Chapter 25

LINKS AND SYNCHS

Organizations and Organizational Culture From a Network Point of View

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This chapter develops five propositions about networks and how they apply to organizations and organizational culture. The propositions are synthesized from research across multiple disciplines. Each proposition has implications for managing organizations and working with organizational culture. The chapter is organized around five topics that appear in the network literature that have implications for organization culture: (a) organizational cultures as manifestations of networks; (b) the nonessential nature of organizations; (c) network locations of the observer and the observation; (d) small-world social networks; and (e) networks, chaos, and complexity. These five topics will be discussed in turn, each one concluding with a proposition. Next the discussion considers the joint implications of the propositions on organizational culture and on the development of measures for future work. Last, in light of the propositions, a number of network theory terms that are used in this chapter are explicated.

The Manifestation of Organizational Cultures as Scale-Free/Power-Law Networks

Networks are often described as impermanent (Fuchs, 2001), but they are not wholly unpredictable. [AU: please provide first names]Erdős and Rényi (1960) modeled network growth, and at each step two nodes were randomly chosen and linked. While it is certainly the case that some unpredictable ties form between social actors, not *all* ties between social actors are unpredictable (Barabasi & Albert, 2002). [AU: please provide first names]Barabasi and Albert (2002), for example, argue that many social networks do not form randomly and that our social world is predictable in the sense that networks form and that many networks form predictable patterns. Furthermore, these patterns are often based on two basic principles: the scale-free/power-law principle and the nesting principle.

While there are differences between social networks and physical networks, both may take the scale-free form. Scale-free social networks are characterized by the presence of hubs, growth through increasing preferential attachment (Barabasi & Albert, 1999), and power laws (Barabasi & Albert, 2002). That is, as a scale-free social network grows, a smaller percentage of nodes account for more and more of the network interactions/transactions. So, while we cannot predict how connected any particular node will be, a general macro-level structure does emerge. Organized by power laws and affiliations, social actors (often called "egos") have at least somewhat predictable network ties. This means that it may be expected that a few egos will become giant hubs, allowing the majority of egos to enjoy network efficiencies while operating quite locally and relatively independently.

Applying these principles to organizational culture is straightforward. The scale-free network point of view suggests that it takes relatively few cultural entities (hubs), very broadly accessed, to have an efficient culture. The specific culture that emerges depends on the

particulars of these critical cultural hubs, the particulars of the social actors, the dynamics of the sensemaking rules, and the idiosyncratic network resources. In other words, to the extent that a culture may be said to have emerged from a particular set of resources, actors, and ideas, it is an *organizational* culture. In short, organizational culture is an outgrowth of a particular group of networked actors, ideas, and resources that becomes structurally dominated by a relatively small subset of all these. We call these dominating entities "cultural hubs."

Furthermore, as organizational culture takes a scale-free form, efficiencies are gained by having only a few major cultural hubs, together with a relatively few long ties between them all. This is simply a manifestation of the small-world network effect (see Proposition 4 later in this chapter). To the extent that efficiency is a driver in organizational life, then the network of organizational culture may be expected to grow in this (somewhat) predictable way. Such predictability in processes makes it possible to talk about organizational structure without relying on ideas of explicit or even consciously formed parts and agreed upon understandings.

It should be expected that each organizational culture will be different due to local specifics of the broader network field. However, each will exhibit a certain, predictable degree of homophily. Homophily is the idea that "similarity breeds connection," and "the result is that people's personal networks are homogeneous" (McPherson, Smith-Lovin, & Cook, 2001, p. 416). [AU: please provide first name]Brass (1985) noted that observed growth of local network homophily is good evidence of growth in shared social norms of organizational members (Brass, 1985; Marsden, 1990). The contemporary network perspective updates this notion: Homophily will be in evidence around a few highly prevalent norms, while the organization may be largely heterogeneous and broken into clusters on much of everything else.

Another key claim by Barabasi (2001b[AU: not Ref for this citation; please add]) is that when networks are nested, at each scale the basic network patterns are similar. At every level one can observe similar densities of network clusters and nodes and ties between them. Furthermore, the strength of the ties in any given network is not related to the strength of the ties of the more macro- or more micro-level networks with which that given network is linked. That is, ties are not "weaker" at more micro levels and "stronger" at more macro levels, or vice versa. One can observe the same strength of network ties in very micro networks as in very macro networks, and all networks in between. Fractals offer a good model for understanding this scale-free quality of many social networks (Sheard, 2009). A fractal is a rough geometric shape that can be split into parts, each of which is an approximate reduced-size copy of the whole (Mandelbrot, [AU: spelled Mandelbrott in Refs; please reconcile]1982). Ties also go between levels of networks (Kogut & Walker, 2001). A micro network can be tied more or less strongly to a macro network than to the local level network. Therefore a manager's ties to his within-department colleagues will have no tendency to be less strong than department to department ties. Nor will they tend to be stronger—network scale is immaterial.

Social network paths and hub formations are prone to upward and downward spirals in adoption due to network externalities, commonly referred to as the "network effect." Network externalities exist when the value of something is directly related to the number of users of that thing. Network externalities may be direct or indirect. Direct network externalities exist when the increase (or decrease) itself is the source of the added (or reduced) value. Indirect network externalities exist when an increase in the size of a network attracts outsiders to make increasing complementary and supplementary items available to the members of the network. On an upward spiral, direct, complementary, and supplementary externalities increase the value of the network

attracting more members, which in turn creates even stronger network effects (Schilling, 2008). This process, also described as increasing returns to adoption in the path dependency literature (Arthur, 1987), leads to increased attractiveness of a network path as transaction traffic grows. This "rich get richer and poor get poorer" phenomenon occurs with network hubs in power-law networks (Barabasi & Albert, 2002). Very rapidly accelerating spirals of adoption (and defection) are associated with network "cascades." Cascading is the process through which rapid transformation and information/innovation diffusion occurs in networks (Watts, 2002). A cascade results from microactivity at the individual social-actor and local-tie level[AU: is this the same level or 2 different levels?]. Downward spirals are no less frequent or likely than upward spirals. As an organization, an idea, a value, or any other hub loses ties or traffic, the more there are reduced returns to adoption. Reduced ties motivate fewer complementary and supplementary network ties, thus lowering the hub's value, and so forth. [AU: please provide first name]Watts (2003) offers an in-depth review of node "vulnerability" conditions under which upward or downward spirals of adoption (cascades) most likely will begin to occur. In general, a node is vulnerable to adoption if "it has a low threshold (thus, a predisposition for change); or because it possesses only a very few neighbours, each of which thereby exerts significant influence" (Watts, 2003, p. 233).

