From Disasters to WoW: Enabling Communities with Cyberinfrastructure

Noshir Contractor
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Professor of Ind. Engg & Mgmt Sciences, McCormick School of Engineering
Professor of Communication Studies, School of Communication &
Professor of Management & Organizations, Kellogg School of Management,
Director, Science of Networks in Communities (SONIC) Research Laboratory
nosh@northwestern.edu
1. Turn on power & set MODE with MODE button. You can confirm the MODE you chose as the red indicator blinks.

2. Lamp blinks when (someone with) a Lovegety for the opposite sex set under the same MODE as yours comes near.

3. FIND lamp blinks when (someone with) a Lovegety for the opposite sex set under different mode from yours comes near. May try the other MODES to “GET” tuned with (him/her) if you like.
From *Clever Collections* to *Clever Connections*

- Multilevel motivations for creating, maintaining, dissolving, and reconstituting social and knowledge network links.

- Opportunity for 3D approach to networks: Discovery, Diagnosis, & Design at P&G

- Other Examples: Tobacco research, CI-Scope, Emergency Response, World of Warcraft
Aphorisms about Networks

- **Social Networks:**
  - Its not what you know, its **who** you know.

- **Cognitive Social Networks:**
  - Its not who you know, its **who they think** you know.

- **Knowledge Networks:**
  - Its not who you know, its **what they think** you know.
Cognitive Knowledge Networks

It’s not who you know.
It’s what who you know knows.

Source: Newsweek, December 2000
INTERACTION NETWORKS

Non Human Agent to Non Human Agent Communication

Non Human Agent (webbots, avatars, databases, “push” technologies) To Human Agent

Retrieving from knowledge repository

Publishing to knowledge repository

Human Agent to Human Agent Communication

Source: Contractor, 2001
COGNITIVE KNOWLEDGE NETWORKS

Non Human Agent’s Perception of Resources in a Non Human Agent

Human Agent’s Perception of Provision of Resources in a Non Human Agent

Non Human Agent’s Perception of what a Human Agent knows *

Human Agent’s Perception of What Another Human Agent Knows

* Why Tivo thinks I am gay and Amazon thinks I am pregnant ....
Human to Human Interactions and Perceptions

Human to Non Human Interactions and Perceptions

Non Human to Human Interactions and Perceptions

Non Human to Non Human Interactions and Perceptions
Multidimensional Networks in Web 2.0
Multiple Types of Nodes and Multiple Types of Relationships
WHY DO WE CREATE, MAINTAIN, DISSOLVE, AND RECONSTITUTE OUR COMMUNICATION AND KNOWLEDGE NETWORKS?
Social Drivers:
Why do we create and sustain networks?

- Theories of self-interest
- Theories of social and resource exchange
- Theories of mutual interest and collective action
- Theories of contagion
- Theories of balance
- Theories of homophily
- Theories of proximity
- Theories of co-evolution

Sources:
“Structural signatures” of MTML

Theories of Self interest

Theories of Exchange

Theories of Balance

Theories of Collective Action

Theories of Homophily

Theories of Cognition
“Structural signatures” for MTML Theories

- Theories of Exchange
- Theories of Structural Holes
- Theories of Balance

- Theories of Collective Action
- Theories of Homophily
- Theories of Cognition
Enter ERGM Framework

- Statistical “Macro-scope” to detect structural motifs in observed networks

- A team at the University of Melbourne (led by Professors Pip Pattison & Garry Robins) is one of the three premier global hubs on ERGM research
Empirical Illustration

Co-evolution of knowledge networks and 21st century organizational forms

- Co-P.I.s: Bar, Fulk, Hollingshead, Monge (USC), Kunz, Levitt (Stanford), Carley (CMU), Wasserman (Indiana).
- Three dozen industry partners (global, profit, non-profit):
  - Boeing, 3M, NASA, Fiat, U.S. Army, American Bar Association, European Union Project Team, Pew Internet Project, etc.
MTML analysis of information retrieval and allocation

Why do we create information retrieval and allocation links with other human or non-human agents (e.g., Intranets, knowledge repositories)?

