ORGANIZATIONAL COMMUNICATION NETWORKS

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Communication and other social networks have been the subject of considerable scholarship since the eighteenth century (Mattelart, 2000), but the past two decades have produced unprecedented growth in network theorizing and research. Further, this interest in communication and information networks now spans the social sciences, including sociology, psychology, history, political science, organization science, and economics, as well as the physical and life sciences. As Castells (2000) has so comprehensively elucidated, we are now living in the age of the network society.

Networks, in general, are structural configurations that emerge when sets of relations are applied to sets of entities. Entitles are typically called nodes, points, or elements and relations are called links or ties. Communication networks reflect patterns based on message and information flow relations among the elements of the network, thereby creating the information infrastructure on which all organizations and societies depend. Network configurations that occur across a large number of organizations are called network forms, and organizations that share a common network form are viewed as a population. Historically, organizational communication focused almost exclusively on nodes defined as people who were members of specific organizations. Today, a much broader view of networks envisions both human and nonhuman nodes, the latter including elements like computer avatars, webbots, and knowledge repositories.

The study of networks tends to pursue one of two general research questions: 1) why are particular networks configured as they are? and 2) what are the effects of different network configurations on the people who comprise them, the performance of

the institutions which contain them, and the fitness and survival of the larger organizational communities in which they operate. These questions will be addressed after a brief presentation of basic network concepts. We conclude with a brief discussion of recent trends in the field.

Network Concepts and Measures

Nodes and ties can be studied in a variety of ways. Many relations can be applied to create organizational communication networks. "Shares information with," "innovates with," "is friends with," are all different relations. Network research has indicated that when different relations are applied to the same organizational members they produce very different networks. Networks can be created by applying one relation to the nodes, forming a uniplex network, or by applying two or more relations to the nodes, forming a multiplex network.

Typically, relations are defined on one set of entities, such as people in organizations, called one-mode networks. However, relations can also be defined between two or more different sets of entities, such as organizations and people. These are called n-mode networks. Two mode networks that relate people through common participation in organizations (such as professional associations) or events (such as meetings) are often called affiliation networks.

Ties typically have a number of properties that impact the nature of the network. Many organizational communication relations link people directly with each other. Links that tie people together through intermediaries are called indirect links. Relations also have properties such as sign (positive or negative), frequency (how often the link is used),

strength (weak to strong), direction (from one member to another), and stability (existence over time).

A number of important measures can be applied to the people or elements of a network. Degree is the total number of links with others in the network. In-degree is the number of directional links pointing to a person and out-degree is the number pointing away from a person. Centrality measures (in several different ways) how close each person is to all other members.

Metrics also exist for networks as a whole. Size simply indicates the number of people in the network. A component is the largest subset of connected people. Connectivity is the extent to which people are linked to one another. Density is the ratio of the number of actual links to the possible number of links. Centralization measures the variation in average nodal centrality of the entire network.

One important aspect of networks is their suitability for multilevel analysis, which compares different parts and wholes. For example, analysis can be at the level of nodes, dyads (a pair of nodes), triads (three nodes), cliques, or the entire network. Dyadic network properties include the degree to which directional ties are mutual or reciprocated, i.e., the degree to which a link from A to B is mirrored by a link from B to A. For triads, properties of transitivity and cyclicality apply. Transitivity implies that if A communicates to B and B communicates to C, then A also communicates to C. Cyclicality represents a closed loop: A →B, and B→C, implies C→A. The next higher level in the network is the clique or group, which is composed of members who relate more to each other than to others in the network. Cliques have properties such as cohesion, the degree to which the members of the clique are tightly connected to one

another. Given the various properties mentioned above, it is easy to see that networks are inherently multilevel. Scores at one level, such as a large number of isolates, do not necessarily affect the network's dyadic reciprocity or triadic transitivity. Further, these measures do not necessarily indicate the properties of the overall network, such as density (See Brass, 1995 for additional details).