Proposition 1: Organizational cultures manifest themselves in the same nested and scale-free ways as other power-law social networks.

The Non-Essential Nature of Organizations and the Role of Organizational Culture

[AU: please provide first name]Fuchs (2001) demonstrated how society (and culture) can be described as a network of fields, forces, and flows. A social actor does not have an identity apart

from its location in a network context (Fuchs, 2001). Fuchs's network location theory attempts to eliminate "essentialism" from the idea of what an organization is. "Essentialism searches for the intrinsic 'nature' of things as they are, in and of themselves. The opposite strategy is relationalism" (Fuchs, 2001, p. 12). Network location theory is relational and accounts for the observer and for network location, without eliminating objectivity. From the "nonessential" perspective, a network is not an object; it is a collection of forces, activities, and dynamics—and that is all that it is. This contrasts with theories in which organizations are conceived as objects based on explicit legal arrangements, a set of stable understandings among participants, or as a network of physical nodes and pipes. An organization is a linked collection of (social and/or physical) processes, actors, resources, and activities at a particular moment in time. Pathways are not essentially "pipes" or "pipelines" or necessarily anything more specific than artifacts of forces with direction.

Organizational network research often analyzes nodes that correspond to traditional structural units that are conceived of as based on legal or other forms of explicit legitimization. Another element of Fuchs's (2001) thesis, however, is that making and sharing meaning, and making sense of observations, occurs in the culture network nested within the broader network of an organization or society. This begs the question that if organizational culture is also a network, then what kinds of things may count as a nodes or as a hubs in these networks? With essentialism abandoned, network parts and pieces need not be fundamentally physical things or explicitly legitimated social objects, and there is now room for the constructs that are so much a part of culture. Social constructs such as institutional facts, values, theories, and missions may just as appropriately be included as nodes within the culture network as a physical organization member, a building, a department, or any other social actor. The claim that ideas and meanings

should be understood as networks is not new, nor should it be considered overly controversial. For example, there is general agreement in the education literature that internal representations of knowledge resemble organized webs or networks of ideas (Williams, 1997[AU: no 1997 Ref for this author; please add or reconcile with 1998 present in Refs]), and concept maps (Kolb & Shephard, 1997; Novak & Cañus, 2008) have long been used to measure and represent networks of ideas. What is new is how physical or explicit social networks impact belief network structures (Ghosh & Velázquez-Quesada, 2009), and the proposition that those concepts with a disproportionately large number of links to other nodes are functioning as hubs in the culture network. This means that a cultural hub could just as well be a nonphysical entity such as a dominant logic, a schema, or a social norm as it could be a physical entity such as a person, an office, or a building. For example, if social actors constantly link and, in a sense, "lean upon" an organizational value or a particular theory to make sense out of ongoing events at work, then that value with its many ties to organizational actors is functioning as a local hub.

Building on Proposition 1, it should be expected that scale-free network rules apply to all cultural entities, including ideas, schemas, and sensemaking rules. That is, it should be expected that some ideas in an organization become widely adopted and utilized, while most ideas are only utilized on a very limited and very localized basis. *Utilized* means used to make sense of events, used to deal with events, and used to make decisions. Put simply, organizational members are expected to frequently utilize a relatively small set of sources when they are working, although many potential sources exist and the network is searchable. Furthermore, in a small-world organizational network, the vast majority of knowledge (ideas that have been demonstrated as true) and of live hypotheses (ideas that could be true) are not frequently used within the organization (Meckler, 2001[AU: no corresponding Ref; please add]). We propose

that this flexible, nonessential collection of hubs, nodes, and interactions nested within the general organization network is organizational culture. Furthermore, Fuchs (2001) argues that society may be understood as the sum of network activity at a given moment. Therefore, beyond the transactions and fluctuations of a local actor network, there is no organization culture object.

Proposition 2: Organizations and social actors are temporary, nonessential manifestations of network flows.

Network Locations of the Observer and the Observation

Fuchs (2001) demonstrated that network stability and wholeness is relative to an observing actor's location in the network. That is, the more locally a social actor is observed, the less solid and unified it is. The farther the observational location, the more stable and "structured" the organization, a society, a culture, or other social entity will be. Organizational forms should be understood as nothing more or less than patterned paths of flows that may be observed when studying a node or cluster of nodes from a distance.

Networks behave in a way that brings doubt upon our existing ontology of organizations. From a distant location, an organization is a node in a broader network, linked to other nodes. From a closer location, an organization is a hub, embroiled in transactions. From an even closer location, an organization is a network that contains its own nodes, hubs, and links. From within, an organization is a collection of networks. An organization is all of these things, depending on the location of the observer: a network, a hub, and a node. Furthermore, none of these entities are essential—*node* is simply a word used to describe a relatively tightly linked cluster of network flows in a broader system of more loosely linked network flows. That is, nodes are networks in themselves, and clusters are what appear from a distance to be a group of nodes with short ties to each other. Organizations are, at the same time, nodes within networks, hubs in network fields,

and clustered networks of nodes in themselves. To be consistent, organizational forms should also be understood as nonessential and location dependent. That is, forms are essentially nothing more than patterned paths of flows that may be observed when studying an organization from a distance.

