well as people, can be very dangerous.

<u>Principle 2.6</u>: Pay special attention to central actors in your organization.

<u>Organizational diagnostic 5</u>: Who are the central actors in the network data you collected in the first diagnostic?

Carlson (1965—also Rogers 1995: 281-284) provides a nice example of this in studying the diffusion of a new approach to teaching math in Allegheny county. The new math did not spread after the first adopter adopted—because the superintendent of the first school system to adopt did not have ties to other superintendents. It was not until a particularly central set of superintendents adopted that the new math rapidly spread through Allegheny County.

The DNA database community provides another example, where an informal survey indicates that the heads of the labs in Florida and Virginia are especially central in the DNA lab network. Innovations adopted in those labs are therefore particularly likely to spread to other labs.

Conclusion

This essay has focused on the role of the network in spreading information regarding innovations in an organization. Paraphrasing Rickey, we argue that innovation is the residue of the organizational network. The key message here is that the network allows an organization to take advantage of the synergies and complementarities among its members. In innovation, these issues are fundamental—what one member of an organization knows might provide the missing piece of an innovative solution to another member's problem. From the individual point of view, the key question is: how do I maximize my chances of finding out about innovations that would be useful to me? From the organizational point of view, the question is: how do we design policies that maximize the likelihood that individuals who could usefully learn from each other will talk to each other? The 11 principles outlined above are a design to create individual and organizational "luck."

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Appendix 1

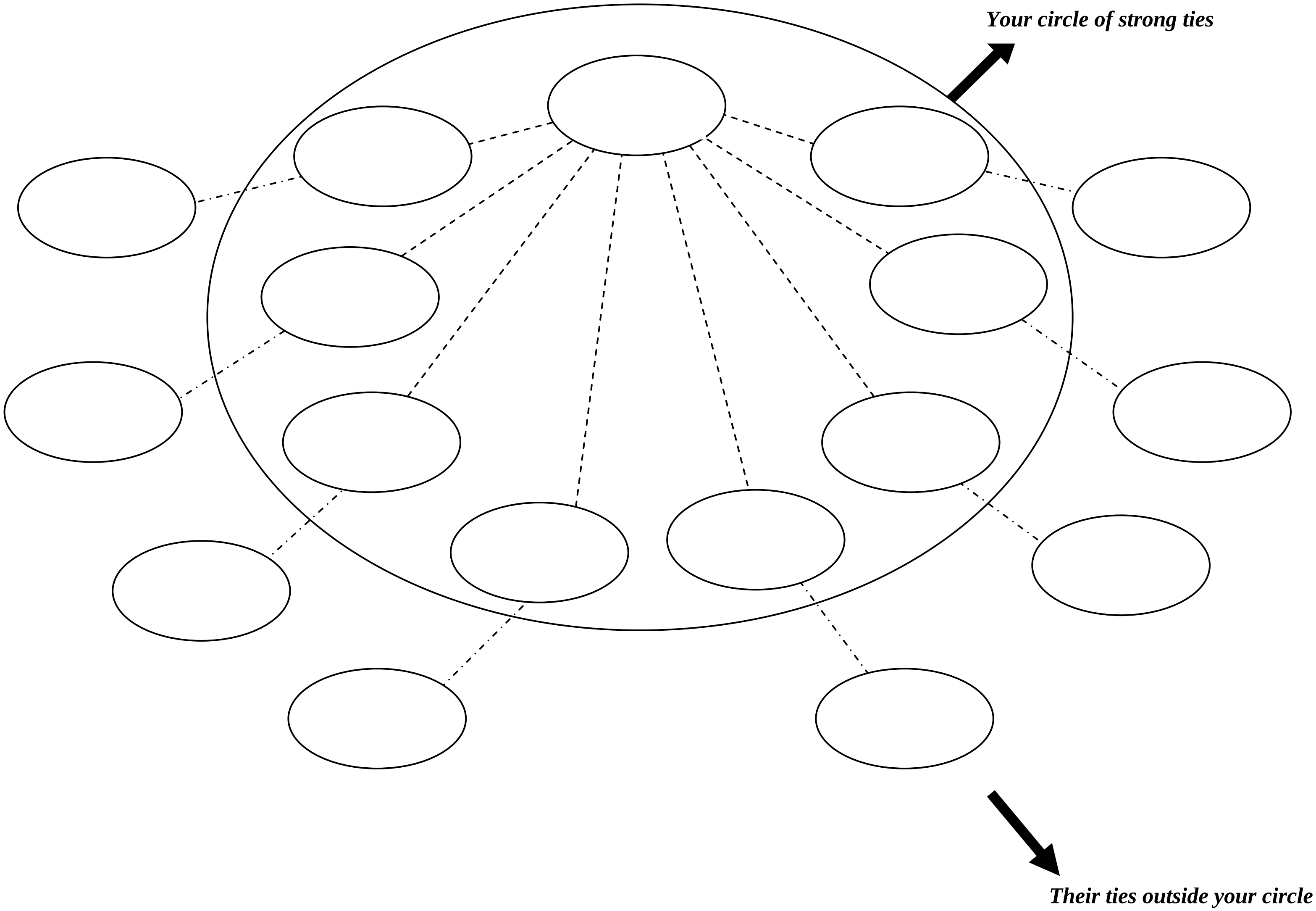
NAME	LIST OF USEFUL INFORMATION GAINED FROM THIS

Appendix 2

Other factors?

	Name	**Gender** Same/ Different?	**Age** Years- Difference?	**Exp. in Organization** Years- Difference?	**Physical Proximity?**			
WHO DO YOU TALK TO REGULARLY ABOUT PROBLEMS AND OPPORTUN-ITIES?								

Appendix 3



Appendix 4

Names of relevant individuals in your organization:	✔ Have you met this individual?	✔ Do you regularly consult with this individual regarding managerial issues?