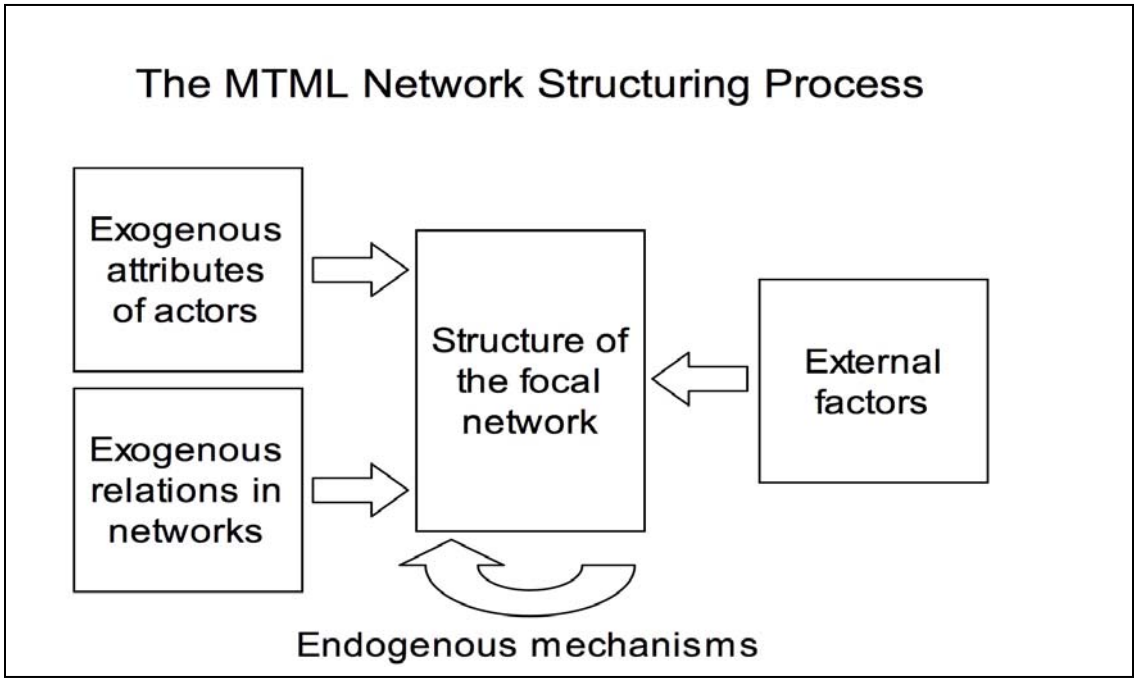
The analysis of network properties requires a special set of statistical methods. Because networks describe relationships between entities that are inherently related to rather than independent from one another, the assumptions required for the use of normal parametric statistical tests are violated. Thus, network researchers have developed a variety of tools for addressing networks in a statistically appropriate manner (see Wasserman & Faust, 1994). The key concept in most statistical analysis of networks is that an observed property of a network should be compared to the likelihood that such a property could have occurred by chance in a network of the same size. (See Robins, et al, 2007).

Theories of Network Structure

One of the critical challenges in network research is to explain how specific communication network configurations evolve out of the extremely large set of possible configurations that could evolve. The evolution of the observed configuration of a focal network can be explained by four major factors. These are (1) endogenous factors internal to the network, (2) attributes of the people or other nodes in the network, (3) other networks, including the same network at earlier points in time, and (4) network externalities. Endogenous factors are those tendencies within networks toward particular kinds of configurations. These tendencies include factors such as reciprocity among

dyads, cyclicality or transitivity among triads, etc. Attributes are those characteristics of the members of networks that make a difference in terms of how people relate to each other. Typical characteristics include physical and social variables like age, gender, religious and political affiliations, and physical proximity. Other networks reflect other sets of relations that might impact the focal network. For example, a work network might be highly influenced by a friendship network (defined on the same people). Other networks also include auto-regressive networks, which is the same network at earlier points in time. Thus, last week's "shares ideas with" network is likely to be highly predictive of this week's "shares ideas with" network. Finally, network externalities refers to those factors outside of the network itself that are likely to influence a focal network, including market forces, regulatory regimes, major environmental events, etc.

