International Conference on Complex Systems 2007

Special Day on Networks - November 2, 2007

Are Organizations Networks?

Jeffrey Stamps, PhD, and Jessica Lipnack

www.NetAge.com

Presentation Outline

- Introducing ourselves and networked organizations

- Virtual teams as little networks

- Mapping organizations as networks
  - What is an organizational network?
  - OrgScope: displaying and analyzing a large-scale organizational network while discussing what immediate analysis and application mean to management
  - Node-link taxonomies and logic underlying organization network theory

- Is the "objective organization" a natural network? Five questions

Goal: Open organizations to the full power of network and complexity science as represented by ICCS 2007

We need large-scale organizational intelligence, both concentrated and distributed, to meet the great challenges of our current planetary moment

In the beginning:

## International Communications Network, Oxford, 1968


Him

Me

Began by contacting one richly-connected networker

Original information sources from grass-roots movements of 1960s-early '70s

- *Health and the Life Cycle*
- *Communities and Cooperatives*
- *Ecology and Energy*
- *Politics and Economics*
- *Education and Communications*
- *Personal and Spiritual Growth*
- *Global and Futures Networks*

People Connecting with People, Linking Ideas and Resources
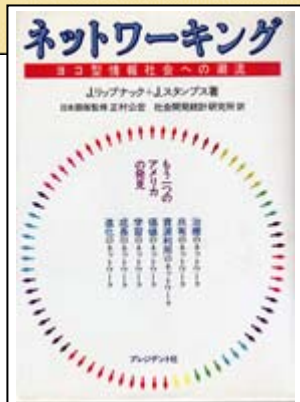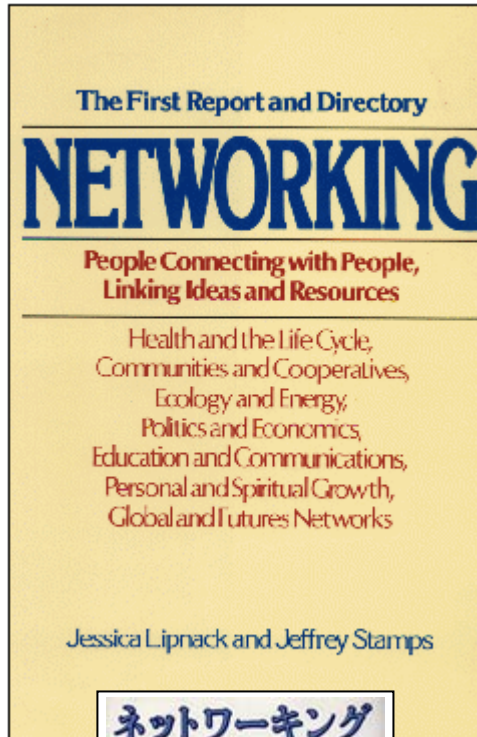
First network model combined field research materials with General Systems Theory

Structure

- Holons
- Levels
- Decentralized
- Fly-eyed
- Polycephalous

Process

- Relationships
- Fuzziness
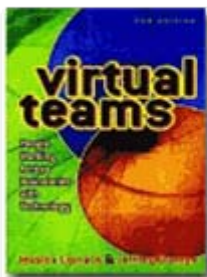- Nodes and Links
- Me and We
- Values

NetAge Background

Harvard Business Review
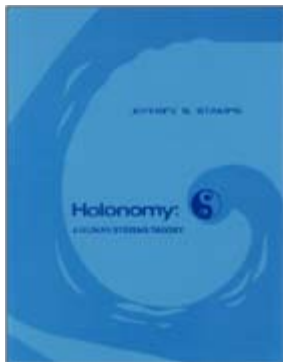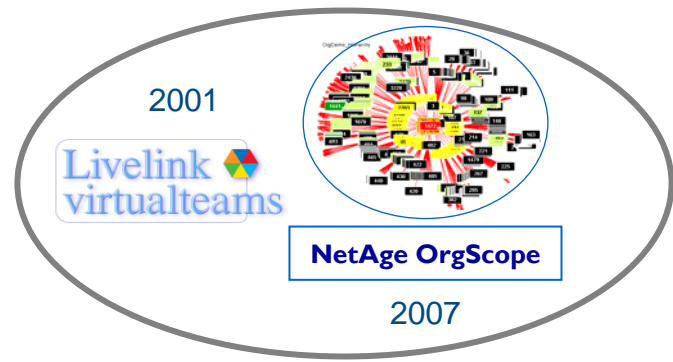Can Absence Make a Team Grow Stronger?

2004
1982
1986
2000
1993
1994
1997

1980
Holonomy: A Human
Systems Theory
Foreword by Prof. Kenneth
Boulding

1992   1994   2006
2004   1997
1994   1994
1984
1994   1995
                   1998
2003   1982   1997   2007

VOLVO   QANTAS   hp
NCR   intel
AT&T   FINANCE   Pfizer
digital   Roche
Steelcase   Apple
USJFCOM   GE

2001
Livelink virtualteams
NetAge OrgScope
2007
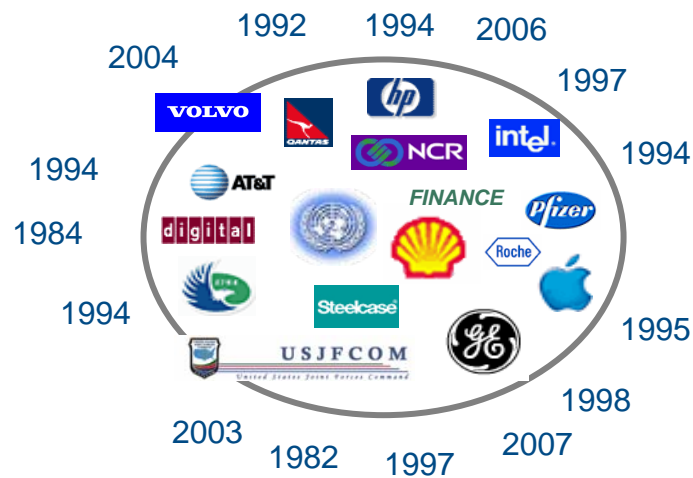
Evolution of Organizations

It takes variety to survive in variety
Internal complexity must match or exceed external complexity (Ross Ashby)

Today

Communications drivers

Cost

Speed

Variety

Nomadic	**Agricultural**	**Industrial**	**Information**
Members	Levels	Specialties	Links
Small groups	**Hierarchy**	**Bureaucracy**	**Networks**
Tribes	Empires	Corporations	Networks
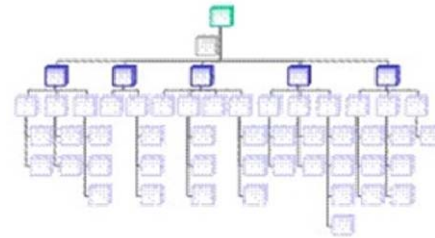
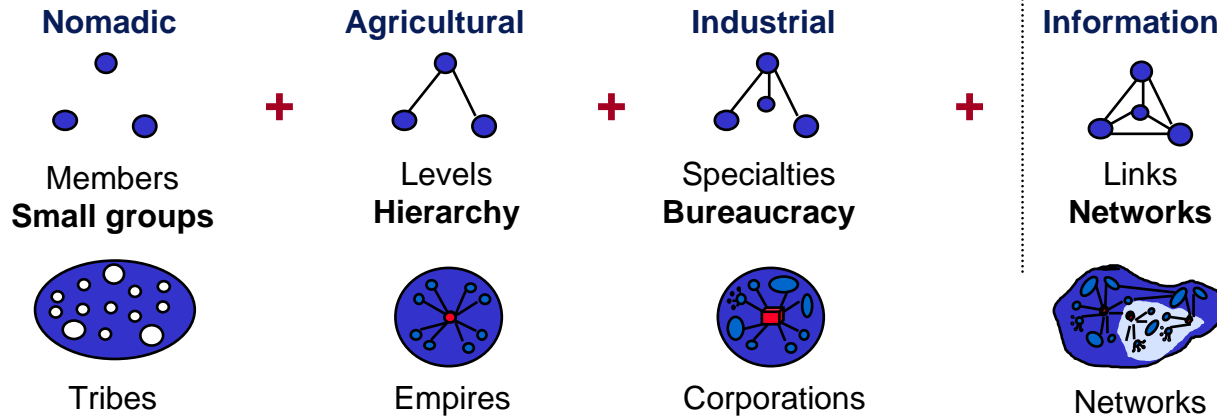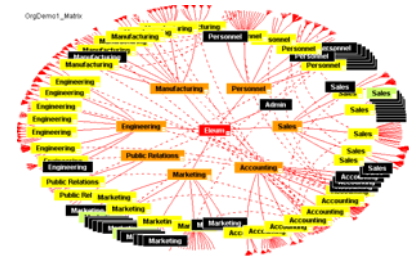*Diagram developed with Shell Oil Co*

- "Networks are nodes linked with common purpose."

