

# Digital Government Conference

**“Evaluating Cyber-Infrastructures  
& the Social Networks They Enable”**

**Panel: “Cyber- Infrastructures for Public Health”**

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# Quotations

1. What's the major source of problems – solutions.
2. David Snowden: “Property understood knowledge is paradoxically both a thing and a flow.” & “Knowledge and action are intimately intertwined.”
3. There's only one thing worse than an inefficient bureaucracy - an efficient bureaucracy.
4. Life (agency) is relational only.
5. Richard Feynman: science is a way of trying not to fool yourself.
6. Winston Churchill: Definition of success, “keeping your enthusiasm between failures.”



# Duncan J. Watts

Six Degrees: The Science of a Connected Age (2003)

Viewed over a longer time horizon, the ability of the scientific community to innovate, and also to agree, has profound (if somewhat indeterminate) consequences for the production of new knowledge and its conversion to technology and policy. Inasmuch as the social structure of collaborations is a mechanism for scientists to learn new techniques, dream up new ideas, and solve problems they would not have been able to solve alone, then it is critical to the healthy functioning of the scientific enterprise. In particular, one would hope that even a very large collaboration network of scientists would be connected as a single community and not many isolated communities.



# Networks - Defined

A set of self-organizing working relationships among actors such that any relationship has the potential both to elicit action and to communicate information in an efficient manner. (Not an abstract and/or disembodied processes of change, e.g., logic modeling.)

The study of relations as systems, how the pattern of relations among actors affects individual behavior or system properties: social cohesion; relation (as opposed to property) notions of class, hierarch and domination and inter-group relations. How does the network environment affect an actor's behavior.



## Multiple (Academy) Sources (Inform Network Analysis)

Sociometry, psychometry, social anthropology, sociology, ecology, organizaional studies, epidemiology, linguistics, poliitical science, discrete maths (e.g., graph theory, matrix algebra, group theory, etc.).

## Network Analysis: Background or Early Use

Study by Coleman, Katz and Menzel, the diffusion of tetracycline (introduced in 1953) among doctors in four Illinois towns in 1955-6, used network analysis to determine diffusion of innovation.



## Network Analysis: Websites & Journals

- International Network of SNA, see:  
<http://www.sfu.ca/~insna/>
- Journal of Social Structure (JoSS) is an electronic journal of the International Network for Social
- Network Analysis (INSNA), see,  
<http://www.cmu.edu/joss/>
- CONNECTIONS, bulletin of INSNA



# Network Analysis: Listserve

- Socnet
- Redes

# Network Analysis: Software Products

- Gradap
- Krackplot
- NetDraw
- NetMiner
- NetViz
- Pajek
- Structure
- UCINET
- VISIO



# Networks In The News

- SARS epidemic
- Terrorist cells
- Internet linkages



# Network Analysis: Recent Publication of Note

The March 2005 Harvard Business Review  
published:

“A Practical Guide to Social Networks.”



# “Six Degrees” of Separation

- (1967) Harvard Professor Stanley Milgram sent letters randomly to residents in Wichita and Omaha to link to Boston. Some believed it would take up to 100 links. He found the median number of intermediate persons between the mid-westerner and the Bostonian was 5.5.
- The “small world phenomenon” - John Guare, 1991 Broadway play re: Degrees of separation (or the clustering co-efficient):
- Kevin Bacon (46 movies w/1,800 actors): average separation from all else in Hollywood is 2.79. Rod Steiger is at 2.53; Donald Pleasence is at 2.54 and Martin Sheen, Robert Mitchum & Charlton Heston are at 2.57.
- In academia: the mathematician Erdos: 1,500 papers & 507 co-authors.
- The Rich Get Richer: Corporate Boards & Interlocking: Fortune 1,000 companies have 10,100 directorships held by 7,682 directors: 79% serve on one; 14% on two; and 2.7% on three or more. The distance between any two belonging to the major cluster (containing 6,724 directors) is 4.6 handshakes away, i.e., Vernon Jordan.



