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Network Theory

Prologue to the Special Section: Network Multidimensionality in the Digital Age

MANUEL CASTELLS[1]
PETER MONGE
University of Southern California

NOSHIR CONTRACTOR
Northwestern University

There is a long and distinguished history of research on communication and other types of social networks. Some trace the intellectual foundations of this tradition to the work of John Stuart Mills and Herbert Spencer in the 19th century (Mattelart, 2000/1996), and others to the pioneering empirical work of Jacob Moreno in the early 20th century (Wasserman & Faust, 1994). Much has been learned about a wide variety of social networks, such as the use of mobile telephones in rural Africa (Castells et al., 2007), the spread of sexually transmitted disease among high school students (Bearman et al., 2004), and the development of transactive memories in work teams (Palazzolo et al., 2006), to name just a few. Interestingly, almost all of the published research has explored a single set of objects and a single set of relational links that connect them. In network parlance, these are called unidimensional networks, or equivalently, unimodal, uniplex networks. And yet, multiple types of objects can be tied together into a single network, such as a set of people (one type of object) who attend a number of different social events (a different type of object) (Davis et al., 1941). Likewise, the same set of objects can have multiple relations as reflected in the differences between formal (authority) and informal (social) communication relations that are typical in organizational networks (Krackhardt & Hanson, 1993). The "multiple types of objects network with single relations" model is called a multimodal, uniplex network, and the "single set of objects with multiple relations" model is called a unimodal, multiplex network. Both would be considered to be partial multidimensional networks because they contain only multiple sets of objects or multiple sets of nodes, but not both. Of course, it is possible to construct multidimensional networks that have two or more relations defined on two or more different types of objects, that is, partial multidimensional

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Manuel Castells: castells@usc.edu
Peter Monge: monge@usc.edu
Noshir Contractor: nosh@northwestern.edu
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networks that are both multimodal and multiplex. Typically, this type of partial multidimensional network has relations only between different types of objects. Finally, a fully multidimensional network is one that includes multiple types of relations both among the same types of nodes and between different types of nodes. Thus, a fully multidimensional network has multiple types of connections among all possible types of entities.

Why explore multidimensionality? The answer is simple. Unidimensional networks often fail to capture the richness of the full set of relations that link together different sets of objects. Sometimes, the subject of inquiry is a single relationship defined on a particular set of objects, in which case, unidimensional analysis is entirely appropriate. At other times, the phenomena are more complex. A good example of this level of complexity is the work of Woody Powell and his colleagues (2005), who studied the evolution of the biotechnology industry over a 10-year period of time. The objects they studied were different emergent members of the community, specifically dedicated biotechnology firms, public research organizations, venture capital firms, government regulatory agencies, and pharmaceutical companies. The relations they explored were research and development, finance, commercialization, and licensing. Powell et al. could have undertaken a unidimensional analysis that focused on each type of relation, such as financing or licensing, one at a time, separately, on each of the sets of firms that made up one type of object in the biotechnology community, for example, venture capital firms or regulatory agencies. It should be clear that this approach would have produced 20 different networks. The information generated by this approach would be useful on a piecemeal basis, but it would not have been very informative of the nature of the community as a whole, with its different constituents and different relations. Only their efforts at moving towards a multidimensional perspective could capture the complexity inherent in this community-level phenomenon.

To date, there are almost no network theories that attempt to articulate the multidimensionality of networks. To do so, they would need to specify multiple types of objects and multiple types of relations. Theoretical claims would need to specify the nature of single types of relations on multiple kinds of objects, or multiple types of linkages on single types of objects, or multiple relations on multiple kinds of objects. Although few analytic tools are available to study this level of network complexity, a number are currently under development. And so, it behooves the network scholarly community to begin to develop multidimensional network theories that capture more of the complexity inherent in the communication and other social processes that we study. To this end, the Annenberg Networks Network, a research center at the Annenberg School for Communication & Journalism at the University of Southern California, and the Science of Networks in Communities (SONIC) Research Group at Northwestern University convened a two-day workshop at USC in the spring of 2010, inviting leading network scholars to present their ideas about network multidimensionality in the digital age. The articles published in this special section of *IJoC* were presented and discussed in detail at that workshop. They have subsequently been revised, reviewed, and revised again. We think you will find them provocative and challenging, as they collective help to lay out a new agenda for network multidimensionality.

