PATHWAYS OF OPPORTUNITY IN DYNAMIC ORGANIZATIONAL NETWORKS

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Abstract

How do organizational networks change continuously to provide new opportunities for members? We view organizations as complex adaptive systems embedded in heterogeneous networks consisting of different kinds of nodes (such as people, machines, projects, and heterogeneous components of the modern technological environment), and consider new opportunities to reside in the creation of new pathways linking previously unconnected nodes. We identify two broad classes of ideology relevant to opportunity creation in organizational networks: serendipity and goal-directedness. These ideologies operate as explicit and tacit theories of networking, affecting the addition of new nodes as well as the creation and rearrangement of ties.
Organizations can be understood as networks of procedures, puzzles, interpretations, and behaviors that provide opportunities for sense-making (Weick, 1979: 4). These fluid and shifting networks are at least in part constituted in terms of tacit or explicit theories concerning what people expect to experience. Managers and other occupants of formal leadership positions who expect the world to be stable and routine may well help confirm this expectation for themselves and others by structuring experience as a series of habitual routines. Theories about organizations -- concerning their design and their operation -- may have even more powerful self-fulfilling prophecies (cf. Ferraro, Pfeffer, & Sutton, 2005). To the extent that organizational theories emphasize stability rather than change, routines rather than serendipity, and control rather than self-organization, organizations themselves may not only appear to be inertial, but may also be constituted according to taken-for-granted theoretical prescriptions. Thus, organizational research that posits the importance of routines and inertial processes (cf. Hannan & Freeman, 1977) is likely to both see and experience the world of organizations in terms of stability of organizational forms.

Organizations as complex adaptive systems embedded in environments both internal and external are often described in terms of bundles of routines that store the cumulative results of learning (e.g., Kilduff, 1992). This emphasis on the recursiveness by which systems self-learn and self-organize is a starting point for understanding the process of opportunity creation within dynamic, open-system organizational networks. Complexity theory seeks to understand how system level self-organization emerges from interactions among nodes in the system (Anderson, 1999; Eisenhardt & Bhatia, 2002; Kauffman, 1993). In drawing from complexity theory, we propose a view of
organizational systems that includes the following characteristics associated with complex systems (cf. Cilliers, 1998: 3-5). a) The organization contains a large number of interacting nodes (cf. McKelvey, 1999), such nodes comprising both individual people as well as other heterogenous elements such as technologies (cf. Carley, 2002). b) Small investments of effort (such as efforts to establish new connections between nodes) are capable of non-linear yields (such as dramatically increased connectivity across the organizational system). c) Opportunity creation and destruction are recursive processes in that activities initiated by particular nodes are likely to cycle back into the vicinity of these nodes. d) The organization, to the extent that it is understood as a complex network system, operates far from equilibrium, requiring a constant flow of energy: "equilibrium is another word for death" (Cilliers, 1998: 4). e) The historical memory of the system (embedded in routines) undergoes constant change. f) Each node has only local knowledge -- no god-like purview of the whole system is possible.

Thus, complexity emerges from the interactions of heterogenous nodes -- it cannot be imposed by an omniscient organizational designer. We draw from these complexity ideas throughout the chapter to explore how leadership can be understood in terms of continual opportunity creation in a system of emergent complexity. From this perspective, opportunity creation can be facilitated or hindered by those in formal leadership positions. Not all organizations exhibit the dynamic properties of continual opportunity creation -- indeed, we think that network stagnation is the more likely outcome for most organizations most of the time, given the well-known human aversion to constant change. But, just as at the individual level, people are interested in the extent to which exceptional states of 'flow' can be attained in the production of work.
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(Csikszentmihalyi, 1991) so, at the organizational level, organizational leaders are likely to be interested in the extent to which exceptional states of dynamic opportunity creation can be attained.