## Separation (II)

- Molecules in the cell are separated on avg. by three chemical reactions.
- Species in food webs are on average are two links away.
- Scientists in different fields are separated by four to six co-authorship links. (bibliometrics)
- The WWW holds the record at 19 links.
- The World Wide Web, maybe the most studied. Governed by the subtle yet unforgiving law of preferential attachment (the probability that a node will choose a given node is proportional to the number of links the chosen node has. Early nodes are advantaged (i.e., the rich get richer phenomenon). Google is one very fit node.
- (Altogether, all studied are between two and 14 links.)



# Network Analysis: What's Assumed

- Patterns of connections matter, they support resource flows;
- Both direct and indirect ties matter, especially the strength of weak ties;
- Social structure matters, it enables and constrains action;
- Access is related to power, influence and position;
- Networks are pervasive; and,
- They help to shape action & can change and reproduce as a result of purposeful/intentional action.



# Network Analysis: Principles

- Ties often are asymmetrically reciprocal differing in content and intensity;
- Ties link network members indirectly as well as directly hence ties must be analyzed within the context of larger network structures;
- The structuring of social ties creates nonrandom networks hence network cluster;
- Boundaries and cross-linkages arise;
- Cross-linkages connect clusters as well as individuals;
- Asymmetric ties and complex networks distribute scarce resources differently; and,
- Network structure collaborative and competitive activities to secure scarce resources.



# Network Analysis: Underlying Assumptions: “Knowledge”

- Knowledge or knowledge creation is a process of developing “shared learning” or “shared meaning.”
- Knowledge arises in the complex responsive processes between human beings.
- Knowledge, or knowledge creation (& innovation), is not a thing or a system but an active process of relating. It cannot be “transferred” since it arises out of mutual adaptation.
- It is continuously reproduced and potentially transformed.
- Neither can one own knowledge nor can it be stored, measured or managed.
- Knowing & knowledge creation is the property of interaction or relationships.



# Knowledge (II)

- Meaning does not lie in an individual's gesture alone but in the social act as a whole, meaning arises in the responsive (gesture-response) interaction between two or more actors. It does not arise first in each individual to be subsequently expressed in action. It is not transmitted from one individual to another but rather arises in the interaction between them. Meaning is not attached to an object or stored but perpetually created in interaction.
- Meaning only becomes apparent in the response to the gesture and therefore lies in the whole or completed social act of gesture-response. Meaning is only in continuous gesture-response making.
- Knowledge is not shared as mental contents but perpetually arises in action. It is not transmitted from one mind to another but is the process of relating in the living present.
- The individual mind arises continuously and transiently in relationships between people.
- Human agency in this paradigm is not located anywhere because it is not an "it."
- Agency is instead a process of interaction.
- Neither the individual nor the social is prior, they are simultaneous. Since people jointly construct or create knowledge, the individual and social are the same level of being. Human agency is forming itself while being formed at the same time.

# Knowledge (III)

- Meaning (or here, “dissemination”) arises or occurs in social action since knowledge is not stored anywhere, it is (again) continuously reproduced and transformed in relational interaction between individuals.
- Knowledge creation and change is simply the act of conversing. Learning occurs when ways of talking and therefore patterns of relationships change.
- Knowledge assets therefore lie in the pattern of relationships between relating beings and are destroyed when those relational patterns are destroyed. In this sense there is no “transfer” – or “transfer” is only the partial or incomplete expression of the gesture-response dynamic.
- In sum, this is an action-based approach that emphasizes the social or collaborative nature of the action of talking in which people make sense of their actions together, taking account of each other’s sensibilities, spontaneously sustaining and repairing an unceasing flow of speech-entwined activity.

# Knowledge (IV)

## Contrasting Paradigms

### Sender/Receiver

- Reified Information (tools)
- Function of Source
- Product/Thing/Object
- “Knowledge” (true & useless)
- Mechanical (get it right)
- Think/Decision-making
- Technical/Engineer
- Disseminate & Transfer
- Manage/Control
- External/Hierarchical
- Organization/Structure

### Gesture/Response

(Shared) Learning/Meaning  
Product of Recipient  
Relational/ships/Co-Evolve  
“News” (true & useful)  
Inter-personal (ID ways that work)  
Act/Action-Based/Sense-making  
Adaptive/Discover  
Innovate & Create  
Emerge/Empower  
Internal/Local  
Individual/Interact Via Dialogue