- Nodes are people, positions, teams, and/or organizations

- Networks are as big as cross-enterprise, cross-industry, cross-sector alliances working on global scales or as small as virtual teams of two

- Organizations are growing more networked

- All organizations are networks
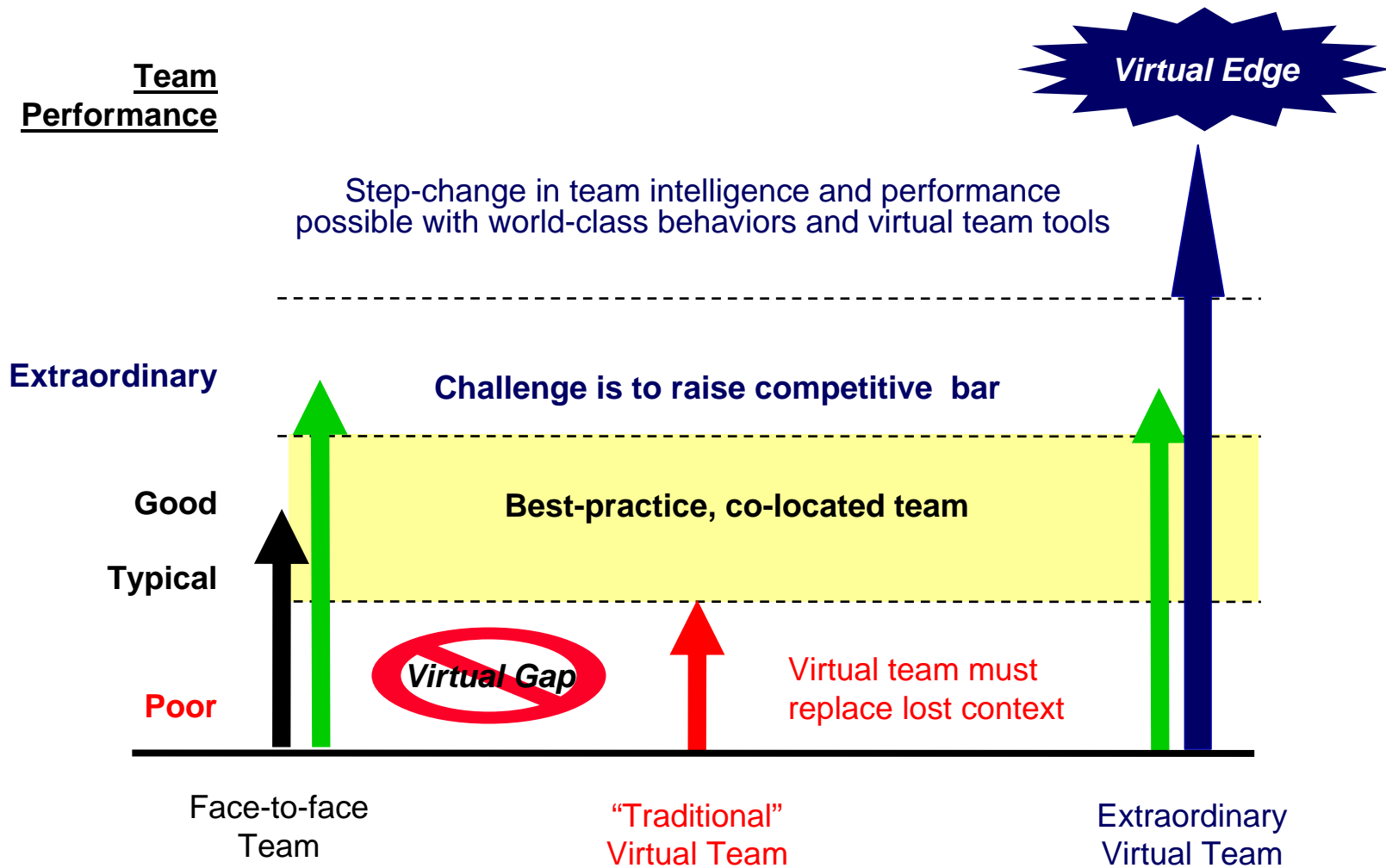
The New Vocabulary of Networks

- **Virtual teams** = small **groups** of people working interdependently across boundaries of space, time, organizations, discipline, language, culture; both ongoing or temporary

- **Teamnets** = **net**works of **team**s, both virtual and collocated, linked by shared purpose that reach across boundaries

- **Organization networks** = all large-scale human structures, including hierarchies and bureaucracies

- **Networks of organizations** = external connections among organizations working in common pursuit

- **Communities of practice** = people learning and exchanging information related to their "practices," their expertise

- **Social networks =** people connecting with others on basis of personal relationships

New Type of Small Group in Information Age: Virtual Teams

Team Performance

Virtual Edge

Step-change in team intelligence and performance possible with world-class behaviors and virtual team tools

Extraordinary

Challenge is to raise competitive bar

Good

Best-practice, co-located team

Typical

Poor

Virtual Gap

Virtual team must replace lost context

Face-to-face Team

"Traditional" Virtual Team

Extraordinary Virtual Team

Use four common principles to …

Why and What?
- Goals
- Tasks
- Results

Purpose

When?
- Calendar
- Process
- Phases

Time
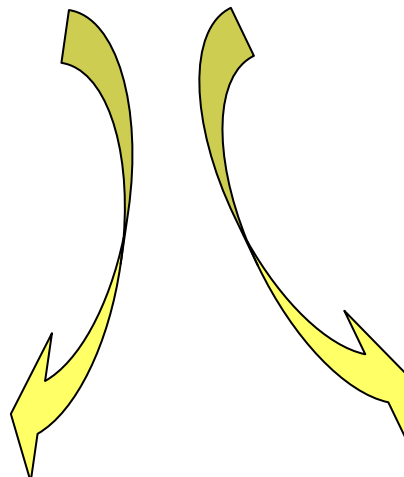
How?
- Media
- Interactions
- Relationships

Links

People

Who?
- Members
- Leaders
- Levels

… help shape technology

… help develop virtual team behaviors

Virtual Team Assessment

90% People + 10% Technology

Myth:

Leading virtually is about using right technology.

Reality:

Leading virtually requires understanding people, culture, organization, and collaboration.