We consider organizations as transformational engines that generate opportunities for members to learn from each other and from organizational resources such as databases, procedures, and goals. Given that an organization functions in part as a dedicated arrangement of specialized resources (Lawrence & Lorsch, 1967) we consider how the arrangement of specialized resources leads to the emergence of opportunity generation. Specifically, given the self-organizing, emergent characteristics of complex systems, our research question is: How can leadership arrange for organizational networks to change continuously, providing new opportunities for members, and avoiding the fate of stagnation? In order to answer this question we first must define what we mean by an organizational network in this complexity context.

HETEROGENEOUS NETWORKS

A network can be defined as a set of nodes and the relations that connect them. The nodes in any specific network are often assumed to be of the same kind. Thus, we have studies of interpersonal networks in which the nodes are people (e.g., Mehra, Kilduff, & Brass, 2001) and interorganizational networks in which the nodes are organizations or organizational units (e.g., Tsai, 2002). But we have almost no studies of heterogeneous networks in which different kinds of nodes and their relationships are studied simultaneously. In fact, a key assumption in previous network studies is that nodes are homogeneous or, at least, at the same level (Wasserman & Faust, 1994). This
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assumption simplifies the job of conceptualizing or defining the boundary of a network but ignores the possibility of interactions among different kinds of nodes or across different levels. As a result, previous studies tend to find that networks are stable or relatively inert over time because the way nodes are defined in these studies excludes cross-level effects of network change and development. To more meaningfully observe change and new opportunities in networks, we need to consider a broader set of nodes. For example, in an organization where employees utilize different technologies and work on different projects, we should not narrowly focus on “people” as the nodes in the organizational network without considering “technologies” and “projects” as nodes as well.

Although research in the Actor-Network Theory (A-NT) tradition (Law & Hassard, 1999) has described the importance of studying connections between people, machines, texts, projects, and other heterogeneous components of the modern technological environment, this research tradition appears to have had almost no influence on social network. Whereas A-NT research is deliberately qualitative in its pursuit of connections that are considered important from the point of view of the participant-observer, and eschews the use of quantitative methods (Law & Hassard, 1999), social network research is relentlessly quantitative in its use of mathematical algorithms to detect network structure. Without abandoning the advantages of quantitative modeling, it may be possible to incorporate more heterogeneous components within standard social network analyses. (Indeed, in pursuit of optimal organizational design considerations, computational modeling approaches have incorporated diverse network elements within what is termed the "metamatrix" -- see Carley, 2002, for a
review. And the discussion of heterogenous agents in interaction with each other and with artifacts in Axelrod and Cohen, 1999 explores organizational implications of a complexity perspective.)

We know from A-NT research that large-scale technological projects can produce self-organization among human actors whose relations with each other are subservient to relations with the many dynamic aspects of project management (Knorr-Cetina, 1981). In such circumstances, there appears to be no need for conventional leadership initiatives. We also know that people have intense relationships with texts and machines of all kinds (Latour, 1996). Thus, in considering what entities to include in an organizational network, the analyst is faced with a boundary choice that differs from the usual dilemma omnipresent in social network research. Whereas social network researchers are usually concerned at the beginning of a research project with the question of which nodes of the same kind to include (Wasserman & Faust, 1994: 31), in organizational research the analyst is less concerned with the boundary of the population, because the formal boundary of the organization can be taken to contain the relevant set of internal entities. However, within that formal boundary there is a potentially unlimited set of heterogeneous nodes that could include entities such as people, routines, cognitions, ideologies, texts, and machines.