In the same light, organizational culture is a network in itself, a node within the organization network, and in some organizations a critical hub. Organizational culture from a distant location is a node; from closer observation, it is a hub; and locally it is a network. The closer the observational location, the more variable and fluid and less "essential" the organizational culture is. Forms of organizational culture (e.g., Trompenaars's 1993 [AU: no corresponding Ref; please add or reconcile with 1996 Ref]guided missile, Eiffel Tower, incubator, family) are likewise nonessential patterned paths of social thought and action as observed from a distant location.

Note that this is how the network "is" and not how the network "appears." This move reflects a major contribution by Fuchs (2001) to our understanding of social networks. In short, relativity to network position does not undermine a social actor's ability to make factual nonsubjective observations about networks and social actors. Network actors simply are more specific and essential as the network position of any observer increases in distance. Nonsubjective means that multiple social actors can still make consistent, repeatable, predictable, and truthful observations from these different levels of reflexive location. Therefore any meaningful subjectivity is not so much an individual social actor as it is a function of network location. For insiders, their network is less essential than it is for an outsider. As observers are positioned at more distant levels of aggregation, the subject becomes more defined and the

operations within that culture more essential. Social *structure,* then, is a matter of degree between more or less fluid and essential.

Because of close proximity, it would then be expected that organizational members would experience organizational norms and behaviors as highly context sensitive, flexible, nuanced, and nonabsolute. At the same time it would be expected that outside observers would see the same organizational culture more concretely and rule based as network distance of the observer increases. Importantly, both observations are true and are not subject to individual interpretation. From up close, organizations, departments, and their cultures are full of semistructured, ill-defined, and sometimes even random decision situations, while from a distance they are structured and defined black boxes with inputs and outputs. Thus there is no inconsistency in claiming, for example, that a culture measured on Trompenaars's (1996) eight dimensions are true, while also admitting that within that culture those same truths may or may not hold true.

Proposition 3: Social actors are less specific and essential the closer the network location is to an observer, and more specific and essential the farther away the network location of observation.

Small-World Social Networks

In 1998, [AU: please provide first names] Watts and Strogatz used the term *small-world networks* to describe networks with a very large degree of clustering and a very small average shortest path length of ties. Their work had its roots in seminal research by Stanley Milgram in the 1960s (Milgram, 1967, Travers & Milgram 1969), who inspired thinking about how few degrees of separation there are between any two people. The evidence for the small-world hypothesis grew when [AU: please provide first name]Granovetter (1972[AU: change to 1973,

as in Refs?]) demonstrated the importance of weak ties in networks. Watts and Strogatz (1998) showed how a very small proportion of randomly distributed long ties (strong or weak) and nonrandomly distributed and highly clustered nodes produce the small-world phenomena. Long ties are direct paths between nodes that skip over possible short-path local nodes. They connect with nodes in locations beyond local clusters.

There is evidence that social networks are somewhat different from other networks. Watts (2004) reviews how work by [AU: please provide first name]Kleinberg (2000) and by [AU: please provide first name]Newman (2003) advanced understanding of how social networks compare with other networks. Social networks have characteristics such as clustering, short average tie length, and a small percentage of long ties (Watts & Strogatz, 1998). Social networks also have been found to be readily amenable to searches for information from any network location (Kleinberg, 2000) and to contain networks of affiliated social actors (Newman, 2003). [AU: please provide first name]Nebus (2006), for example, makes use of both affiliation and search to explain advice networks in organizations.

The small-world concept has been used to study national ownership networks (Kogut & Walker, 2001), scientific collaborations (Newman, 2001), board interlocks (Davis, Yoo, & Baker, 2003), and Broadway play producers (Uzzi & Spiro, 2005[AU: 2005 Ref only cites Uzzi as author; please reconcile]). It turns out that social networks are similar in their basic architecture to many other kinds of networks, such as neurons in the brain (Scannell, 1997; [AU: no corresponding Ref; please add]Manev & Manev, 2005), the World Wide Web (Barbasi & Arthur, 2002), food webs in ecosystems, and even streams and rivers in water sheds (Barabasi & Albert, 2002). One major difference is that social networks are searchable while physical networks may or may not be searchable (Kleinberg, 2000).

Networks allow synchrony between otherwise disparate nodes. Synchrony exists when two nodes/actors behave at the same time as though they are in agreement. Smith (1935) discussed synchrony in the seemingly miraculous rhythmic flashing of fireflies separated by relatively great distances. Small-world networks reduce connectivity requirements without sacrificing too much in transmission speed and accuracy, allowing even somewhat distant and disconnected nodes to synchronize, thus solving Smith's (1935) firefly problem. From the organizational point of view, small-world networks function as effective economizers (Latora & Marchiori, 2001).

Some network theorists use the term *synchrony* liberally, so that any kind of agreement between nodes or similarity in characteristics between nodes on or about anything can count as synchrony. A *synch* is a synchrony instance. In general, a synch implies a link. Synchrony requires connectivity, a high transmission speed, and transmission accuracy.

Proposition 4: Small-world social networks of actors and affiliations are searchable, have highly clustered nodes loosely linked by a low percentage of long ties, and allow high synchronization efficiencies between distant nodes.

Network Efficiencies and Network Economics

Despite repeated calls, network effectiveness has not been well examined in the empirical organizational literature (Kim, Oh, & Swaminathan, 2006; Podolny & Page, 1998; Provan &Milward, 1995, 2001). [AU: please provide first names]Provan and Kenis define network effectiveness as "the attainment of positive network-level outcomes that could not normally be achieved by individual organizational participants acting independently" (2007, p. 230). And what, in general, is a positive network-level outcome? The present discussion suggests, first, that "network effectiveness" means at least the extent to which a network successfully ties nodes

together and the extent to which the network synchronizes the various desired states of those linked nodes. If a network fails to link nodes together, we cannot claim it is effective. Second, if two nodes engage in a transaction, the network is effective to the extent that both nodes indicate that what they acquired from the link is synchronized with what they desired from the link.