"We always get the technology right and the sociology wrong"—Paul Trevithick

Mapping
Organizations as Networks

Four Networks Weave the Enterprise

Transparent

PUBLIC

PRIVATE
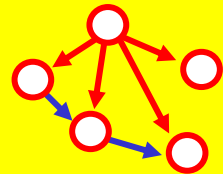
Opaque

1 — Organization Network
My Position
Who do I work for?
Org Chart
Hierarchy-bureaucracy is a network
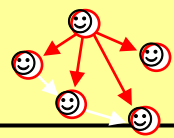*Functions flow as process network from suppliers to customers*

2 — Working Networks
My Job
Who do I work with?
Management teams
Ongoing and project teams
Communities of practice
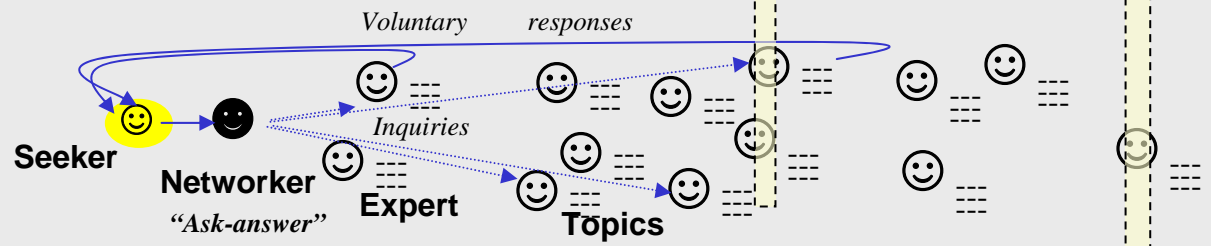*Special Events* "Jam"

3 — Knowledge Networks
My Topics
Who knows what?
Voluntary responses
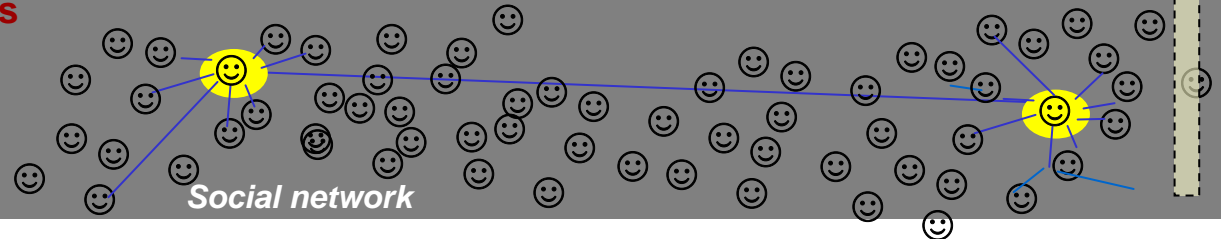**Seeker**
Networker
"Ask-answer"
Inquiries
Expert
Topics

4 — Social Networks
My Friends
Who knows whom?
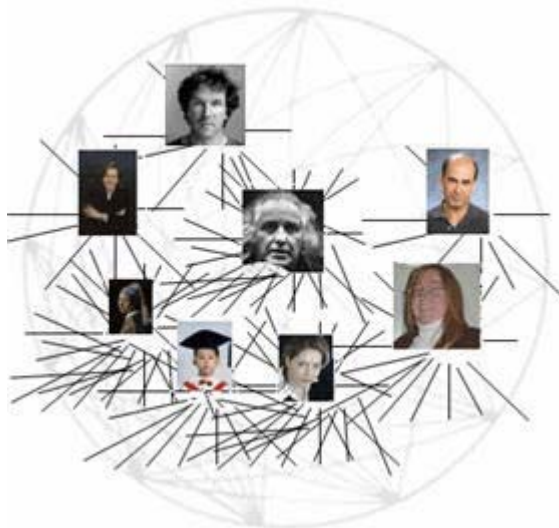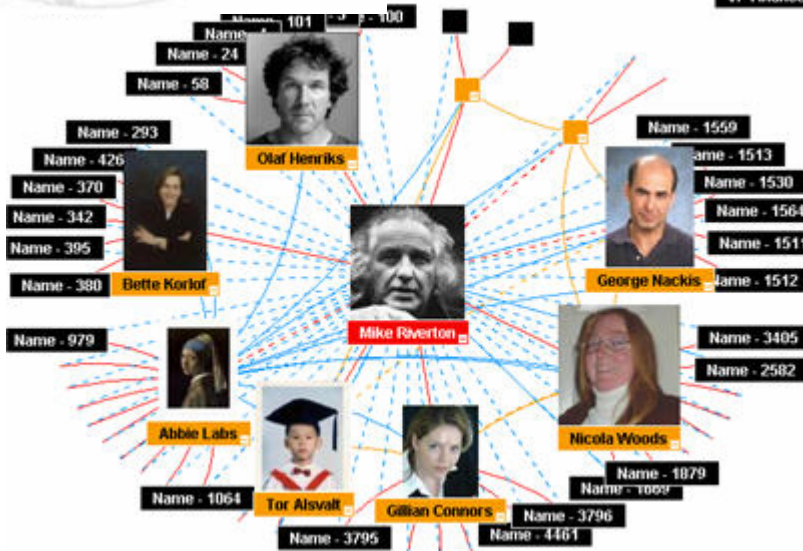*Social network*

People with their social networks

Organizations with their position networks

"Subjective" organization
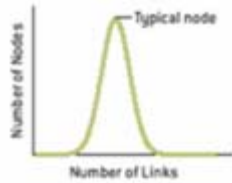
"Objective" organization

Organizational networks at intersection of people and positions

# Quest for an "Organization Network" Science

Random networks

US road network

For past 50 years, scientists have regarded networks in two ways: either as relatively static node structures of uniform lattices or as webs of **randomly** distributed links (with averages).

More recently, scientists have found that networks have a few highly-connected nodes — **hubs** — that link to many nodes, but that most nodes have very few links. This dynamic model grows and changes over time, with new nodes preferring to attach to the hubs.

Scale-free networks
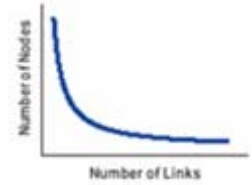
US airline network

Summary of key data from original paper by Réka Albert and Albert-László Barabási' in Reviews of Modern Physics, *January, 2002*

Network	Type	Nodes	Links
Cellular metabolism	Biology	Molecules involved in burning food for energy	Participation in same biochemical reaction
Protein regulatory network	Biology	Proteins that help to regulate a cell's activities	Interactions among proteins
Sexual relationships	People	Individuals	Sexual contact
Hollywood	People	Actors	Appearance in same movie
Research collaborations	People	Scientists	Co-authorship of papers
Internet infrastructure	Technology	Routers	Optical and other physical connections
World Wide Web	Knowledge	Web pages	URLs

From "Scale-Free Networks" by Albert-László Barabási and Eric Bonabeau, Scientific American, May, 2003

	Network	Type	Nodes	Links
?	Hierarchy (org chart)	Organization	Positions	Reporting relationships
	Working organization	Organization	Position, group, and organization nodes	Matrix reports Process links Group memberships Information flow
			People-in-positions	Personal relationships

Levels: The Most General Systems Principle

- Herbert Simon's classic paper "Architecture of Complexity" (1962)

- Watchmaker parable explains evolution of complexity

- "Tempus" (smooth time) and "Hora" (chunky time): two watchmakers assembling watches with 1000 parts

  - Tempus assembles watch as single assembly in maximally-efficient 1000 steps

  - Hora takes extra steps to construct sub-assemblies of 10 parts, combining them into modules of 10, 10 of which make up a complete watch

- Simon assumed, life being what it is, *interruptions* require watchmaker to put down partial assembly, which decomposes to its parts; watchmaker attends to business, then starts assembly afresh

  - Tempus always goes back to beginning to build single assembly

  - Hora loses at most a few steps in sub-assembly

- Simon says:

  - *Complex systems will evolve from simple systems much more rapidly if there are stable intermediate forms than if there are not. The resulting complex forms in the former case will be hierarchic. We have only to turn the argument around to explain the observed predominance of hierarchies among the complex systems nature presents to us. Among possible complex forms, hierarchies are the ones that have the time to evolve.*