Manuel Castells' contribution to this special issue, "A Network Theory of Power," is focused on the loci of power inherent in the multidimensional networks that comprise the institutional relations of the network society. He argues that power is the relational capacity by which people or institutions can impose

their will on others, a position similar to that articulated by Benkler. And, since networks are based on relations, it follows that power resides in the network. Castells identifies four crucial network power foci. The first is networking power, which, similar to the definition offered in the Wilson and Tongia essay, is the power that comes from inclusion in the global network society over those who are excluded. The second is network power, which accrues from the standards that are created and enforced to define who may be included in the global society. This issue is also addressed in Nahon's paper on fuzziness in network gatekeeping. Third, networked power is the unique power that people exercise over each other in the network. Finally, network making power is the ability to program networks to facilitate the goals of the programmers, and to create strategic network alliances that preserve the power of network elites. This might be a rather one-sided picture of network power, were it not for the fact that Castells also discusses counter-power, the processes by which the same or different networks seek to counter the exercise of power in the four loci of the established networks. Mechanisms of resistance exist which enable resisters to reprogram the codes of the network, or to create meta-programs that express structural domination. Power, Castells concludes, is multidimensional because it is constructed around multidimensional networks.

Karine Nahon's paper, "Network Fuzziness of Inclusion/Exclusion," raises important issues pertaining to network gatekeepers and the people they gate. Thus, like Castells, she examines the standards and other processes by which gatekeepers exercise power, and like Wilson and Tongia, she explores the issues surrounding network inclusion and exclusion. Fuzziness, Nahon says, is ambiguity about who is in the network. She uses network gatekeeping theory to argue that ambiguity about inclusion and exclusion is determined by the changing balance of powers between gatekeepers and the entities they gate—the gated. Nahon disagrees with Castells' definition of network power because it focuses too much, she says, on decision-making processes. She prefers, instead, a definition that also includes non-decisional structural factors that control and shape the decision-making process. Failure to decide (i.e., inaction) is also important if it impacts the balance of power between gatekeepers and the gated. Nahon argues for an ecology of networks in which the gated act, creating networks and thus gatekeepers, who then control the gated and the subsequent networks. The gated, in essence, crown the gatekeepers, enabling them to act on their own behalf. A moment's reflection reveals that this theoretical formulation is the reverse of the traditional one that puts all the power in the hands of the gatekeepers. It is, therefore, somewhat ironic that the gated, or some of them, may become the gatekeepers.

"Networks of Power, Degrees of Freedom," Yochai Benkler's contribution, explores the elusive dynamics of power and freedom that are provided by the Internet in the networked society. He analyzes how these dynamics unfolded in the case of Wikileaks and its founder Julian Assange, who released to the world classified video of two U.S. Apache helicopters that fired on a group of people in Iraq, killing twelve, one of whom was a Reuters journalist. The Internet, Benkler argues, layers a "censorship-resistant online platform onto the traditional media environment," which significantly alters both the balance of power and the degrees of freedom among those who struggle over contested information. While Castells' paper focuses on social criticism, Benkler examines relevant methods. He uses Latour's notion of actant to define networks as social systems of individuals. Power is the extent to which actants can influence or control what other network nodes can do. Freedom is the extent to which actants can achieve their desired goals in the context of the power in the network. A node possessing complete freedom implies that other

actants have no power over it. Applying this framework to the case of Wikileaks vs. the U.S. military shows where each has degrees of freedom, power, and no power. Benkler's article closes with a discussion of the democratizing effects of the Internet, or the degree to which it enables greater freedom or imposes constraints.

Noshir Contractor, Peter Monge, and Paul Leonardi's article, "Multidimensionality and the Dynamics of Sociomateriality: Moving Technology inside the Network," explores the theoretical implications of developing multidimensional social networks that include nonhuman technological elements. Using ideas from actor-network theory and sociomateriality that are more fully articulated in Latour's keynote address, they develop a typology for multidimensional networks that includes the multiple kinds of nodes and multiple kinds of relations described in the first paragraph of this essay. This typology includes traditional types of nodes, like people, and traditional types of relations, like "shares information with," along with types of nodes that are technological artifacts, like databases, and types of nonhuman relations, like embodiment. In this way, technology is moved inside the social network and becomes an inherent part of it. An illustrative case shows how the inclusion of nonhuman artifacts and relations in the networks of an automobile design firm significantly changes our understanding of the emergent dynamics in this sociomaterial network. These results are extended by an exploration of how to develop multidimensional, multitheoretical, and multilevel models that include technological artifacts and relations.