Multiple theories: Transactive Memory, Public Goods, Social Exchange, Proximity, Contagion, Inertial Social Factors

Multiple levels: Actor, Dyad, Global

UIUC Team Engineering Collaboratory: David Brandon, Roberto Dandi, Meikuan Huang, Ed Palazzolo, Cataldo “Dino” Ruta, Vandana Singh, and Chunke Su
**Public Goods / Transactive Memory**
- Allocation to the Intranet
- Retrieval from the Intranet
- Perceived Quality and Quantity of Contribution to the Intranet

**Transactive Memory**
- Perception of Other’s Knowledge
- Communication to Allocate Information

**Communication to Retrieve Information**

**Inertia Components**
- Collaboration
- Co-authorship
- Communication

**Social Exchange**
- Retrieval by coworkers on other topics

**Proximity**
- Work in the same location
### Multi-theoretical p*/ERGM

**Theoretical Predictors of CRI**

1. Social Communication  
   - 0.144

2. Perception of Knowledge  
   & Communication to Allocate  
   - 0.995

3. Perception of Knowledge & Provision  
   - 0.972

4. Perception of Knowledge, Social Exchange,  
   & Social Communication  
   - 0.851

5. Perception of Knowledge, Proximity,  
   & Social Communication  
   - 0.882
A contextual “meta-theory” of social drivers for creating and sustaining communities

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Projects Investigating Social Drivers for Communities

Core Research
Social Drivers for Creating & Sustaining Communities

Science Applications
- CLEANER: Collaborative Large Engineering & Analysis Network for Environmental Research (NSF)
- CP2R: Collaboration for Preparedness, Response & Recovery (NSF)
- TSEEN: Tobacco Surveillance Evaluation & Epidemiology Network (NSF, NIH, CDC)

Business Applications
- PackEdge Community of Practice (P&G)
- Vodafone-Ericsson “Club” for virtual supply chain management (Vodafone)

Societal Justice Applications
- Cultural & Networks Assets In Immigrant Communities (Rockefeller Program on Culture & Creativity)
- Economic Resilience NGO Community (Rockefeller Program on Working Communities)

Entertainment Applications
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- Everquest (NSF, Sony Online Entertainment)
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Challenges of empirically testing, extending, and exploring theories about networks … until now
It's all about "Relational Metadata"

- Technologies that "**capture**" communities’ relational meta-data (Pingback and trackback in interblog networks, blogrolls, data provenance)

- Technologies to "**tag**" communities’ relational metadata (from Dublin Core taxonomies to folksonomies (‘wisdom of crowds’)) like
  - Tagging pictures (Flickr)
  - Social bookmarking (del.icio.us, LookupThis, BlinkList)
  - Social citations (CiteULike.org)
  - Social libraries (discogs.com, LibraryThing.com)
  - Social shopping (SwagRoll, Kaboodle, thethingsiwant.com)
  - Social networks (FOAF, XFN, MySpace, Facebook)

- Technologies to "**manifest**" communities’ relational metadata (Tagclouds, Recommender systems, Rating/Reputation systems, ISI’s HistCite, Network Visualization systems)
Digital Harvesting of Relational Metadata

Bios, titles & descriptions

Personal Web sites Google search results

Web of Science Citation

CATPAC

UBERLINK

Digital Harvesting of Relational Metadata

CI-KNOW Analyses and Visualizations

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3D Strategy for Enhancing Knowledge Networks

**Discovery**: Effectively and efficiently foster network links from people to other people, knowledge, and artifacts (data setsstreams, analytic tools, visualization tools, documents, etc.)

- *“If only HP knows what HP knows”.*

**Diagnosis**: Assess the “health” of internal and external networks - in terms of scanning, absorptive capacity, diffusion, robustness, and vulnerability to external environment

**Design**: Model or re-wire networks using social and organizational incentives (based on social network research) and network referral systems to enhance evolving and mature communities
IDC found Fortune 500 companies lose $31.5 billion annually due to rework and the inability to find information.

The Delphi Consulting Group found that:

- Only 12 percent of a typical company's knowledge is explicitly published. Remaining 88 percent is 'distributed knowledge', comprised of employees' personal knowledge.