Myth #1: Networks are flat. They are not. They are multi-leveled. All networks and virtual teams are hierarchical in scientific sense. Even simplest networks comprise interacting parts that are themselves complex, i.e. people or groups

- Hierarchy is most general principle of general systems theory, but only in organizational sense. Wikipedia entry on "hierarchy" provides excellent summary of crucial distinction in two uses of word. Both have same logical structure:

  - **Ranking**, most socially-common meaning of hierarchy, is system of higher-lower relationships, where high is usually judged as better than lower

  - **Organizing** is scientific meaning, sets-within-sets, parts-within-wholes-within-larger-wholes, sense of hierarchy

Ranking – Social network

★ **Organizing – Organization network**

Both have same basic hierarchy relationship

From

To
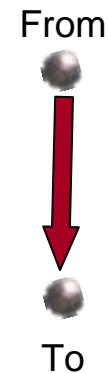
Each element, thing, or person (1 node) has single (unique) superior-subordinate relationship (1 link) to another thing or person that is part of pre-existing system with top element

A node-link is a part with…

In data systems, an organization node carries its whole/part relationship (from parent to child) of its authorization as part of its definition, e.g., a position's manager
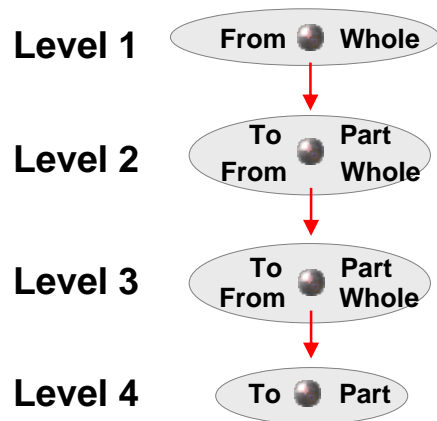
…a whole/part relationship…

Infrastructure core of organization network consists of nodes connected in **whole/part**, parent/child, relationships – logical "containment hierarchy"
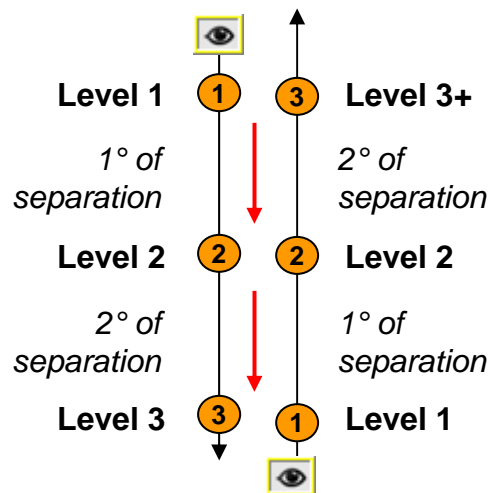
…in a hierarchy
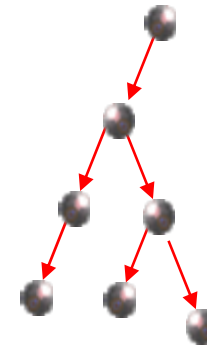
The node-by-node directed relationship structures hierarchies of nested nodes with whole/part relationships

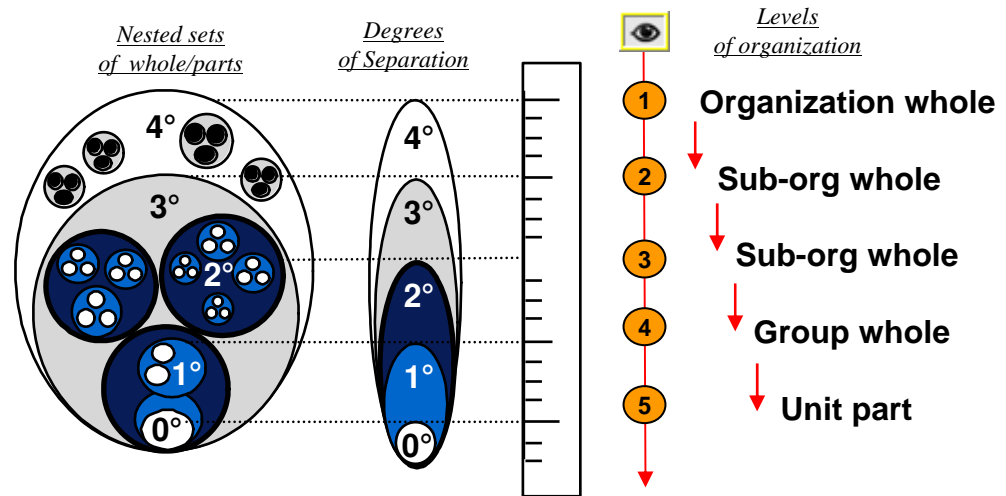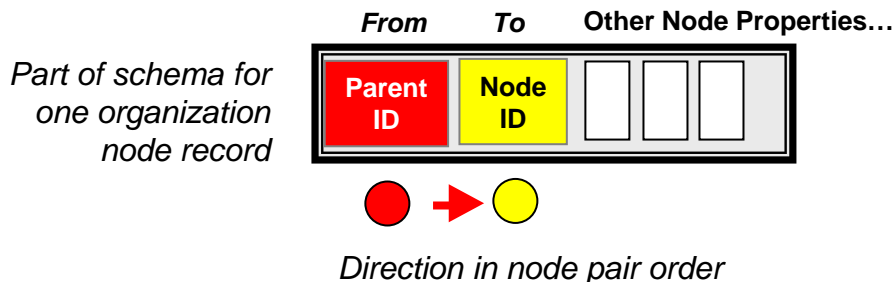|	Top-down Perspective		Hierarchy of Sign Types
Level 1 From ● Whole	**Level 1** ① ③ **Level 3+**	*Executives*	**Symbolic** Category of categories
	1° of separation *2° of separation*		
Level 2 To ● Part From ● Whole	**Level 2** ② ② **Level 2**	*Line mgrs*	**Indexical** Category of units
	2° of separation *1° of separation*		
Level 3 To ● Part From ● Whole	**Level 3** ③ ① **Level 1**	*Staff*	**Iconic** Unit entity
Level 4 To ● Part	Bottoms-up Perspective		Charles Sanders Peirce

Core Hierarchy Creates Classification System

When positions hook together by pattern of one exclusive link (e.g., a direct reporting relationship), they form formal "containment hierarchy." This is the org chart, but it is also the organizational taxonomy. Only two data points, in correct order, are required to reveal this core structure

