Networks Versus Bow Ties:
Metaphors for the New Media Landscape

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The word *network* is often used in media research to describe large, complex, interconnected, technological systems. The "net" metaphor invokes the image of an extensive, evenly distributed pattern of intersecting lines or paths, with regularly spaced gaps throughout: an open mesh rather than a tightly woven fabric, but with consistent form and coverage. When paired with global, as in *global network*, the implication is of a ubiquitous and seamless infrastructure linking anyone in the world to anyone else with digital services.

Of course, few media systems are actually built this way, for economic, cultural, and political reasons as well as the limits of technology (the "digital divide" in Internet access is a striking example). More often systems have dense centers and sparse edges, or form tree, star, or wheel shapes. The variety of metaphors employed in attempts to describe the shape of the new media infrastructure says a lot about the unevenness of the new media landscape.

Transportation networks—highways and railroads—were the original "backbone" for early systems like the telegraph and telephone in the U.S. and elsewhere. Rail and telegraph lines followed the physical landscape, connecting and converging in larger cities and towns. Unless a small town happened to lie along a railway line or telegraph route, its access to transportation or electronic messaging, as well as its economic prospects, was somewhat limited.

Early radio and television broadcasting were urban, with most stations sending signals to local areas around cities. Local broadcasters faced power, frequency, and geography constraints that made their signals stronger in some areas than in others, and cable services were devised to help bring urban broadcast signals to rural communities and areas with poor reception. Later, radio and television networks allied local stations into hierarchical, top-down, tree-shaped organizations. Content and operations decisions originated in major cities like New York, Los Angeles, or London, and directed the choices and services available to progressively smaller markets and stations. The first American telephone systems connected affluent subscribers, such as doctors and stockbrokers, in small urban exchanges.

Like the telegraph (and postal services), telephone networks allowed any subscriber to contact any other subscriber, though local exchanges served fewer customers. Connectivity extended (if unevenly) as local exchanges interconnected (some in the wake of monopoly protections given to AT&T in the 1930s), long distance services were introduced, and rural telephone cooperatives provided services to remote areas.

This point-to-point pattern of connectivity probably comes closest of the electronic media to the popular idealized image of complete interconnection. Point-to-point (indeed, person-to-person) connectivity is the main selling point of today's cellular and wireless services, though availability and connectivity vary drastically from place to place. In Europe and elsewhere, cellular and wireless have been more widely adopted than in the U.S., mainly because they are cheaper than wire-line services and because European firms and regulators, unlike their American counterparts, have adopted common technical standards that permit wide regional and international interconnection.

Today, international cable, satellite, and telephone networks have grown into giant "hub-and-spoke" systems with a few well-served centers or "technopoles," each the center of a "constellation" of secondary markets and connected by heavily traveled paths or "tunnels" (Graham & Marvin, 1996). The Arpanet, and later Internet, backbone was organized around the satellite telecommunications links among major universities, research centers, and military installations.

With their infrastructural roots in telephony, distributed computing and satellite technology, the Internet and World Wide Web are often assumed to be ubiquitous and evenly dispersed. Yet, recent studies suggest that cyberspace too is uneven territory; even regular Internet users find that it can be

difficult to move from site to site or to find the information they need on-line. Not only is the infrastructure unevenly distributed, so is web content.

In theory any website should be just a few mouse clicks from any other, but a team of researchers at IBM's Almaden Research Center, AltaVista, and Compaq have found that most websites are only weakly connected to any others, when they are linked at all (Austen, 2000; Broder et al., 2000). Based on "crawls" of the largest sample of web content collected to date, they describe a "bow-tie" pattern of website connectivity, with about 28% of all sites in a central "strongly connected component." Bordering this central "knot" are, on one side, sites that link to the central group but which the center does not link back to (the so-called "In" group); and on the other side, sites that the center links to, but which do not link back to the center (the "Out" group). The "In" and "Out" groups each comprise about 21% of all websites, and another 22% of sites are in "tendrils" leading off the In and Out groups. Eight percent of all sites are entirely disconnected from the rest of the web.