- Up to 42 percent of knowledge professionals need to do their jobs comes from other people's brains - in the form of advice, opinions, judgment, or answers. More often than not, much of this exchange does not follow channels displayed in an organizational chart.
Discovery Challenges

- Who knows who?
- Who knows what?
- Who know who knows who?
- Who knows who knows what?
Goal of Discovery – “IKNOW”
“Diagnosis”: Why Diagnose the Network?

- Naturally occurring networks are not always efficient or fully functional
  - Gaps, isolates, lack or difficulty of connectivity

- Network measures can be used to diagnose network’s vital statistics
Diagnosis Questions

- How capable at *scanning* external expertise?
- How capable at *absorbing* expertise from the external network to the internal network?
- How efficient at *diffusing* the external expertise within the internal network?
- How *robust* in a specific area of expertise against disruption?
- How *vulnerable* to being externally *brokered*?
Strongest capacity to absorb
From Diagnosis to “Design”

1. Identifying which network links need to be “re-wired” optimize the collective power of the network.

2. Identifying the Individual, Organizational and Social Incentives – for members to want to re-wire.
Industries with small world network structures are more innovative!

Networks where people spend most of their time communicating with one another in a group ("cluster") and spend some time communicating with others outside ("shortcuts")

Small world networks exhibit high levels of "clustering" and few "shortcuts"

- Clusters engender trust and control, maximize capability for exploitation
- Shortcuts engender unique combinations of network resources, maximize capacity for exploration
“Pre-wired” PackEdge CoP Network
“Re-wired” PackEdge CoP Network
Wiring the PackEdge CoP Network for Success

Increase the likelihood to give and get information to the right target and source respectively

Benefits for CoP
- Increase absorptive capacity from 45.3% to 53.4%
- Reduce number of steps for diffusion from 4.3 to 2.6

Costs for CoP
- Increase communication links of network leaders from 28 to 38 (~ 150 new links).
- Increase criticality of network leaders from 26.7 % to 48.5%
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Hurricane Katrina 2005

- **Formed:** Aug 23, 2005
- **Dissipated:** Aug 31, 2005
- **Highest wind:** 175 mph
- **Lowest press:** 902 mbar
- **Damages:** $81.2 Billion
- **Fatalities:** >1,836
- **Areas affected:** Bahamas, South Florida, Cuba, Louisiana (especially Greater New Orleans), Mississippi, Alabama, Florida Panhandle, most of eastern North America

Map source: http://hurricane.csc.noaa.gov/
Data and picture source: http://en.wikipedia.org/wiki/Hurricane_Katrina/
SITREP Content

**Basic Format / Information**

1. **Situation** (What, Where, and When)
2. **Action in Progress**
3. **Action Planned**
4. **Probable Support Requirements and/or Support Available**
5. **Other items**
*Colorado Division of Emergency Management

SITUATION REPORT 2005-6
(Hurricane Katrina)
August 30, 2005*

*Event Type:* Hurricane Response

*Situation:* On August 29, Hurricane Katrina hit the gulf coast east of New Orleans. It was considered a Category 5 Hurricane, which brings winds of over 155mph and storm surge of 18 feet above normal. Massive property damage has occurred and undetermined number of deaths and injuries.

Colorado response to date include two deployments:
- Two members from the Division of Emergency Management to the Louisiana
  EOC, departed on August 29.

*Weather Report:* Katrina is moving toward the north-northeast near 18 mph. A turn toward the northeast and a faster forward speed is expected during the next 24 hours. This motion should bring the cent

*Agencies Involved:* Colorado Department of Military and Veteran Affairs, Department of Local Affairs, Division of Emergency Management, Governor's Office.*

*Additional Assistance Requested:* Type III teams, consisting of Operations, Plans, and Logistics personnel (two individuals for each area). These teams could deploy to Alabama, Louisiana, and/or Mississippi. Teams will be at either working the State or Parish/County EOCs.
Human Coding Procedure

n Using an HTML editor to mark entities (people, organizations, locations, concepts)

u as bold and include a unique HTML tag

u <b><a name="F10005505a00003">FEMA</a></b>
Automatic Coding

D2K – The Data to Knowledge application environment is a rapid, flexible data mining and machine learning system.

Automated processing is done through creating itineraries that combine processing modules into a workflow.