◆ Complete classification system for this unique organization

◆ Categories for culture's common language
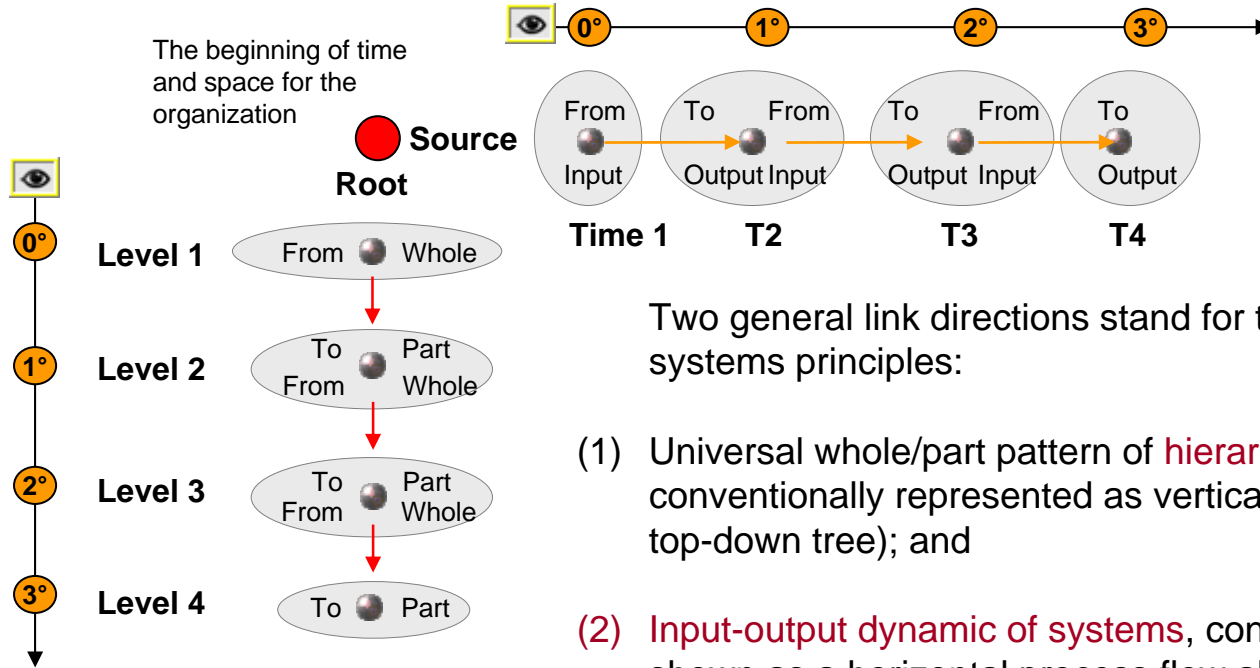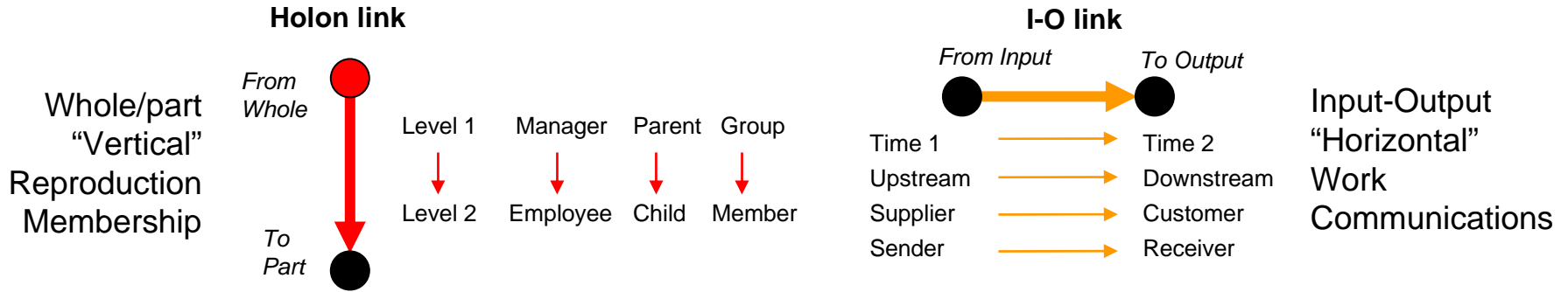
◆"End-of-the-day" management accountability structure

Nested sets of whole/parts

4°
3°
2°
1°
0°

Degrees of Separation

4°
3°
2°
1°
0°

Levels of organization

1. **Organization whole**
2. **Sub-org whole**
3. **Sub-org whole**
4. **Group whole**
5. **Unit part**

Data record for position, employee, or user must contain manager field

Part of schema for one organization node record

From	To	Other Node Properties…
Parent ID	**Node ID**			

Direction in node pair order

In preparing data for OrgScope, as for any digitized information hierarchy, each unique ID node record must contain ID of its parent record in same data set—except top element, root, that has no parent. This is an organization node record

Holon link

I-O link

From Input → *To Output*

Whole/part
"Vertical"
Reproduction
Membership

From Whole

To Part

Level 1	Manager	Parent	Group
↓	↓	↓	↓
Level 2	Employee	Child	Member

Time 1	→	Time 2
Upstream	→	Downstream
Supplier	→	Customer
Sender	→	Receiver

Input-Output
"Horizontal"
Work
Communications

The beginning of time and space for the organization

● **Source**

Root

	0°	1°	2°	3°

From Input	To Output / From Input	To Output / From Input	To Output
Time 1	**T2**	**T3**	**T4**

|		Root
0°	**Level 1**	From ● Whole
1°	**Level 2**	To ● Part / From ● Whole
2°	**Level 3**	To ● Part / From ● Whole
3°	**Level 4**	To ● Part

Two general link directions stand for two central systems principles:

(1) Universal whole/part pattern of hierarchy, conventionally represented as vertical structure (a top-down tree); and

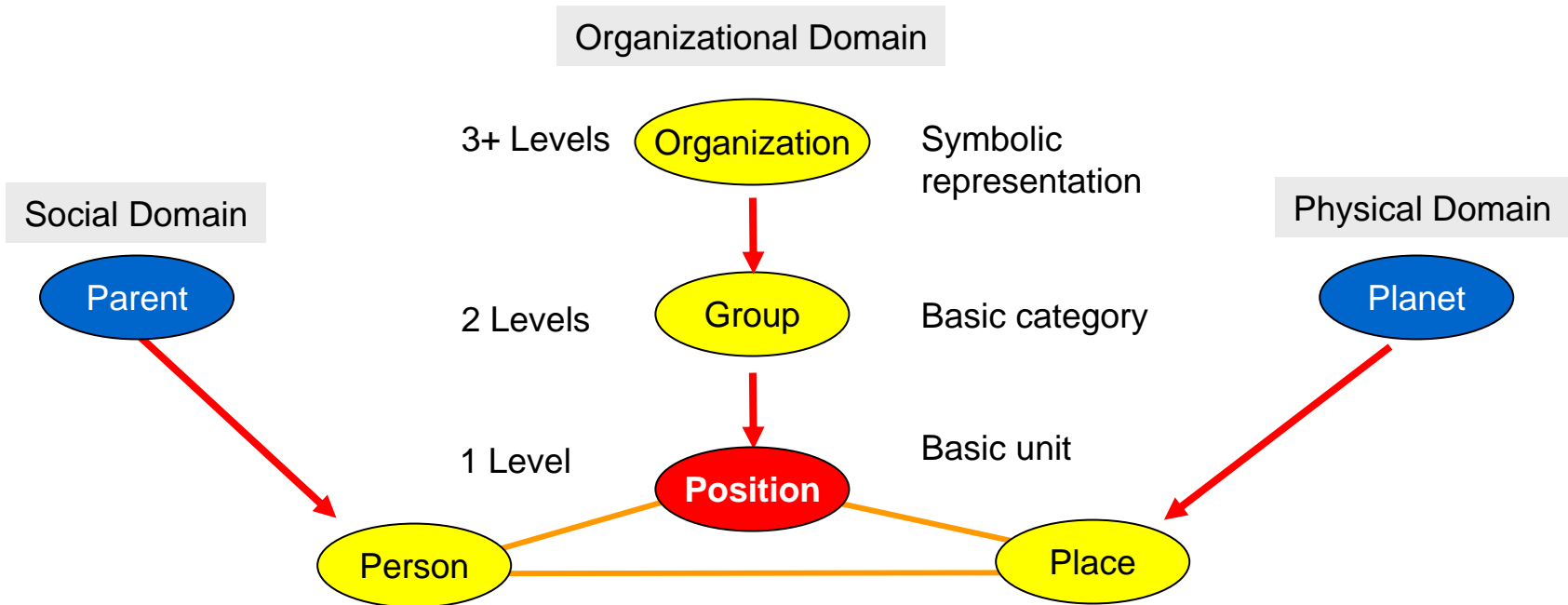(2) Input-output dynamic of systems, conventionally shown as a horizontal process flow along a time axis