**Network Regions**

Heterogeneity refers not only to the different types of nodes but also encompasses different network regions within the overall organizational network. Figure 1 (adapted from Dorogovtsev and Mendes, 2003: 20) illustrates the typical topography of a complex
organizational network. The outer belt -- labeled the Disconnected Component -- consists of isolated clusters that have few or no connections to other parts of the network. Moving inwards, we reach the region labeled the Weakly Connected Component in which all nodes are mutually reachable if direction of ties is ignored, the assumption being that "the mere presence of a relationship, regardless of its direction, allows some possibility for communication" (Scott, 2000: 104). At the center of the network, within the Weakly Connected Component, is the Strongly Connected Component, within which all nodes are mutually reachable and all paths "are aligned in a continuous chain without any change of direction" (Scott, 2000: 103). Thus, communication and other resources flow along paths "without interruption" (Scott, 2000: 104). The In Component contains all the nodes from which the Strongly Connected component is approachable, whereas the Out Component contains all the nodes that are approachable from the Strongly Connected component by directed paths (Dorogovtsev & Mendes, 2003: 21). The relative size of these regions is likely to vary from one organizational network to another, and is also likely to vary over time as weak and strong components wax and wane.

-- Figure 1 about here --

The topological structure illustrated in Figure 1 is likely to emerge as a result not of deliberate ordering by leaders but through self-organizing processes, the most important of which is the process of preferential linking: popular nodes will tend to attract more connections than unpopular nodes (see Simon, 1957, for an early development of this idea). By default, therefore, growing networks will tend to produce a
surprisingly robust topology, with distinct regions. Such self-organized networks may prove highly resilient to disruption, and highly efficient in the transmission of information across large distances. The resiliency and efficiency are directly related to the emergence of network hubs (i.e., highly popular nodes) within the strongly connected component and elsewhere. These hubs direct traffic within the network and tend to keep even rapidly-growing networks compact in terms of short average distances between nodes. One of the keys, therefore, to understanding how heterogenous networks self-organize in the absence of control by formally appointed leaders is the emergence of network hubs.

Organizational networks may be subject to other organizing processes, however, in addition to the default process of preferential linking characteristic of other complex networks. Specifically, goal-directedness and serendipity may facilitate the structuring of growing networks in ways we discuss in the next section.

NETWORK IDEOLOGIES

Under what circumstances are opportunity-generating processes likely to emerge in organizational networks? Our speculation is that the emergence of opportunity-producing processes are less likely to derive from the efforts of organizational leaders than from the sensitivity of the organizational system to a range of initial ideological conditions that include organizational culture, standard operating procedures, and taken for granted assumptions. As we suggested earlier, organizations -- and the networks within them -- exhibit self-fulfilling prophecies with respect to their dominant ideologies. Two broad classes of ideologies relevant to opportunity creation in organizational
networks are goal-directedness and serendipity (Kilduff & Tsai, 2003). These ideologies operate as explicit and tacit theories of networking, affecting the addition of new nodes as well as the creation and rearrangement of ties.

From a goal-directedness perspective, relationships develop around specific group-level or network-level goals. This process exhibits purposive and adaptive movement towards an envisioned end state (Van de Ven & Poole, 1995). Individual nodes are attracted to the network by the promise of goal-fulfillment. It is the collective goal rather than preferential linking that drives the development of relationships. Thus, the goal itself acts as a substitute for a formal leader in attracting resources, promoting relationship building, and directing energies toward a valued end state.

In contrast, from a serendipity perspective, relationships develop haphazardly based on opportunistic encounters. There is no group-level or network level goal in this process. Individual nodes interact without guidance from any leader or leader substitute concerning goals. To the extent that a formally appointed leader promotes serendipity, this is likely to be exhibited in the randomization of ties between nodes. For example, a manager may attempt to promote diverse linkages among staff by placing people from different disciplinary backgrounds or functional areas next to each other. By discouraging the powerful pressures toward homophilous networking, the leader may be targeted for strong criticism by individuals whose cliques are disrupted.

Regions of organizational networks that are strongly goal-oriented may incorporate mechanisms that trigger corrective action whenever 'deviant' processes emerge. Such network regions may minimize the emergence of self-organizing systems in favor of opportunity generation around shared goals. Thus, formal or informal leaders
may play a role in policing adherence to all-important goals. By contrast, regions in which ambiguous ideologies encourage serendipitous changes to procedures, unexpected interactions between members and technologies, and the articulation of heretical thoughts, may witness the emergence of opportunity generating systems that span across conventional boundaries. Projects may be nurtured until they reach into hitherto isolated corners of the organization, providing previously unconnected members with opportunities to connect to forms of thinking, novel routines, and collaboration possibilities with established cliques. Formal or informal leaders in these settings may work to prevent the tendency for closed networks to monopolize knowledge.