Networks are effective in the sense that they are efficient in transferring knowledge and other resources (Etzkowitz, Kemelgor, & Uzzi, 2000[AU: please provide entry in Refs]; Reagans & McEvily, 2003[AU: please provide entry in Refs]). Weak ties across otherwise disconnected structural holes are beneficial, acquiring unique information (Burt, 1992; [AU: please provide entry in Refs]Granovetter, 1973). Network ties do not tend to form if they are not efficient or effective (Nebus, 2006).

However, not all ties increase local efficiency. That is, some ties are negative in the sense of differences or heterogeneity in the characteristics of two nodes or some sort of disagreement or mutually incompatible behavior when nodes are social actors. There is at least some evidence that a negative tie between two nodes can be destructive to one or the other (LaBianca & Brass, 2006[AU: please provide entry in Refs]). A negative relationship, however, does not preclude network synchrony. When two (or more) nodes agree that they disagree, there is synchronization. Learning occurs when network actors take the negative into account when establishing subsequent ties. However, nonsynchronous negative relationships can be quite disruptive to a network. For example, one of the tied parties may believe the relationship is positive, while the other actually has a negative disposition (Labianca & Brass, 2006). Barabasi and Albert (2002) discuss a watershed network of brooks, streams, and rivers. In this circumstance, almost all local ties are negative, leaving flowing water only a relatively few possible paths downhill. In general, the path of least resistance to gravity is followed and the network is highly efficient. In general,

then, we expect that as network synchrony increases network efficiency also increases, regardless of whether the synchronous ties are positive or negative.

Applying these principles of network efficiency and effectiveness to organizations, organizations function as hubs that enhance network synchrony. That is, nodes and resources organize as they do into a cluster that constitutes an organization to facilitate either local synchrony with another network actor or to facilitate synchrony between two or more remotely located network actors.

Physical network flows, as do water drainage and electricity, finding the path of least resistance toward synchronization, structure themselves in predictable ways characteristic of other scale-free, power-law networks (Barabasi, 2001b[AU: no entry in Refs; please add]). Social networks follow similar if not equivalent patterns (Collar, 2007). [AU: please provide first name]Williamson's (1975)[AU: no entry in Refs; please add] thesis about the economic position of organizations to reduce transaction costs is consistent with this expectation of networks. That is, if economies are networks, then business organizations are clusters in these networks. Organizational culture plays an important role in organizational and broader network efficiency. In their comprehensive review of network theory research, [AU: please provide first names]Borgatti and Foster (2003) report that homophily breeds efficiency to the extent that similarity aids the transmission of tacit knowledge, simplifies coordination, and avoids potential conflicts. From the general network perspective, efficiency and economizing mean providing network flows with paths of lesser resistance to their destination. Alternatively, when there is not a set destination for a network flow, the network will tend toward a path of lesser resistance in the intended direction of the flow. This is a general way of saying that if an agent cannot

efficiently broker a transaction between two parties, over time a more efficient broker will be employed.

Organizations are these network "brokers." Organizations persist because they offer network transfer efficiencies. From a broad network perspective, a business organization is a sociotechnical device that organizes economic resource transactions and extracts a reasonable amount of energy from a network as profit. Within this network at a micro level, a manager is a network efficiency/effectiveness device who solves throughput handling and transaction issues that nonthinking machines cannot handle.

While efficiency and effectiveness are hallmarks of business organizations, social networks on their own are not necessarily driven by maximized efficiency of synchronization. Social actors have a multitude of reasons to engage in organization. Some social actors may resist change that would otherwise be implicit in the search for increased efficiency or effectiveness by others. Strategy from a network point of view can be seen as clever attempted manipulations of network synchrony. Organizations that function strategically may be said to synchronize the social desires of one network by disturbing synchrony in another network.

When an organization becomes institutionalized within a larger network, it is forced to operate consistently within a broader community of goals and norms (Selznik, 1959)[AU: please provide entry in Refs]. For example, the institutionalized business organization may turn aside somewhat from economic network forces as it succumbs to the demands of a broader social network of stakeholders. The business organization remains an economizing cluster, but with the institutional constraints that come from operating within a broader network field. [Au: please provide first names]Powell, White, Koput, and Jason (2005) provide an excellent overview of how network fields evolve as diverse interest networks come together and interact. From an

economic standpoint, institutionalization may seem to restrict the efficiency of economic flows. However, this is a narrow understanding. Networks are prior to individual organizations and institutions; to a large extent, network flows and fields (and their synchronization imperative) drive an organization's form and function. The institutionalized organization is not so much inefficient as it is shaped by strong ties to alter networks with noneconomic synchronization needs. When noneconomic institutional network forces intrude to the point that it makes an organization a less efficient transfer point than other accessible clusters, economic network traffic will likely take another path. The organization then risks triggering a downward cascade and failing.

Sustainability is demonstrated by a node or cluster that draws on the resources of a larger network without reducing the energy of the network. That is, in a sustainable economic or business network, any energy removed from the network flow by an organization is offered back in terms of synchronization efficiencies. "Profiteering," or taking more from the network than is given back in synchronization efficiency/effectiveness, is possible until the network finds an adequate alternative path of lesser resistance. Disruptive network transformation leaves formerly critical nodes surviving only on their own stored energy, consuming themselves until they disappear.

A network functions most sustainably with minimal resistance along its paths. A node is "sustainable" only insofar as the total transaction cost associated with flowing through that node does not exceed the efficiency the network gains by including that node. When a firm, for example, adds a very high total transaction cost to the network in terms of salaries, prices, rents, profits, time, and so forth, it may drain too much from the network. The network would experience this as high resistance to its flow, and subsequently the transaction flow may migrate

away from that firm. In that sense, it may be said that the firm is not sustainable or that the transaction costs to the network are not sustainable. It might then be expected that the firm will enter into a downward spiral driven by decreasing returns to adoption. Thus a firm's mandate is to fulfill its "hub" role as quickly as possible and to send outputs to destination nodes that head the overall transaction through the most efficient and effective future paths to its desired end states.