Positions, jobs, can stand for, can represent, all other key node types: people hold positions, which gives them a physical place; manager positions represent organizations and groups
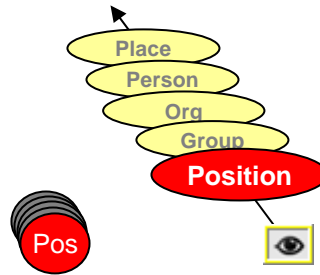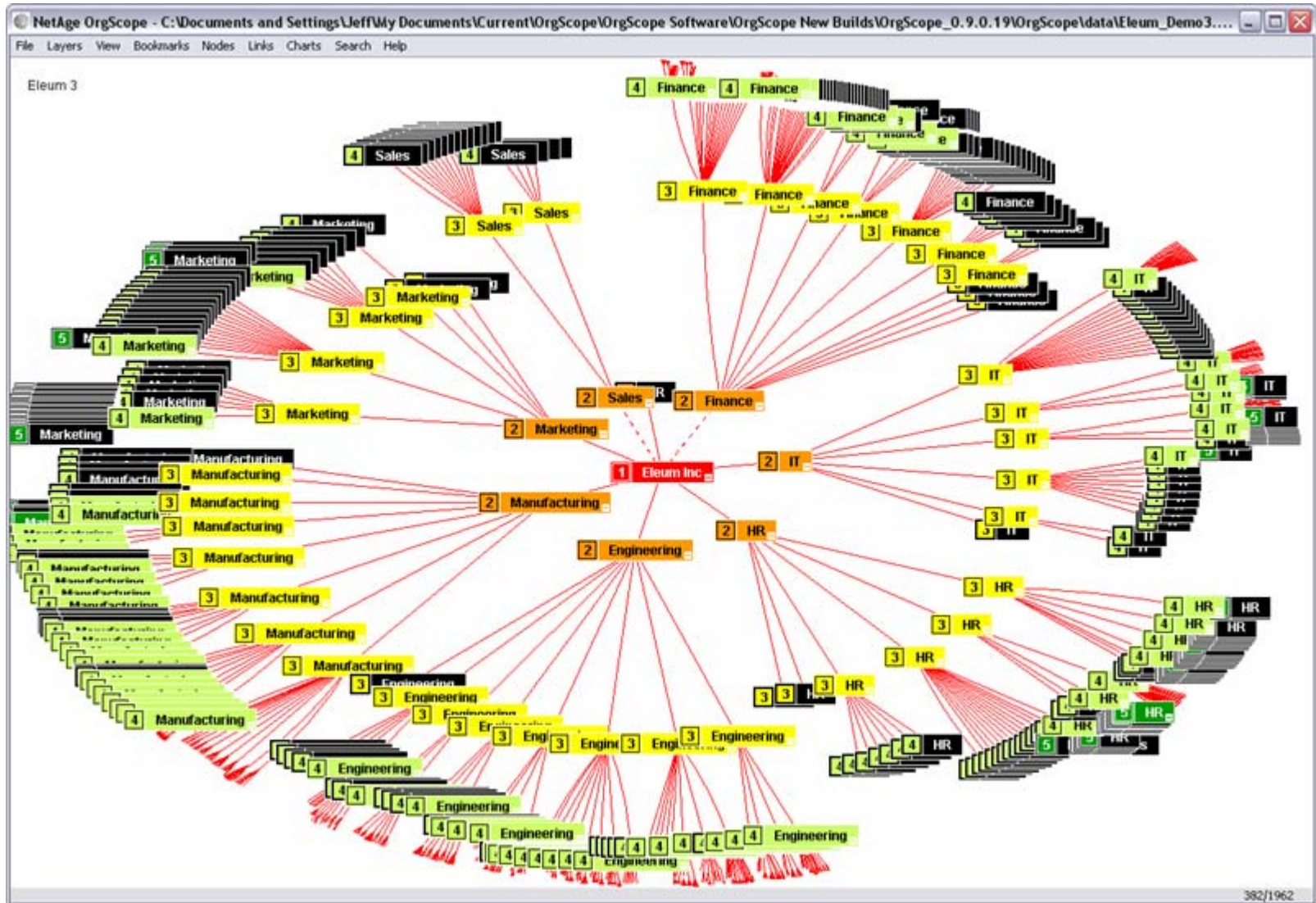
When we map network of positions, we are also bringing along all other types of nodes that are part of full model of organization. They are the "hidden" **node mode** types hiding "behind" the position node

Place

Person

Org

Group

Position

Pos

Organizational Domain

3+ Levels — Organization — Symbolic representation

Social Domain

Parent

2 Levels — Group — Basic category

Physical Domain

Planet

1 Level — **Position** — Basic unit

Person

Place

Mapping Organizations with OrgScope

Organization Link Taxonomy

Organization networks comprise singular nodes and multiple links of multiple types

Two *whole/part* link types, **Reporting** (**A)** and **Group** (**C)**, offer multiple ways to represent parent/child, group/member relationships

Two *input-output* link types, **Process** (**B)** and **Information** (**D)**, offer multiple ways to represent before-after, upstream-downstream, sender-receiver relationships

Whole/Part	Input-Output

Strong	A Report	B Process
Weak	C Group	D Info

Social	E Personal
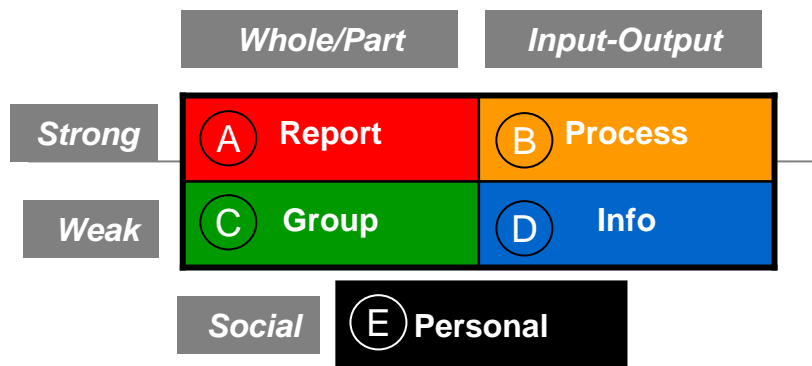
Two *strong* organization link types, **Reporting** (**A)** and **Process** (**B)**, are few in number but very forceful in their impact

Two *weak* organization link types, **Group (C)** and **Information (D)**, are influential and may be many in number

Personal (E) links connect people (employees) in an internal social network separately threaded through organization network of positions and relationships

| Reports (whole/part)	A1	Direct Reports
	A2	Matrix Reports
Process (input/output)	B1	Primary Process
	B2	Feedback Process
Group (whole/part)	C1	Member Group
	C2	Participant Group
Information (input/output)	D1	Primary Information
	D2	Secondary Information
Personal (directed)	E1	Strong Personal
	E2	Weak Personal