Goal-directedness and serendipity orientations can coexist in different regions of the same extensive network even though the two ideologies represent dramatically different organizing principles. But both of these organizing principles may require generating mechanisms to prevent entropy from dissipating the production and reproduction of structure. Goal-directedness may require goal iteration and extensive monitoring to maintain network relations focused on consensually-accepted end-states. Either a human node -- such as a local leader skilled in focusing attention -- or a nonhuman node -- such as a dominant technology or an attractive project -- can provide the center around which ancillary nodes can cluster. The central node can thus play the role of a goal-generating device, helping to prevent the network cluster from dissipating into the surrounding space.

Serendipity also requires an active generative presence if network relations are to be organized to maximize surprise and knowledge flow. As discussed above, networks, by default, tend to operate according to the principle of preferential linking: new nodes
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attach themselves to nodes that are already popular (Barabasi & Albert, 1999). To counter this strong inertial tendency may require the creation of specific policies to allocate resources -- such as coffee bars, technology labs, and exercise facilities -- to different network regions rather than allowing them to congregate collectively. Leaders, in this context, are the facilitators of network emergence. Serendipity generators may take the form of particular individuals who systematically attempt to bring together disparate nodes that otherwise would have little chance of connecting. Serendipity generators can also take the form of organizational procedures such as random lotteries to determine such important aspects of networking as office allocation. If goal-directedness dominates the whole network, then a core-periphery structure is likely to emerge with tight coupling and few structural holes. In contrast, when serendipity is dominant, a network tends to have a decentralized structure with a diffuse boundary and many structural holes.

Dynamic networks may exhibit both the rigid discipline of goal directedness and the spontaneity of serendipity either serially (over time) with fluctuations from one state to the other; or simultaneously in the sense that some parts of the network may be goal directed whereas other parts may exhibit serendipity. Indeed, the dynamic production of pathways of opportunity (in terms of new structural holes and brokerage to span across these structural holes -- Burt, 2005) may require the network to maintain a balance between the two organizing principles of goal-directedness and serendipity. For a network to stay in this edge-of-chaos region (Kauffman, 1993) requires a great deal of energy that can be supplied by the generative mechanisms we have mentioned as well as by the strategic management of the throughput of new cognitions or new network
members (March, 1991). To the extent that these new ideas of members are significantly different from those currently passing through or comprising the network system, the network can continue to exploit new knowledge and transform its relationship with the environment.

**THE EMERGENCE OF OPPORTUNITIES IN NETWORKS**

What do we mean by "opportunity"? In the context of a network perspective on opportunity creation, an opportunity is defined as the possibility of new pathways of connections among nodes in the network. Leadership, from this perspective, involves a sophisticated understanding of the ways in which new knowledge emerges from the interstices between nodes whereas existing, relatively mundane knowledge in one part of the network may offer new ideas to nodes in a distant part of the network.

Thus, we focus on pathways in networks because of the overwhelming importance of connectivity in the production and diffusion of knowledge within organizations (Hansen, 1999; Powell, Kogut, and Smith-Doerr, 1996). There are three possible types of connectivity pathways we consider -- walks, paths, and trails (Wassermann & Faust, 1994: 105-107), as Figure 2 illustrates. These different types of pathways have different implications for opportunity creation. The most general type of connectivity is a walk, defined as a sequence of nodes and ties between these nodes. In a walk, nodes and the ties that connect them can be included more than once. Thus, a walk provides for the possibility for reciprocal flows of knowledge and resources within an egalitarian network structure. A trail, by contrast, is more restrictive in that each tie occurs only once but each node may occur more than once. The identification of trails,
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therefore, allows the analyst to determine which nodes serve as the hubs of local activity in opportunity provision. Paths are the most restrictive of all three types of connectivity -- in a path, each node and each tie occur only once. Thus, paths allow only for linear flows of knowledge, and other resources -- for example, from peripheral nodes to the center. Adding new nodes, adding new ties, or rewiring ties to different nodes in the existing network can open up these pathway possibilities.