Assigning Value. Organizations in an economic network have pressure to economize in their role in value chains to the extent that the broader economic institution encourages efficiency. Rents can be understood as the gains to an organization for the increased synchrony efficiency or effectiveness that it provides to the broader network flow. Organizations may add value by contributing local resources and by directing network flows in ways that increase the synchronization in the network.

By thinking differently about organizations and incorporating knowledge from multiple fields, network scholars have gained useful information from nontraditional contexts. [AU: please provide first names]Uzzi and Spiro's (2005)[AU: please confirm that this citation now matches an entry in Refs] realization that Broadway playbills are artifacts that can be used to measure the movement of social actors within a closed network was highly innovative. Further, cross-referencing these movements with gate receipts and other artifacts from this industry produced important insights about networks from an empirical setting that is quite different from settings such as equity joint ventures, strategic alliances, and supplier networks that have been studied more frequently. Watts (2007) suggests that enough network data will eventually be available to successfully model and perhaps forecast human social behavior. Although questions about network constraints, performance, value, and failure rose to prominence in the late 1990s

(Podolny & Page, 1998), most management questions are about network efficiency, effectiveness, and value (Holloway, 2009; Kim et al., 2006).

Using Old Measures for New Things. Whereas Uzzi and Spiro (2005) successfully designed new measures to study old topics, another way to move forward is to use old measures of new things. From the present review so far, it does not appear that networks are so radically different from previous conceptions of organization that existing measures cannot be successfully applied. At least for the more macro examinations of networks, there may already be a host of measures and descriptors at our disposal that can be reconceptualized for network application. First, a researcher might borrow measures from business administration and economics. For instance, network valuation might be approached using financial valuation techniques. Even simple financial models that value bundles and flows of transactions are consistent with network concepts. For example, a simple accounting ratio such as inventory turnover might be useful as a measure of network flow. That is, when quantities and values are put on inventory flows with economic and cost-accounting measures, flow and value measures of network transactions are also being provided. Furthermore, fluctuating financial markets provide a continuous flow of information about the changing monetary value of things. Old measures such as trade volumes and frequencies seem very much in the spirit of network descriptions and measures.

Thus one of the unsung benefits of understanding organizations in network terms is that it allows us to simplify measurement. Researchers require observations of network input flows, throughput flows, and output flows, where these flows come from, and where these flows go. In many cases, we have this data in growing digital email archives, detailed sales records and marketing databases, and electronic purchasing records. Using old measures of these new network data sets may provide unexpected insights.

Furthermore, as discussed earlier, recent findings (Barabasi, 2001[AU: please confirm Ref has been added]) provide a statistical distribution to use as a base for hypothesis tests: Specifically, the binomial, fat-tailed, power-law distribution. So there are at least two tools for prediction and testing. First, there is the power-law distribution. Second, there is all the measures of volume, resistance, and flow. Finally, there may also be endpoints that constrain these measures. That is, if networks are scale free, they not only contain each other, they constrain each other.

Rationally speaking, almost any measures related to connectivity, flow, throughput resistance, and accuracy might prove useful to organizational scholars. Economic transactions, resource bundles, and resource flows are not materially different from information exchanges, packets of data, and data flows that move through the Internet. We might borrow from microwave physics, applying amplitude and voltage measures to represent networks. Voltage drop might be used to measure efficiency or the net transaction cost of a firm embedded in a broader economic network. Amps might be used to measure the velocity at which network flows move through an organization. Measures of flowing water may also provide an excellent menu of useful measures. From basic measures such as volume to complex mathematical models such as those that describe fluid dynamics in areas of confluence, previously developed measures are available that can be applied in a straightforward way to anything that flows.

In general, if organizations are networks and if networks are in flux and defined by flows, then the measures that may be most useful will likely be the same ones that are used to measure other dynamic and efficient networks. Output flows relative to input flows will tend to reveal the efficiency of transaction flow through an organization. Furthermore, if small-world social

networks really are scale free, then these same old and simple measures might do just fine at the micro level for measuring a social actor's value added toward synchronization.

Organizational Culture, Networks, Chaos, and Complexity

Networks are complex but are not always chaotic. The development of culture is a complex process, full of variables and feedback loops (Chick, 1997; DiMaggio, 1997[AU: please provided entries in Refs for both of these citations]). Yet demonstrating that something is complex is not the same as showing that it is chaotic. Chaos describes a particular situation or subset of complexity in which there is some predictable underlying order that manifests itself and dissolves on unpredictable scales of frequency, reliability, and strength. Complexity refers to situations in which there is feedback among and between nodes. Complexity is characterized by rapidly evolving indeterminacy. Complexity may exist when there are many or only a few nodes. The indeterminacy of complex situations, systems, and networks stems largely from general unpredictable sensitivity to micro-level variation and general unpredictable sensitivity to macro-level variation. [AU: please provide first names]Chatrath, Adrangi, and Dhanda (2002) modeled and tested for chaos using financial market data and provide a good short summary of the properties and various tests for chaos.

Chaotic paths will have the following properties that should be of special interest to those attempting to understand organizational culture: (a) the universality of certain routes are independent of the details of the culture map; (b) paths are extremely sensitive to microscopic changes in the parameters that define the system, and this property is often termed sensitive dependence upon initial condition; and (c) observations appear stochastic even though they are generated by deterministic systems. That is, the vast majority of empirical data of chaotic series

are the same as those generated by random variables, which implies that chaotic series will not be identified as such by most standard techniques.

Are Social Networks Chaotic? Some characteristics of networks are consistent with the principle of chaos. For example, in the small world of the work group, culture does develop around initial contextual conditions. Specific network path formation is unpredictable, and the behavior of nodes is also unpredictable as the network is forming. The various cultural norms, values, beliefs, expectations, and behaviors that form are subsequently at least somewhat predictable. Furthermore, the actual network routes that emerge and the behaviors of the nodes will be independent of micro-level details. Once these paths are begun and a network is established, they are at least somewhat deterministic, even if micro-level instances of behaviors appear random. Social networks have many of these properties. For example, social networks exhibit the same micro-level variance and macro-level determinism.