Network Map of an Org Chart + Systems Diagram

(A) + (B) Positions represent organizations and groups that are related in process chains as well as reporting structures. These two types of relationships are each implied in other's conventional way of charting organization, but rarely brought together, as here
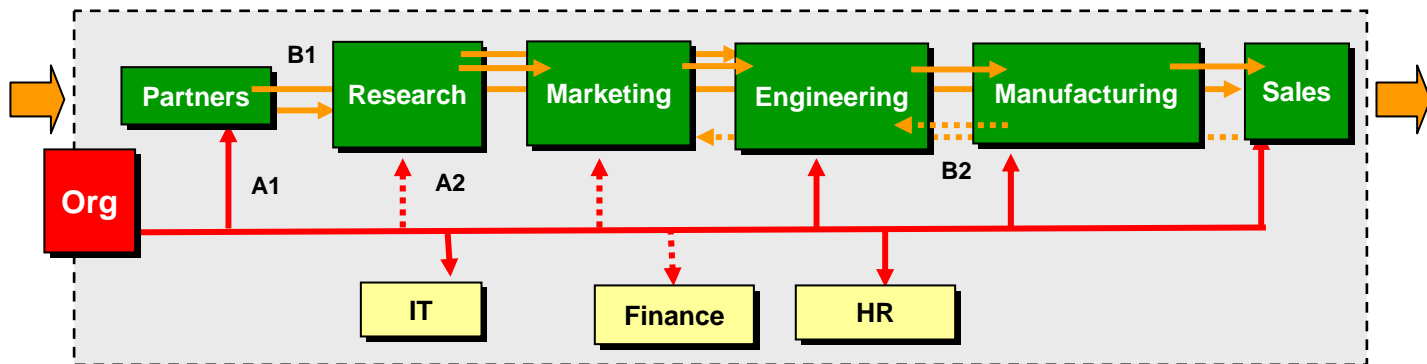
An organization's overall purpose can be seen in obvious (to industry insider) relationships among its major components. It provides strategy frame for organization's activities to succeed in its particular market. The level down from top answers question: "What do we do for organization as a whole?"
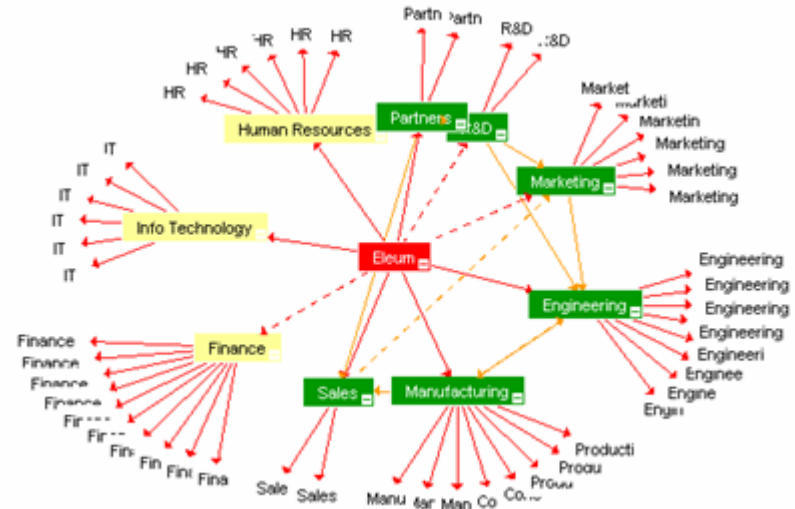
Organizations Are Parts of Larger External Networks

(A) + (B) + (C)

Larger view will include key relationships coming into and going out of organization. As micro-worlds of sub-organizations can be mapped with these link types, so can macro-worlds of organizations be mapped with same types. Indeed, for many positions, their responsibilities are incompletely represented without connections to key external players
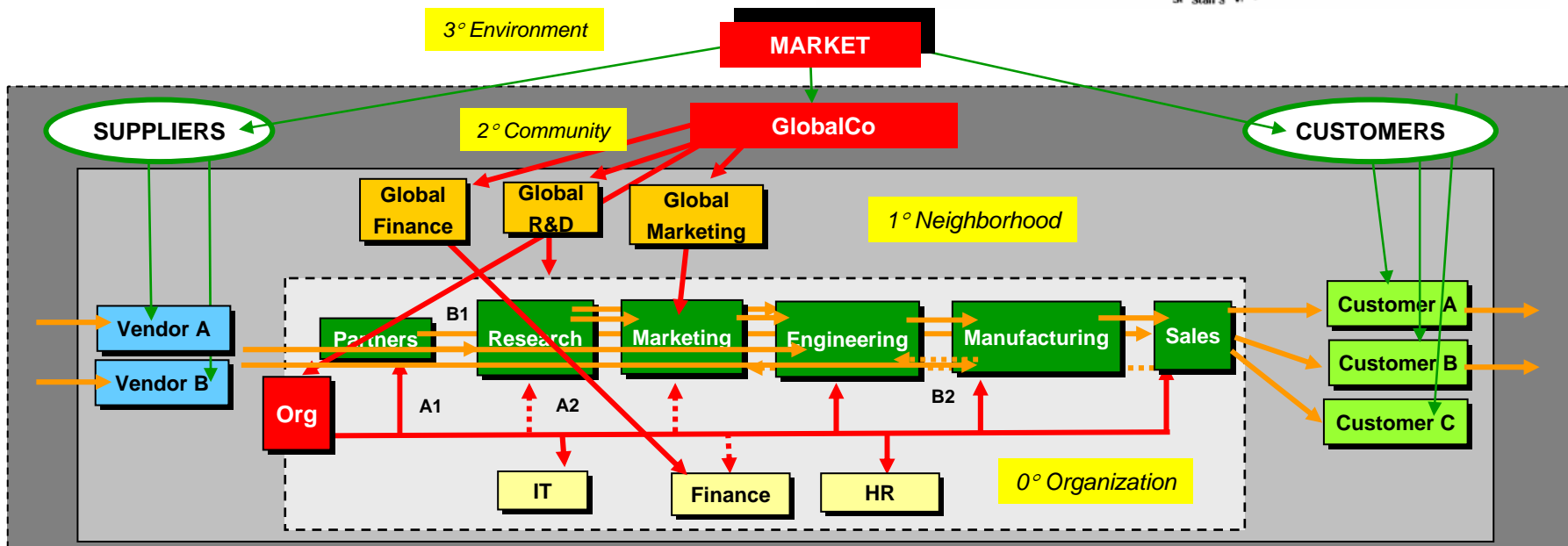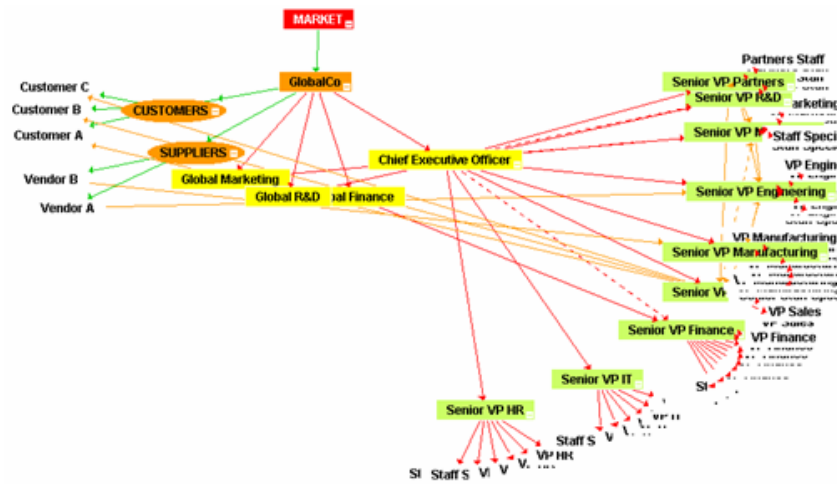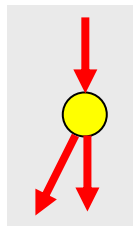
Counting Real Working Responsibilities

$A + B + C$ — What is my real management load?
Is mine a hub position? Depends on the links you count
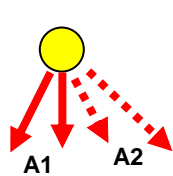
How the hierarchy sees my position

My real responsibilities

My bosses
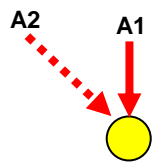
My reports

My suppliers and customers

My key groups

A2 A1

B1 B2

C2 C1

A2 A1 C1
C2
B1 B2
B2
C1 A1 A2

Direct Span = 2

Matrix span = 4
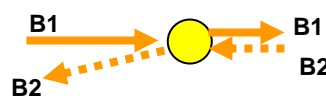
Conventional manager measures
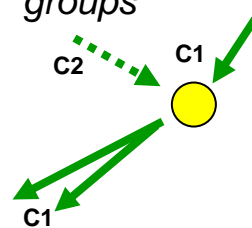
All report links = 6
All process links = 4
All group links = 4

Total Position degree = 14
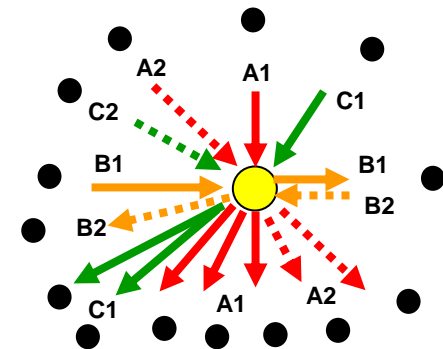
A position's 1-degree circle of relationships

What Is Organization Thinking?