-- Figure 2 about here –

New Nodes

The addition of new nodes (such as new projects, new thinking, new members, random variations in established routines, and ambiguous mandates) increases network interaction capacity. For example, a mandate from the top leadership of the organization concerning the importance of "convergence" can represent a new node that organizes activity and members. The arrival of this new node may lead to the development of cross-departmental procedures and interactions that take on a life of their own unrelated to the minimal requirements of interactivity between different groups.

Nodes may be added to a network randomly (through serendipitous processes) or purposively by leaders (through goal-directed processes). In a network region dominated by serendipity, nodes will be added in a deliberately randomized fashion. There may be high variation in terms of the type of nodes that are considered, with less concern given to whether or not nodes and the connections they bring with them survive competitive selection procedures. There may be an acceptance of the likelihood of high mortality in
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terms of nodes -- such as projects -- balanced by an expectation of continual new knowledge production given unexpected opportunity creation through novel pathways of resource flow. This contrasts with network regions governed by goal-directedness, where variation in potential node addition will tend to be lower and selection criteria more strict. To the extent that new nodes are deliberately attached to existing centralized and goal-oriented networks, there will be much greater concern to nurture the survival of nodes and to protect node activity from predations of neighboring network regions. Nodes are likely to be seen as belonging to centralized clusters rather than being available for opportunistic exchange. The rate at which new nodes are added will depend on the extent to which the network can find goal-oriented nodes or convert nodes to the prevailing ideology.

The addition of new nodes to the system creates new opportunities for network members. A new node changes the pathways of network interaction from the perspective of network agents. For example, consider a goal-directed research network where pathways consist of interaction between researchers and data. The introduction of a new statistics package will create a new pathway between researcher and data and thus a new opportunity to interact with such data. Thinking of networks in terms of heterogeneous mixtures involving people, units, technology, and projects provides organizational leaders with many possibilities for encouraging pathways of opportunity.

In a goal-directed network, the goal itself may emerge as the central node, and its influence may help prohibit divergent path creation to the extent that new nodes are efficiently socialized into the existing ideology. A new node recruited into such a network is likely to be immediately imbued with the nature and dimensions of the
network goal. Slow learning nodes (those that resist adaptation to the prevailing norms, values and routines) are likely to provoke conflict within such network regions, and may offer novel pathways such as walks in an environment dominated by paths (cf. March, 1991). Thus one leadership initiative to promote new opportunity to existing network members may involve the judicious recruitment of slow learners of organizational cultural norms.

A slow learning node could, for example, consist of a new technology discrepant with established procedures that throws into confusion networks of exchange comprising people and machines (e.g., Barley, 1986). The recruitment of certain nodes can, of course, change the whole pattern of future node recruitment. For example, when the Oakland A's baseball team recruited new general manager Billy Beane in 1999, he brought to the organization a new system of statistical analysis based on past player performance (in high school and college) that led the organization to target players largely overlooked by rival teams (Lewis, 2003).

As networks increase in size, the average number of connections per node decreases (Bossard, 1945). Therefore, new nodes (and the new ties that they bring with them) in a goal-directed network may eventually result in a polarized network -- as the network core becomes denser, the periphery may become isolated. The principle of serendipity, therefore, may be more important in large growing networks than in smaller networks. It is in the larger networks that a leader's systematic encouragement of random ties between nodes is likely to considerably reduce average path length, as we discuss in the next section.
New Ties

The World Wide Web is one example of a self-organizing network in which new ties, and thereby network opportunities, are created every minute – in chat rooms and online gaming sites, via financial transactions, or through simple information transfer. No leader controls access or distribution. Through the principle of preferential linking network ties tend to pull the edges of the vast network closer together in a striking demonstration of the small world effect (Albert, Jeong, & Barabasi, 1999). Even though no person or organization can be said to dominate the Web, there are leadership activities going on all the time in terms of the promotion of network links by organizations that include the major search engines (Google etc.) and the growing number of interpersonal networking services that provide opportunities for strangers to connect to similar others.