# Network Analysis: Underlying Assumptions: “Control”

- Since the interaction within a network is a process of relating in which patterns of meaning emerge. Therefore, paradoxically we are in control & out of control simultaneously.
- We know the design procedure (a network) but the unknown are the variations within it.
- Our assumption here is that any health care system can be characterized by a plurality of meaning and contingencies and therefore what works (in re: quality improvement) is determined primarily by the user. A co-evolutionary process.
- Work towards: manage the starting conditions not an idealized end state, e.g., create barriers to prevent certain types of behavior; use attractors to encourage self-organizing identities; and, disrupt negative patterns early.



## Control (II)

- Example: West Point seniors asked to manage kindergartener's playtime: they planned objectives, backup; & response plans all using rational design principles.
- The structure of the system is not the result of an *a priori* design nor determined by external conditions. (It's not a question of what do I need to do, rather what can I create from what I have?)
- Agents cannot forecast total system response to their actions, they alone cannot improve the system as a whole (leadership implications).
- Act however on the basis of an expectation of an outcome.

See, Philip J. Streatfield, [The Paradox of Control in Organizations](#) (2001).



# Assumptions Leading To: Innovation

- Innovation does not start with a set of competencies and tools, purposefully brought together in order to develop a solution.
- Instead, potential users by conversing w/disseminators force them back again into a period of redundant conversations from which a new understanding will emerge in the living present.
- No one therefore can actually design or control innovation & no one can arrange or operate organizational processes of interaction - only participate in them.
- The identification of the need is consequence of success rather than a pre-condition for it.

See, Ralph Stacey, Complex Responsive Processes in Organizations (2001), Brenda Zimmerman, et al. Edgware, Insights from Complexity Science for Health Care Leaders (VHA, 1998), and Walker Percy, "Message in a Bottle."



# Network Analysis: Purposes

- Mobilizing
- Exchanging
- Integrating
- Forming/convening/combing strategic partnerships and alliances/new capacities
- Aligning (new identify)
- Supporting (communities of practice)
- Improving (learning and decision making)
- Delivering (increase capacity)
- Diffusing and dissemination
- Assessing (diverse feedback)
- Advocating/agitating
- **All lead to: Innovating**

# Network Analysis: What Can Be Learned

1. Communities of practice: identify key members assess the overall health of partnership connectivity.
2. Collaboration: measure and assess the extent to which partners are collaborating to determine whether the appropriate cross-collaboration or intra-collaborations are occurring to support goals re: research agenda setting, etc.
3. Information flow: measure and assess information flow both within and across in order to integrate expertise required to improve innovation.
4. Integration: large-scale and organizational system change is knowledge intensive & therefore substantially a matter of network integration. NA identifies players/parties required for initial dissemination as well as sustained dissemination months after initial implementation.
5. Decision-making: provide diagnostic information in assessing connections within/among network nodes & within individual nodes & how information is entering and leaving the network & individual nodes.
6. Innovation: examine how nodes are drawing upon & integrating various expertise of those throughout the network & w/in their particular organization;



## Network Analysis: General Measures

- Clustering coefficient (e.g., direct = 1.00)
- Energy levels or fitness/fitness distribution
- Pareto 80/20 rule: e.g., 80% of www links to 15% of web pages)
- Power laws: the few carry most of the action
- Preferential attachment/treatment
- Resiliency and robustness
- Strong v. weak ties: later more important

# Network Analysis: Basic Measures

## Individual Measures

In-degree/out-degree centrality

Between-ness centrality

Closeness centrality

Brokerage measures

## Group Measures

Density

Cohesion



# Network Analysis: Effectiveness Measures

- Centrality: how central an actor is within a network.
- Betweenness: how often an actor is a network is found in the shortest pathway between other actors in the network.
- Connectedness: a path or tie between every pair of actors.
- Density: proportion of possible lines or ties that are actually present.
- In-degree: is the number of orgs. in the network that reported referring clients to it for direct services.
- Out-degree: the number of other orgs. in the network from which an org. reported receiving clients for direct services.
- Multi-plexity: strength of ties between network agencies, i.e., if connected in more than one way, the more ties the stronger the relationship.
- Prestige: examined in directional relationships, one that is the object or recipient of many times in the network. (Normalized in-degree: used to measure prestige, indicated the number of directional ties terminating at or pointing toward an actor.