Developed by the Automated Learning Group at NCSA.
Florida is the Topic of the Conversation

Petroleum Network formed Early

Time Slice 1: 8/23 to 8/25/2005

Florida is the Topic

Petroleum Network formed Early
Time Slice 1 to 2

[Network diagram with nodes labeled ARC, SAL, Shelter, KY, GA, TX, AL, LA, FL, Power, FP&L, Gov Bush, Military, NO, and connections between them.]

[Legend showing node types: Organization, Location, Unknown, Concept, Person.]
Time Slice 2: 8/26 to 8/27/2005
Time Slice 2 to 3
Time Slice 3: 8/28 to 8/29/2005
Time Slice 3 to 4

Diagram showing various locations and organizations such as AL Power, National Guard, FP&L, Shelter, ARC, TX, FL, GA, NC, NO, MS, LA, Gov Bush, Military, S & R, and Power.
Time Slice 5: 9/1 to 9/2/2005
Time Slice 5 to 6
Time Slice 6: 9/3 to 9/4/2005

- ARC
- FEMA
- Shelter
- TX
- MS
- LA
- NO
- FL
- Outages
- AL Power
- National Guard
- NO
- AL S & R
- Urban S & R
- GA
- ARC
Change in Network Centrality Rankings

- “American Red Cross” starts in the 200s and moves to the teens
- “FEMA” starts in the 20s, moves to the teens, and ends in the 60s

Crossover where American Red Cross becomes relatively more central than FEMA (Sep 1, 2005)

FEMA drops rank and American Red Cross moves up
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Tobacco Surveillance, Epidemiology, and Evaluation Network (TSEEN)

- National Cancer Institute
- Center for Disease Control’s National Center for Health Statistics (NCHS),
- Center for Disease Control’s Office of Smoking and Health (OSH),
- Agency for Healthcare Research and Quality (AHRQ),
- National Library of Medicine (NLM) and
- Non-government agencies such as the American Legacy Foundation.
Low-tar cigarettes cause more cancer than regular cigarettes ...

A pressing need for systems that will help the TSEEN members effectively connect with other individuals, data sets, analytic tools, instruments, sensors, documents, related to key concepts and issues
CI-Scope:
Mapping the science of cyberinfrastructure

Demo
Projects Investigating Social Drivers for Communities

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WoW:
Massively Multiplayer Online Role Playing Game
Rise of WoW

Source: http://www.mmogchart.com/
Goals of WoW Community

- Teams perform diverse quests within the game environment, typically varying in length from one hour to several days, with the goal of achieving an objective, gaining resources, and increasing experience.

- Exploiting, Bonding & Swarming
## Contextualizing Goals of WoW

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Mapping *Goals* to Theories: WoW Gaming Community

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Information Retrieval - Time One
Information Retrieval - Time Three
Unraveling the “Structural Signatures”

Incentive for creating a WoW link with someone

= -1.08 (cost of creating a link) [Self-interest] + 0.29 (benefit of reciprocating) [Exchange] + 3.07 (benefit for being a friend of a friend) [Balance] + 0.04 (benefit of connecting to an expert) [Cognition]

All coefficients significant at 0.05 level
Summary

- Research on the dynamics of networks is well poised to make a quantum intellectual leap by facilitating collaboration that leverages recent advances in:
  
  - Theories about the social motivations for creating, maintaining, dissolving and re-creating social network ties
  
  - Development of cyberinfrastructure/Web 2.0 provide the technological capability to capture relational metadata needed to more effectively understand (and enable) communities.
  
  - Computational modeling techniques to model network dynamics in large-scale multi-agent systems
  
  - Exponential random graph modeling techniques to empirically validate the local structural signatures that explain emergent global network properties
1. Extend theories to predict the dynamics of networks (MTML)

2. Develop agent-based computational models to assess and evaluate alternative trajectories of network dynamics (Repast/Blanche)

3. Collect/capture longitudinal empirical network data (KAME/NAME/D2K/Automap)

4. Develop interventions including cyberinfrastructure tools to enable networks (CI-IKNOW)

5. Statistical methods to empirically validate networks dynamics predicted by agent based models based on MTML theories (p*/ERGM techniques using MCMC methods)

FRAMEWORK FOR MTML MODELING OF NETWORK DYNAMICS
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Acknowledgements