However, social networks have important properties that are not chaotic. We know from recent research (Barabasi, 2002) that many social networks are subject to power laws. We know that hubs develop, and we know that powerful path dependencies develop. It has been well demonstrated that these scale-free social networks are highly stable in the face of micro-level changes in conditions. In organizational cultures, process expectations are set, behavioral habits develop, rules for humor emerge, work intensity stabilizes, and allocation rules for work inputs become settled.

Networks Are Both Robust and Highly Vulnerable. A multitude of strong short ties ensures that work culture is strong and robust. In most social networks, each social actor has multiple ties, which ensures that the network is durable despite a broken tie here or there. In organizations, minor nodes are frequently removed or fail. [AU: please provide first

names]Kogut and Walker (2001) demonstrated that in a power-law network, many minor and even not-so-minor nodes or ties can be removed and the network most likely will remain stable, adjusting quickly and easily. Organizational culture fits this description. Employees and policies may come and go, product lines may be introduced and expire, and still the culture remains generally recognizable and persistent. Organizational culture, at least in its mature form, is apparently not chaotic. Organizational culture is better understood as developing out of complexity to delicate chaos then to robust network.

Power-law networks are also highly vulnerable to catastrophic failure as a major node or cluster fails or falters. Much like the airline industries hub-and-spoke system, if a major hub such as Atlanta were to shut down, then the whole network can fall apart very quickly. Even without complete failure, sudden bottlenecks in transaction processes can quickly have a domino effect on a network, creating huge cues [AU: do you mean, perhaps, "queues"?] and backups in the process. Once backups occur, it can take a lot to restart the system and get things moving again.

Another source of network vulnerability is rapid transformation. When a new node or a new context is introduced, a cluster may form at that node because of some new synchronization efficiency or effectiveness it offers. When a cluster forms into a hub and subsequently reaches a critical upper boundary of ties, then the network can rapidly cascade and transform. Cascades and network transformation that stem from micro-level "percolation" is another unique source of network instability and change. And although network transformation is not frequent, it is also not unusual. We can deduce, then, that network models and chaos models are different manifestations of complexity and that they have different properties. Organizational culture is chaotic only at the very boundaries of formation, dissolution, and very local micro levels. At the

macro level, and seen from any distance other than very local, organizational culture is better described using the network model of complexity than using the chaos model of complexity.

Proposition 5: Organizational culture is a network subordinate to complexity laws but only subject to chaos at the time of initial formation and final late-stage dissolution.

Networks, Synchrony, and Organizational Culture

The preceding discussion of network characteristics included examples of applications to organization culture issues. The remaining discussion considers several aspects of organizational culture. Networks research has provided a good answer to explain synchrony in a very complex world. What started as a way to understand the synchronous flashing of fireflies (Smith, 1935) by applying small-world principles (Granovetter[AU: please provide year]) led to the explanation of synchrony in neural networks (Castelo-Branco et al., 2000[AU: please provide entry in Refs]) and the brain (Chicurel, 2001[AU: please provide entry in Refs]). Organizational culture is certainly understandable in these terms. For example, one can understand why it is something complex and relatively stable, because it is a network. It is not easily disrupted like chaos. Each department is a network cluster of flows through ties. Flows that require guidance, combination, and forwarding "arrive" and push through the department. Local behaviors, meanings, values, and assumptions are generated through direct association with those flows and transactions. Organizational culture is the collection of interfaces between social actors and network flows in a cluster. The network of a department has short strong ties between department members. Behavioral norms get set within that kind of network rather quickly and hold as strongly as the ties. Strong ties indicate close interaction and thus broadly shared meaning between members. This powers a strong local organizational subculture. A few short strong ties sometimes form between departments, and frequently a few long ties develop between

a member or two of different departments. It is the occasional long ties across major divisions within a firm that become critically important if a small-world network is to provide cultural and operational synchrony.

What Sort of Actor (Ego or Hub) If Removed Is Most Likely to Radically Alter the Culture? Although generally robust, cultural networks can certainly be disrupted. Although we expect that organizational culture is generally resilient to the removal of noncritical nodes and hubs, the removal of a critical cultural hub would likely fundamentally alter the culture. If an organizational culture is in the scale-free, small-world network state, Barabasi and Albert (2002) suggest that removing just one critical hub can cause a scale-free network to crash. Within industries, organizations, departments, and groups, certain social actors are highly central network hubs (Brass, 1984). If a major hub is removed or disabled in a small-world culture network, the network may become highly disrupted and dysfunctional.

It follows from the present discussion about hubs that relatively few organizational centers of interaction, power, decision making, sensemaking, social prominence, and so on are critical to the culture. What these hubs will be in any particular organization is indeterminate and must be observed locally, as they will emerge through a complex interaction of organization-specific factors. Examples of possible cultural hubs include a meeting room, a repeating event/ceremony attended by many members, a core policy or belief, a building, a value, a person, and even a common assumption that allows members to make sense of events. What they have in common is that a large percentage of network actors connect with that hub on a regular basis.

A cultural hub is a highly frequented network node that influences local sensemaking (Weick, 1995). A cultural hub sets meaning in a way that an outsider who is not utilizing that hub would find distinctive. If department members very frequently made sense of events by

thinking of some prime directive, then that directive is a cultural hub. If that particular directive lost it legitimacy so that members could not rely on it, then researchers could predict the culture to morph substantially because it was a critical hub. In the absence of another efficient (i.e., in terms of its sensemaking capability) directive that could absorb the now displaced and unfulfilled need to make sense of things, the department's culture might even collapse.