Figure 1. The Network Structuring Process (adapted from Monge & Contractor, 2003)



Though researchers have identified these fundamental factors influencing the creation, evolution and maintenance of network structure, there is no unified theory of network structure. Nonetheless, several social science theories have extensive implications for organizational communication networks. Monge and Contractor (2003) review seven families of social theories and discuss in detail the network implications of each. These theories are summarized in Table 1. Importantly, each theory has a unique structural signature, a particular configuration of relations that should exist if the logic of the theory is operating in any focal network. For example, exchange theories suggest that people will seek to maximize their connections to others with valuable resources. Thus, exchange theories predict networks will demonstrate redundancy. On the other hand, transactive memory theory suggests that individuals will seek to outsource cognitive tasks, such as the storing and updating of specialized knowledge, to other individuals, thus reducing redundancy. Thus, the degree of redundancy in a network can serve as a structural signature indicating which logic is operating in the network. Because several theoretical mechanisms might be operating on any specific focal network, Monge and Contractor (2003) recommend combining multiple theories to provide more comprehensive explanations.

The Effects of Networks

Network scholars have always been curious about the effects that information and other content flows can have on various entities. These include (1) the people and other elements that comprise the networks, (2) the performance of the institution which contains the networks, and (3) the fitness and survival of the larger communities to which

the organizational networks are connected. Advances in network methods are making it increasingly possible to pursue these issues.

Network Members. Considerable network research has considered how people and organizations make use of networks to meet their needs. For example, Wellman (2007) and his colleagues have documented the types of extended networks that exist in different local communities to understand how people rely on social organizations, such as family, friends, and institutions to meet their needs. Burt (1992) demonstrated that nodes that fill or broker particular network positions called structural holes tend to thrive and outperform other nodes. Miner, Amburgey and Stearns (1990) found that organizations used linkages to other organizations to buffer threatening environments.

Institutional Performance. Because networks are inherently relational, their effects cannot be examined only at the individual level. Positive effects at the node level can have negative effects at the network level and visa versa. Though brokering benefits individual nodes, the network as a whole performs poorly if all nodes attempt this strategy. If one organization dominates the network by becoming a central hub, this can lead to organizational stagnation for other organizations (Stark & Vedres, 2006) The transformation of networks has had dramatic implications for the organizations and institutions in which they reside. Castells (2000) describes how companies, industries, and national economies have all been challenged by the changes in underlying social structure, with some thriving and others suffering. In particular, a new form of organization, the network organization (→ Network Organization), has emerged. Network organizations are flat organizational structures, as opposed to hierarchical, that are more flexible than hierarchies yet more stable than markets. Network organizations

have performed exceedingly well in the environment of the Network Society (→ Network Society), though it remains to be seen if they can sustain this advantage as social structures continue to change.

Community Fitness and Survival. Often overlooked are the effects that networks have on communities. Most organizational networks are tied to multiple other organizations in their own populations and in their larger communities, including suppliers, regulators, retailers, professional standards organizations, and other community institutions. Organizations and their networks both cooperate and compete with each other. Often, competition for scarce resources leads to the demise of weaker organizations and networks. Further, research in a variety of fields indicates that networks may have a carrying capacity for links, i.e., a total number of links that the network can support. Thus, an organization could, in the course of optimizing its own network, overdraw this community capacity and begin an overall network decline. Individual organizational networks contribute to the fitness of the communities in which they reside, which often, in turn, impacts their own survival.

Research on the implications of network structure has recently begun to focus on the new networks that have emerged with the development of new communication technologies. For example, the online collaboration of social resistance organizers (→ Social Movements) or of players in online role playing games (→ MMORPGs) have both been studied. Researchers have also begun to consider the implications of the participation of non-human actors in these networks, particularly the mediating effects of cyber-infrastructure. For example, MySpace participants create enormous affiliation networks as they communicate with each other. Members of online communities may

create both person-to-person and avatar-to-avatar networks as they communicate in different contexts.