Even among the most strongly connected or popular websites, the IBM team found that it takes an average of 16 hyperlinks (clicks) to get from one site to another. (As a comparison, this is many more than the hypothetical "six degrees of separation" or "small world" theory in social network research, which says there are an average of just six acquaintance links between any two people in the world.) They found that searches starting from any given strongly connected website tend either to reach a dead end after a few links or "explode" into millions of hits. Overall, they estimate that web searchers find what they are looking for only about 24% of the time.

Furthermore, websites appear to be distributed according to a "power law" (Broder et al., 2000; Huberman et al., 1998; Markoff, 1999). That is, a few popular or strongly-connected sites cluster at one end of a distribution, with all others trailing off in a long tail. This principle is similar to Zipf's Law in bibliometric studies of research publications, Pareto's Law in economics, Yale's Law in statistical studies of literary terms, and the "Matthew Effect" proposed by sociologist Robert Merton in studies of the reward system in scientific research. Essentially, all of these state that a few sites (scientists, publications, economic actors, literary terms) attract most of the attention (hits, wealth, fame, citations), and that this advantage tends to attract further attention and advantage. The majority of sites are ignored or lose visibility quickly. (Merton derived his label from Matthew 13:12, "Anyone who has will be given more and will have more than enough; but anyone who has not will be deprived even of what he has.") Bernardo Huberman of Xerox PARC describes what he calls "social search," where recommendations among friends and family influence website popularity (Huberman et al., 1998; Markoff, 1999).

It is probably not surprising that the Internet, or any other media system, is distributed and used unevenly. Systems are as much a product of users' expectations, capacities, successes, and failures as they are built technologies. The diversity of metaphors, however, that has developed around new media gives us a sense of just how dynamic systems and users are and that the "topology" of new media will probably remain rugged for some time to come.

References

Austen, I. (2000). Study reveals web as loosely woven. *New York Times*, May 18, p. D8.

Broder, A., Kumar, R., Maghoul, F., Raghavan, P., Rajagopalan, S., Stata, R., Tomkins, A., & Wiener, J. (2000). *Graph Structure in the Web.* [Available: http://www.almaden.ibm.com/cs/k53/www9.final/]

Graham, S., & Marvin, S. (1996). *Telecommunications and the city: Electronic spaces, urban places.* London: Routledge.

Huberman, B., Pirolli, P., Pitkow, J., & Lukose, R. (1998). Strong regularities in World Wide Web surfing. *Science*, 280: 95–97.

Markoff, J. (1999). Not a great equalizer after all: On the web, as elsewhere, popularity is self-reinforcing. *New York Times*, June 21, p. C4.

Greene Announces Guidelines for Future HCR Submissions

John O. Greene of Purdue U, recently named editor of *Human Communication Research* for volumes 27–29, is now receiving manuscript submissions to the journal.

HCR maintains a general behavioral- and social-scientific focus and is devoted to publishing the highest quality theoretical statements, critical syntheses, and empirical investigations of the broad spectrum of human communication phenomena.

Authors should submit four copies of the manuscript plus a diskette version. The computer diskette should contain two files: (1) a complete copy of the paper, including title page, abstract, figures and tables, and (2) a single-page document, with all author identification removed, containing the title, abstract (not to exceed 200 words), and key words for indexing. A separate sheet submitted with the manuscript should provide complete contact information (address, telephone, fax, and email) and brief biographical summaries (full name, highest earned academic degree, institution granting that degree, and present academic or professional title) for each author.

Manuscripts must conform to the specifications of the *Publication Manual of the American Psychological Association*, 4th edition, and authors should verify that the reference list is complete and in appropriate form. Additional guidelines for manuscript preparation may be found in recent issues of the journal.

Greene notes that one of his top priorities will be to ensure that manuscripts are processed in a timely fashion. He adds, "It is my sincerest hope that every person who submits a manuscript during my tenure as editor will, regardless of the eventual decision regarding publication, view the process as fair, humane, and constructive."

Manuscripts should be submitted to John O. Greene, Editor, *Human Communication Research,* Department of Communication, Purdue U, West Lafayette, IN 47907. Email correspondence should be directed to hcr@sla.purdue.edu.