# Network Analysis: Relevant Challenges: “Spread”

- The innovation journey is not sequential or orderly but non-linear and disorderly.
- Therefore, science push needs to be complemented by other forces before it effects behavioral change, persuasion is often times required.
- However, boundaries exist between & among professional groups - based on the underpinning of a professional groups social & cognitive or epistemological boundaries.
- Therefore the spread of new work practices are inhibited.
- Interestingly, increased professionalization leads to surplus knowledge production and hyper-complexity which paradoxically enables the end user of research to exercise, or not, choice between potentially clashing but even more plausible knowledge claims. (People talk past one another.)
- E.g., hospital-based docs. more accepting of the RCTs v. primary care docs.
- So . . . some attention on the boundaries between professional groups.

See, Ferlie, et al. & Brass, et al. Academy of Management Journal articles.



# Network Analysis: Seven Challenges Re: Measurement

## ■ Management of Network Structures

Manage interdependencies, i.e., influencing/building legitimacy, maintaining legitimacy/building consensus and building mgt. skills. See Mandell.

## ■ Importance of Centrality

In a study of a group voting on political issues, the link between centrality and power is context bound or highly contingent. See Mizruchi.

## ■ Importance of/Knowing Broker Position or Type

Liaison; representative; gatekeeper; cosmopolitan or itinerant broker; and, local broker or coordinator. See Fernandez.



# Network Analysis: Measurement Challenges (II)

- Interdisciplinary Collaboration  
Non-spread problem, how to be organized, how researchers might behave in collaboration and how activities could be facilitated through better management. See Rhoten.
- The Key Player Problem  
Not easily solved. See Borgatti.
- Strength  
Of a network are tough to measure. See Caldarelli.
- Robustness or ultra-robust networks  
How to avoid congestion-related failure and disintegration. See Dodds, et al.



# Network Analysis Studies: Examples: Tobacco; HIV; & Chronic Illness

State Tobacco Control Networks:  
(WA, IN, WY, NY, MI)

- SNA used to examine the structure of five state tobacco control networks. Found that frequent communication related to highly productive relationships; importance of statewide coalitions in implementing state program; & SNA useful in developing process indicators for control programs. See Krauss, et al.



# Network Analysis Studies: Example: HIV

“Information Flow Aided HIV Decline in Uganda.”

- Uganda has been far and away the most successful African nation in getting the HIV/AIDS epidemic under control, and the success has been attributed largely to social networking and other social processes, which have actually changed behavior, e.g., fewer sex partners, less risky behavior abstinence, etc., because it has become OK to just talk about the problem. Uganda has shown a 70% decline in HIV prevalence since the early 1990s linked to a 60% reduction in casual sex. Response distinctively associated with communication through social networks. (Stoneburner and Low-Beer, Science, 2004).
- (Others, e.g., descriptive epidemiological studies, transmission in Atlanta & Flagstaff & and a study of Winnipeg & Colo. Springs. See two studies: Rothenberg, et al. & Jolly, et al. studies in the Journal of Urban Health.)



# Network Analysis Studies: Example: HIV (II)

- Baltimore, Maryland.
- Inter-organizational relationships between 30 HIV/AIDS service agencies. Two surveys one to assess inter-org. relationships at the direct service delivery level and one to assess relationships at the admin. level.
- Note: Integrative coordination is consistently higher for service delivery networks than for admin. or planning networks.
- (Density scores, in-degree mean was 12.5 and the out-degree mean was 9.67.)

See Kwait, et al.



# Network Analysis Studies: Example: Chronic Care

- Douglas, Arizona.
- Network to build community capacity to provide chronic disease education, prevention and treatment services by developing collaborative partnerships among a broad range of organizations.
- Research ?s: did network ties increase; were increases consistent across types of links measured; were some providers more heavily networked than others; &, what were attitudes toward trust and collaboration.
- (Note: only limited evidence that such methods have been employed in health promotion.)

See Provan, et al.



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