Ernest Wilson and Rahul Tongia penned "The Flip Side of Metcalfe's Law: Multiple and Growing Costs of Network Exclusion." By far, the vast majority of network research examines the processes and implications of participation in social networks. Few such inquiries explore the processes of network exclusion, including their costs. Wilson and Tongia present a new framework for studying network exclusion built on insights gleaned from several laws of network effects. The most important of these is Metcalfe's Law, which states that the value of a network is proportional to the square of the number of people who are connected. Wilson and Tongia point out a number of problems with the existing laws, problems which constitute their basis for reframing the issue of exclusion. Specifically, they argue that as networks change from a small to large number of connected members, the number of excluded members declines (assuming a fixed population). When few are connected, exclusion is widespread, and the advantages of inclusion go to the few who are included. When the majority of the network is connected, the substantial disadvantages accrue to the few who are excluded. Wilson and Tongia also discuss the role that parallel networks play as they interact with other networks and the question of whether inclusion and/or exclusion can alter network structure.

Wendy Hall's paper is entitled "The Ever Evolving Web: The Power of Networks." There can be little doubt that the Internet has evolved dramatically over the past two decades. Wendy Hall, one of the key participants in its development over the years, provides a scholar's view of the Web's evolution from a network perspective. Focusing on the connective role that hypertext and hypermedia play in the Web, Hall traces the history and development of these ideas from their early inception to their embodiment in the World Wide Web during the 1990s, and on to the roles they are likely to play in the Semantic Web, the third generation of the Internet still under development. Hyperlinks define relations among objects; more specifically, they define the relations connecting source objects and destination objects. Historically, the

objects have been documents. But recent developments are moving toward a construction of objects as data, broadly defined, which includes text, documents, media, concepts, images, databases, etc. Hall describes the resource description framework (RDF) which provides a representation of these broad types of data and their associations. As ontologies and folksonomies are included that provide rules about how to interpret the relational associations, we are witnessing the emergence of the Semantic Web. Hall notes that Tim Berners-Lee, the person credited with inventing the World Wide Web, got it right when he argued that the network was the key to the Internet because of the power of networks effects, an argument similar to the one made by Wilson and Tongia. Once again, she says, it is network effects that are transforming Web 2.0 into the World Wide Web of the future, the Semantic Web.

Bruno Latour's paper, "Networks, Societies, and Spheres: Reflections of an Actor-Network Theorist," was the keynote address at the workshop. Latour, an originator and long-time advocate of actor-network theory, articulates a view of human social networks that includes both social actors and various human artifacts as a "mode of inquiry." Latour employs arguments developed by Gabriel Tarde to emphasize that being an actor and being a network are tantamount to the same thing, since people having friends, relations, profiles, and connections is what it means to be a social network. He further asserts that our social theories have the contours of our datascapes, that the enormous amounts of network data that are now available diminish, if not negate, the long-held theoretical distinction between the individual and society. New network navigational tools now make it possible to toggle back and forth between these artificial levels—in essence, eradicating the distinction between them. That is not to say that we can't study collectives, but rather that individuals and their extensive, multidimensional profiles must be taken together as one. This, Latour says, implies that the time may have arrived for us to consider that "the parts are actually bigger than the whole, and where a phenomenon can be said to be collective without being superior to individuals."

We are confident that you will find the ideas, concepts, and theoretical formulations developed in these papers to be useful to your own contributions to network multidimensionality. We commend them to you highly.

References

Bearman, P. S., Moody, J., & Stovel, K. (2004). Chains of affection: The structure of adolescent romantic and sexual networks. *American Journal of Sociology*, *110*, 44–91.

Castells, M., Fernandez-Ardevol, M., Qui J. L., & Sey, A. (2007). *Mobile communication and society: A global perspective*. Cambridge, MA: MIT Press.

Davis, A., Gardner, B. B., Gardner, M. R., & Wallace, J. J. (1941*). Deep South: A social anthropological study of caste and class*. Chicago, IL: University of Chicago Press.

Krackhardt, D., & Hanson, J. R. (1993). Informal networks: The company behind the charts. *Harvard Business Review*, *71*(*4*), 104–111.

Mattelart, A. (2000/1996). *Networking the world: 1794-2000*. (L. Carey-Libbrecht & J. A. Cohen, Trans.). Minneapolis, MN: University of Minnesota Press.

Palazzolo, E., Serb, D., She, Y., Su, C., & Contractor, N. (2006). Co-evolution of communication and knowledge networks as transactive memory systems: Using computational models for theoretical development. *Communication Theory*, *16*(*2*), 223–250.

Powell, W. W., White, D. R., Koput, K. W., & Owen-Smith, J. (2005). Network dynamics and field evolution: The growth of interorganizational collaboration in the life sciences. *American Journal of Sociology*, *11*, 1,132–1,205.

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. New York: Cambridge University Press.