The Evolution of Organizational Communication Networks

Historically, organizational communication research focused on (1) relatively small networks (2) of single relations (3) in single organizations (4) at one point in time and (5) without a theoretical rationale. Early research was descriptive, reporting different network configurations or testing how different network roles related to organizational outcomes. Over the past decade, a new science of networks has emerged that focuses on a wide range of organizational network phenomena, including virtual work teams and organizations, online organizational communities, electronic commerce, massively multiplayer online gaming worlds, the network society, community level alliances such as nongovernmental organizations, and the growth of the world wide web.

Instead of studying small organizational networks, contemporary network research now typically focuses on much larger networks some of which contain thousands of members and hundreds of thousands (or millions) of links. Rather than static configurations, network theorists and researchers now focus on growth, stability, decay and other forms of change over time. Several growth and decay principles have been identified. One is preferential attachment, which states that new entrants to a network will link to the nodes which have the greatest number of existing links. Another principle is a preference for diversity, whereby existing nodes attempt to "hedge their bets" by connecting with as many different types of nodes as possible. An important decay principle is called the liability of newness. Burt (2000) has shown that new links tend to disappear faster than older links, a form of the inertial principle in which it is hard

to establish links because they die out quickly, but once they exist, they tend to last. Ironically, an opposing principle, the liability of aging, asserts that links and networks tend to decline with age.

Network scholars are now beginning to study multiplex rather than single relations. For example, Powell et al examined four separate relations in their study of all the organizations involved in the evolution of the biotechnology industry: research and development, finance, sales and marketing, and licensing. Shumate, Fulk, and Monge (2005) examined the alliances among all HIV/AIDS nongovernmental and intergovernmental organizations from the onset of AIDS in the middle 1980s to early 2000s, thus incorporating all of the organizations that comprised the community. Similarly, there is a significant increase in the number of longitudinal network studies, many made possible by new data capture techniques. Finally, network researchers are increasingly using theory as the basis for forming and testing network hypotheses, particularly evolutionary theory. Evolutionary principles of variation, selection, and retention account for network change and stability. Conceiving of networks as having niches that provide resources necessary for their sustenance provides important explanatory power. Researchers are now seeking to understand the evolutionary factors that induce sequential linking patterns, imprinting, and changes in organizational forms. These principles have the advantage of integrating explanations of how networks form particular configurations with findings regarding the effects of those networks.

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Table 1. Seven Families of Social Science Theories and their Theoretical Mechanisms[1]

Theory Families	Theoretical Mechanisms
Theories of Self-Interest	Maximization of individual benefits
Social Capital	Profit from Investment opportunities
Structural Holes	Control of information flow
Transaction Costs	Cost minimization
Collective Action	Joint value maximization
Public Goods Theory	Inducements to contribute
Critical Mass Theory	People with resources & interests
Cognitive Theories	Cognitive Mechanisms leading to:
Semantic/knowledge Networks	Shared interpretations
Cognitive social structures	Similarity in perceptual structures
Cognitive Consistency	Maintain consistent cognitions
Balance Theory	Drive to avoid imbalance & restore balance
Cognitive Dissonance	Drive to reduce dissonance
Contagion Theories	Exposure to contact leads to infection:
Social Information Processing	Social Influence
Social Learning Theory	Imitation and modeling
Institutional Theory	Mimetic behavior
Structural Theory of Action	Similarity positions in structure & roles
Exchange & Dependency Theories	Control over valued resources
Social Exchange	Equality of exchange
Resource Dependency	Inequality of exchange
Network Exchange	Complex calculi for exchange balance
Homophily & Proximity	Choices based on similarity
Social Comparison Theory	Communicate with comparable others
Social Identity Theory	Choose others based on own group identity
Physical/Electronic Proximity	Influence of distance and accessibility
Theories of Network Evolution	Variation, selection, retention
Organizational Ecology	Competition for scarce resources
Kauffman's NK(C) Model	Network density and complexity

[1] References and citations for these theories are available in Monge and Contractor (2003)

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