If a manager takes away a conference room, some employees, a few policies, or an incentive plan, they may be missed, but the culture will not be impacted in any significant way if these were not critical hubs. However, if the manager were to remove a room, an employee, or an incentive that is a major source of meaning, the culture network could crash.

Phase Transition and Culture. Although generally robust, organizational cultures sometimes undergo transformation. One of the more captivating findings is a network's capability for *phase transition,* the rapid and sometimes dramatic shift from one network state to another. A phase transition may occur when a network is sufficiently connected so that most of the nodes have joined a cluster. At that stage, adding just a few random-length ties to the loose network can cause a very rapid transformation from a loosely linked, not well-synchronized system into a "giant component." Common physical science examples include water freezing and iron magnetizing. No particular molecule is responsible for the transformation event; it is a decentralized, rapidly emergent process. Small events, such as behavioral changes and individual choices, are said to "percolate" through the system, leading to the massive transformation (Watts, 2003).

Social networks are neither completely rational nor entirely random. Organizational cultures are made up of close-knit clusters formed by functional task, common technology, functional department, geography, specialization, and so forth. These clusters are intersected by

long-distance links to other clusters within the organization. This is the small-world network. The long-distance connections are boundary spanners that become shortcuts between clusters.

Why Are Organizations Special? This can be answered by exploring the question, why are there hubs? Hubs are clusters. Organizations are at least techno-social clusters and are probably better described as techno-physico-socio clusters. That is just a fancy way of saying that hubs may be a joining of physical resource networks, technological networks, and social networks. A hub is an organization. An organization is a hub. A previous section described how hubs form as a result of power laws and increasing returns to adoption. But why do hubs form? Hubs form in networks for a number of reasons. One is that they may form by chance. Another is that they exist in response to social institutional–level forces that inpinge on otherwise random transaction flows. Still another is that they exist in response to constantly percolating local requests for connection, transaction, and synchronization. In addition, if cultures are also networks, then we can expect core cultural sources of meaning to be quickly accessible from very remote and seemingly localized locations. This would imply that managers need not worry that organizational culture cannot successfully spread across a physically scattered organization. And if it is true that only a few long ties are needed for cultures to spread, then spreading culture so that meaning is synchronized across an organization's parts need not be a resource-intensive activity.

Within a department, ties will tend to be strong if the level of specialization and complexity is lower, and ties will tend to be weaker as specialization and task complexity build (Fuchs, 2001). Weak ties exist both within an organization and between organizations. For example, ties between competitors often exist but are rarely strong. However, in more mature industries, competitor ties will tend to be stronger, as evidenced by synchronization of pricing

and promotion practices. Ties to suppliers and other stakeholders will vary somewhere between weak and strong. To some extent, owners and governors set the strength of ties between the organization and its stakeholders by declaring in the organizational charter which stakeholders matter most, and which matter least. Furthermore, suppliers and buyers may be more or less tightly linked. For example, an integrated just-in-time inventory pull system would be a tight link; regular outsourced subcontracting relationships with law firms, cleaning company/maintenance, and shipping contracts are less strong ties, yet are not weak ties.

Network theory has advanced over the past decade. While management scholars have paid a lot of attention to network theory, the majority of the advances have come from outside of the field of management. Some of these advances affect our understanding of organizations and the nature of organizational culture. The propositions and discussion in this chapter highlight five areas of network theory that have advanced significantly in the last decade. These propositions, if true, support claims that organizational culture develops around a relatively few core sources of meaning (see Peterson & Smith, 2000; Smith & Peterson, 1988[AU: please provide entry in Ref]) widely used by organizational members when they make sense of events (Weick, 1995). These sources include ideas, objects, people, events, and schemas. Furthermore, if established networks are relatively stable, robust, and chaotic in the birth and demise stages, then managers should expect changing an organizational culture to be very difficult and risky. If network stability is robust to the removal of noncore hubs, the disappearance of a major sensemaking hub should lead to cultural chaos. Furthermore, the disappearance of a nonmajor sensemaking hub will likely "heal" without any appreciable disruption to the functioning of the network in general. It is further implied that managers may "seed" a cultural network by directing organizational members to utilize particular meaning sources until those sources become hubs. However, if (a)

networks are complex, (b) networks emerge in a (small-world) way that promotes efficient network node synchronization, and (c) networks naturally grow within broader networks, then management decisions to direct what hubs are operant may lead to suboptimal and/or unexpected results.

Finally, this network approach implies that top management be intensely aware of the operant cultural hubs and not overfocus attention upon espoused cultural hubs. There are espoused and operant ideas within a culture, but it is failure of the operating hubs that defines the risk. Failure of an operant core hub puts an organization at risk of critical failure.

Terminology Appendix

Following are short descriptions of common network theory–related terms that are used throughout this chapter that stand out as fundamental to the discussion. They are offered as updates for previous definitions and interpretations of common network theory terms offered in the literature, in light of the five propositions presented earlier. This chapter makes no claims that these usages always conform with any specific usage previously offered in the literature. They are a synthesis of previous widely held definitions of these terms and contemporary research perspectives on networks as of 2010.

Alter The term used for any network actor that has a tie with an ego.

Cascade The process through which rapid transformation and information/innovation diffusion occurs in networks. A cascade results from microactivity at the individual social-actor and local-tie level. Cascades are the network versions of rapidly accelerating spirals of adoption (and defection) described in innovation diffusion theory and path dependency theory.

Chaos A type of complexity in which there is (at least some) predictable order or patterning that emerges and dissolves on an unpredictable schedule at unpredictable strengths.

Cluster A description of what appears from a distance to be a group of nodes with local short ties to each other.

Complexity Refers to situations in which there is feedback among and between nodes. Complexity is characterized by rapidly evolving indeterminacy. Complexity may exist when there are many or only a few nodes. The indeterminacy of complex situations, systems, and networks stems largely from general unpredictable sensitivity to micro-level variation and general unpredictable sensitivity to macro-level variation.