The addition of new ties between strangers may have a disproportionately greater influence on opportunity creation in serendipitous, compared to goal-directed, networking. In network regions reflecting goal-directedness, new ties are likely to occur near the center of the network, whereas, in a serendipitous network region, ties may be allocated randomly, often linking previously unconnected parts of the network. The opportunities for knowledge creation and for organizing activities are thus expanded beyond the domain of goal-directed organizational boundaries by the increase in serendipitous encounters in Web-space controlled by networking sites and search engines.
Rewiring

This refers to the cutting of existing connections and their replacement by new connections. There is no net increase in the number of nodes or number of ties in the network, and thus time and other resource constraints are observed. Through the process of rewiring, new pathways are created without burdening nodes with increases in the number of connections.

Rewiring can occur through serendipitous or goal-directed processes. Consider a network describing whose office is next to whom in an organization following the opening of a new building (that in itself represents a new node, of course). This network can be rewired by a manager randomly reassigning individual employees to different offices or by purposively arranging proximate relationships between pre-selected employees (to preserve departmental boundaries, for example). In the case of random rewiring, the network experiences serendipitous variation that may open up pathways of opportunity hitherto not available. In the case of purposive rewiring, preferential linkages are maintained in pursuit of organizational pre-selected goals.

Product architecture can also be rewired in ways that may prove difficult or impossible for competitors to understand (Henderson & Clark, 1990). To the extent that workflow networks within organizations provide for knowledge flow to move in certain directions and not others, the rewiring of relationships within products may well mirror the rewiring of relationships between the humans and technologies that produce those products (Kilduff, Funk, & Mehra, 1997). Thus, technological decisions taken by engineers interested only in product efficiency can have indirect effects on the rewiring of social relationships in workgroups.
The idea of rewiring can be applied at the level of an ego network. Ego may serendipitously rewire its connections due to a haphazard change in the environment or location. Ego can also purposively rewire its connections to maximize its contact efficiency and its ability to span across structural holes (Burt, 1992). To the extent that opportunities to span across structural holes decay rapidly in organizational settings (Burt, 2002) those who wish to become the network leaders of their interpersonal connections must engage in constant monitoring and rewiring of those connections.

**DISCUSSION**

Opportunity creation in the heterogeneous networks characteristic of organizations can be understood in terms of new pathways triggered by additional nodes, additional ties, and the rewiring of existing connections. Organizational networks exhibit complex and multifaceted features that research has only begun to explore in terms of different regions, different entities, and dynamic properties. Leadership from the perspective of pathways of opportunity involves discerning and managing heterogeneous collections of nodes in the service of explicit goals or more serendipitously desired outcomes.

A focus on dynamic heterogeneous networks opens up many important research initiatives. First, we draw attention to the extent to which opportunity generation may depend on the dynamic configuration of the organizational network -- the changing size and shape of different regions. An interesting question is the extent to which new pathways within the strongly connected component affect overall network activity relative to new pathways in the weak and disconnected components.
Second, the issue of rewiring of existing pathways is itself worthy of much greater attention. As organizations attempt to restructure the flow of opportunities (because of new leaders, new technologies, or changing environments) there may be attempts to deliberately destroy old pathways. But research suggests that some network configurations may be highly resilient to flow disruption (see the extensive discussion in Dorogovtsev & Mendes, 2003). In order to completely disrupt the existing flow of resources and communication it would be necessary to destroy the strong and weak components. This would require the removal of most of the connected nodes in the network. Although it is not uncommon for new organizational regimes to remove and replace many existing nodes -- including people, organizational units, technologies, and procedures -- in pursuit of system-wide culture change, it may be that the compensatory tendencies of complex heterogeneous networks are capable of reconfiguring prior resource flows along new pathways. Specifically, to the extent that the weakly connected component survives relatively intact, organizational networks may exhibit resistance to attempted change. It is this weakly connected region within which relatively disordered connectivity may preserve possibilities of resource rerouting to preserve the status quo. The pathways of connectivity may be longer, and new nodes may emerge as brokers, but even the most deliberate attempt at network rewiring may experience puzzling difficulties in establishing the viability of new pathways of opportunity given the resiliency and the importance of the belt of weak connectivity surrounding the epicenter of the network.