Culture Culture from a network perspective is a cluster of subnets of ideas, sensemaking tendencies, emotions, self-interest profiles, action rules, and subsequent artifacts shared within and between social actor networks. A culture is the whole cluster, everything included. Network homophily is an artifact of a culture (see McPherson et al., 2001, for an extensive review of homophily).

Ego A variable term used to note the specific social network actor that is being discussed as central.

Homophily The idea that "similarity breeds connection," and "the result is that people's personal networks are homogeneous" (McPherson et al., 2001, p. 416). "Homophily is the principle that a contact between similar people occurs at a higher rate than among dissimilar people. The pervasive fact of homophily means that cultural, behavioral, genetic, or material

information that flows through networks will tend to be localized" (p. 416). Homophily is used to explain social actors connecting with others like themselves most of the time.

Idea Any cognitive construct counts as an idea.

Link Links attach two nodes. Linked nodes form a network. Growing hubs have increasingly attractive links as they grow. As links increase in number and strength, alters are able to make broad cross-cutting interconnections across all group members (Putnam, 2000). Low resistance, speed, and accuracy define link efficiency and effectiveness.

Long tie paths Long ties are direct paths between nodes that skip over possible short-path local nodes. They connect with nodes in locations beyond local clusters. Long ties allow networks to economize on the average number of degrees of separation between network nodes. Long ties allow efficient synchronization in broad networks.

Network Semi-ordered fields (Powell, White, Koput, & Jason, 2005; Watts, 2004). Networks are primary (Fuchs, 2001) and enable synchronous action. Networks are also the result of synchronous actions/transactions. That is, no synchronous action is independent of a network, and no network is independent of synchronous action.

Node Outcomes of networks. "Node" is also a notation for a network actor (cf. Borgatti & Foster, 2003). Actors can be social actors or technological actors or other physical actors. Neither "node" nor "actor" imply any particular level of aggregation or disaggregation.

Path The actual node-to-node journey of ties taken between nodes by a transmission stream to its end state.

Path dependency Path dependency as generally demonstrated by Arthur (1989[Au: no corresponding Ref; please add]) describes a spiraling feedback process that increases or decreases the likelihood that a subsequent event will synchronize with a prior event. This happens when prior events create increasing efficiency and effectiveness associated with a path, which makes the path more and more attractive relative to other possible paths, and increased adoption is positively related with increased efficiency and/or effectiveness of the path. Antonelli (1997) calls it "the set of dynamic processes where small events have long-lasting consequences that economic action at each moment can modify yet only to a limited extent . . . generated by the overlapping of irreversibility, indivisibility and structural actions of agents" (p. 643).

People Egos and alters that are human.

Power Law/Scale Free In scale-free networks, level of aggregation does not impact overall structure rules, and ties are not normally distributed among actors. Many networks exhibit this architecture, including many social networks. Networks in which the vast majority of nodes have very few ties, while a very few nodes have a large number of ties, are said to be "scale free" and subject to the power law. Power-law and scale-free networks have "hubs," which are nodes that have a disproportionately large number of ties. The power law is a result of increasing returns to adoption: The probability of a new node joining to an existing node is proportional to the number of network links or network synchs that hub already has completed.

Short tie paths Network paths between local nodes. A short tie can exist between nodes within the local cluster or can be between nodes in a closely located external cluster.

Small World The term used for a network that has a very low average degree of separation between any two nodes relative to the maximum number of degrees of separation in that

network. Long ties that bridge local alters and clusters make this possible. Small-world networks are searchable (Kleinberg, 2000), tend toward low average shortest path length, and a high clustering coefficient (Watts & Strogatz, 1998). They are efficient networks (Schilling, 2005; Uzzi & Spiro, 2005). When there are forces for increased efficiency and/or increased effectiveness, small-world networks tend to be in evidence. In social networks, affiliation networks of actors and groups (Newman & Park, 2003) make this possible.

Society The current sum of network activity at a given moment (Fuchs, 2001).

Strong ties, Weak ties The strength of a network tie is determined by synchronicity compliance between nodes. A strong tie is characterized by a high likelihood of compliance between two or more nodes. This is similar to Granovetter's (1973, p. 1361) seminal definition of tie strength as a "(probably linear) combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie." Compliance is inferred from synchronous behavior. Strength is also characterized by ties that do not break under above-normal variation in the network. This is similar to Capaldo's (2007) adaptation of the tie-strength construct. Capaldo suggested that greater resource commitments and a longer duration of a tie increase tie strength. A weak tie is one characterized by low likelihood of compliance and synchronicity between nodes. Fewer repeated ties, more ties with a greater number of partners, ties with fewer resource commitments, and ties lasting for shorter durations characterize weak ties (Capaldo, 2007). Weakness also refers to ties that break due to small variations introduced into the network field.

Synch A synchrony instance (see synchrony).

Synchrony Exists when two network nodes/actors behave at the same time as though they are in agreement. When nonrandom synchrony is evidence of links and transactions and thus a network. A "synch" is a synchrony instance. In general, a synch implies a link, and the occurrence of both implies a network. Strategically speaking, the "reason" networks have links is to promote synchs, so synchs are a good base unit for network performance. Synchrony requires connectivity, a high speed of transmission, and accuracy of transmission. Synchrony is functionally concurrent node agreement or equivalence on or about anything. For example, evidence of synchrony includes shared understanding about something; physical agreement; agreement about meanings of words, sentences, or phrases; agreement about meanings of a contract; exchange arrangements; and same energy output level, same wavelength, and matched expression of internal or external states of being between nodes—that is, anything.

Tie The result of a connection between two network nodes. Ties connect pairs of actors and can be directed or undirected, dichotomous or valued (Borgatti & Foster, 2003). Link values and node relationships may be negative as well as positive (Labianca & Brass, 2006[AU: please provide Ref]). A tie is evidenced by some degree of past or present synchrony between nodes.

Transformation A major change in network architecture that may or may not include a change in local components. Transformation is also known as a phase transition in some physical networks.

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