We have said little concerning how research on these complex and fascinating topics could be undertaken. Clearly, simulations allow an expedient analysis of widely disparate initial system conditions and system adjustments. For example, building on
prior explorations of the impact of slow learners on organizational learning (March, 1991), one could simulate the extent to which diffusion of organizational culture varied under conditions of goal-directedness or serendipity. It might be that goal-directed networks would be more vulnerable to disruption and replacement given their relative efficiency and the absence of redundancy in terms of network pathways compared to self-organized networks that tend to exhibit surprising resiliency. Further, organizational learning might proceed at a faster rate given goal-directedness rather than serendipity, but organizational adaptation (defined as culture change that matches organizational change) might be more effective under conditions of serendipity.

We also see possibilities for the selective application of complexity approaches to organizational network research. The application of complexity theory to organizational science has been stymied by the small sample sizes characteristic of human populations in organizations. The theoretical move to heterogeneous networks results in a vast number of potential nodes and connections available for analysis in any organizational system. These networks can be studied using complexity techniques, such as NK modeling (Kauffman, 1993) and cellular automata (Wolfram, 2002). Already research on the World Wide Web has demonstrated how issues of network evolution and disruption can be investigated from the perspective of self-organization (Dorogovtsev & Mendes, 2003).

Complexity research suggests that dissipative forces tend to pull a network into less complex states (Eisenhardt & Bhatia, 2002). A potential area of future research concerns those networks that are able to overcome this tendency and actually increase network complexity levels. Although complexity theory typically suggests that (in
natural systems) there is no lead agent controlling the configuration of a network, we have drawn attention to the possibility that (for organizational systems) goal-generators and serendipity-generators may act to reconfigure the network by adding nodes, adding ties, and rewiring.

A final implication of our research relates to network node and tie survival from the perspective of opportunity generation. It may be that network nodes and ties survive based on their ability to provide new pathways of opportunity. Opportunity generation may in fact be integral to the life cycle of network nodes and ties. Rates of structural hole bridge decay (Burt, 2002) would thus be related to diminishing opportunity generation provided by these bridges over time.

CONCLUSION

Organizational network research has been colonized by a wide range of inertial theories, focusing on path-dependent member behavior in homogeneous networks. Although dissipative forces do indeed push organizational systems toward stability and equilibrium, network research remains deficient while it continues to neglect the means by which networks avoid such a fate. We offer a first step in redressing this neglect by developing a framework to illustrate dynamic opportunity creation in heterogeneous networks. Theories of network behavior that are dynamic, instead of inertial, heterogeneous, instead of homogeneous, and path-creative, instead of path-dependent, will provide researchers with the means to better understand both the characteristics of network systems and the potential influence of individual network leaders.
REFERENCES


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Tsai, W. 2002. Social structure of "coopetition" within a multiunit organization:


FIGURE 1

The Structure of Organizational Networks

FIGURE 2

How Walks, Paths, and Trails Differ

Walk = \(N_1 \ t_1 \ N_2 \ t_2 \ N_3 \ t_2 \ N_2\)

Path = \(N_1 \ t_1 \ N_2 \ t_2 \ N_3 \ t_3 \ N_4 \)

Trail = \(N_1 \ t_1 \ N_2 \ t_2 \ N_3 \ t_3 \ N_4 \ t_4 \ N_2\)

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