(A) + (B) + (C) + (D)

Every organization link type implies flow of information. Indeed, **A** reporting, **B** process, and **C** group relationships imply a **D1** info flow as well as a **D2** information return channel to their direction of impact
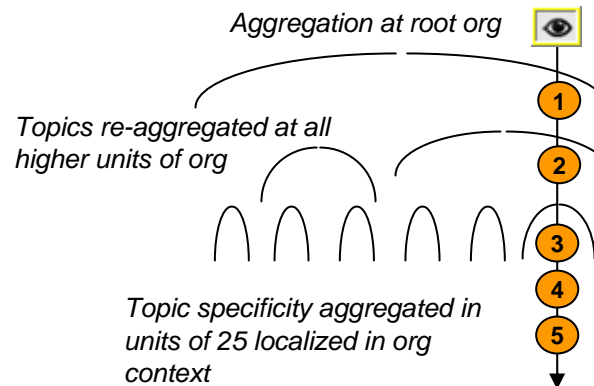
Each era of civilization has been defined, constrained, and elevated by its signature form of communication: nomadic speech, agricultural writing, industrial printing, and now-ubiquitous digital information age. Human organizational memory has taken huge leap in a few short decades, for better and for worse. Only appropriate realms of transparency and privacy will ensure "better" use of our new digital power

Actual information flows of **A-B-C** links "to and fro" between 1° nodes can be mapped, e.g., analysis of email traffic between node pairs

Mining massive information links

Aggregation at root org

Topics re-aggregated at all higher units of org

Topic specificity aggregated in units of 25 localized in org context

1
2
3
4
5

Privacy for people and small groups can be achieved by aggregating message-mining across number of positions. Boundaries of aggregation to protect privacy start at about 25, a typical 3-level organization. In smaller numbers, individual responses become increasingly easier to identify

A + B + C + D + E

By broad "inter-" meaning of "social," all link types together are complete list of "relevant" ties between any two nodes (people, positions, groups, organizations, places)
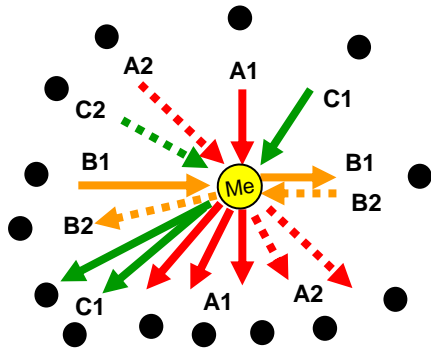
Social networks, then, are inherent in articulation of any and all link types. The patterning of this totality of links represents the impact of individual links on individual nodes, but the measures of impact come from the context of the whole pattern of links. Network measures are all relative

My network at work adds up pretty fast

All my 1° org links are by definition social, i.e., inter-positional
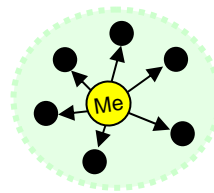
I know (most) members of the (small) groups I am part of
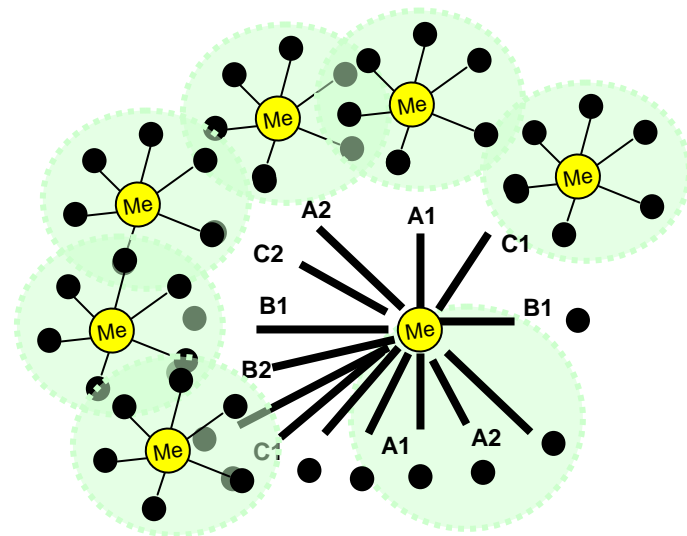
Is the Objective Organization a Natural Network?

Five Questions for Research

Questions for an Organization Network Science

Level

#1. What is distribution of positions by level? (path length, degree of separation)

We expect our hierarchies to be triangular, a small top with broad base, a general slope. However, an unexpected bell-curve-like distribution shows in one organization's true shape by levels. A few cases may, of course, be an anomaly. Only more datasets will tell. Perhaps our hierarchies never were pyramids.

Span

#2. What is distribution of positions by manager span? (degree)

Managers with high reporting degree stand out in an enterprise org chart. The shape of the distribution seems not to be the bell curve expected for spans. However, we need to run same test on many datasets and see what fit really is.

Size

#3. What is distribution of positions by organization size?

Size "hubs" offer second metric from organization perspective, whereby manager of whole sub-organization is responsible for and speaks for all positions reporting either directly or indirectly. Here shape seems to have heavy tail, a scale-free network, but we haven't run test.

Matrix

#4. Will addition of matrix reports act as shortcuts and show "small world" effects?

We have not tested this, but hypothesis accords with experience. We have lived through evolution of increasingly matrixed organizations, and suspect there might just be too much of a good thing.

Order-Chaos

#5. Can simple metric of self-organization be calculated from strong links?

Our most speculative hypothesis is stimulated by Stuart Kauffman, who suggests an absurdly simple measure (total links divided by total nodes) of the self-organizing balance between order and chaos
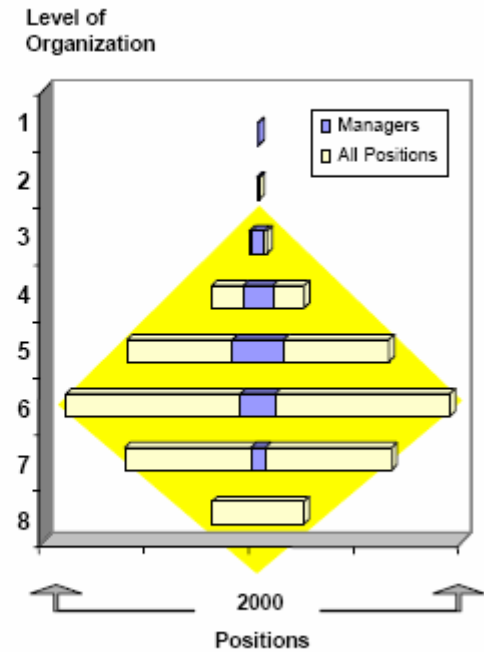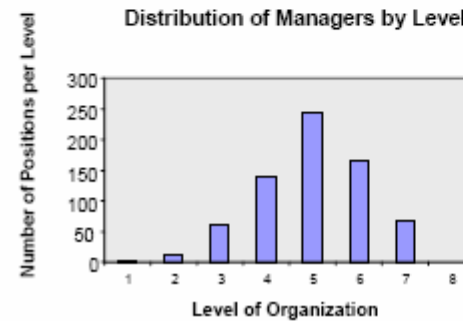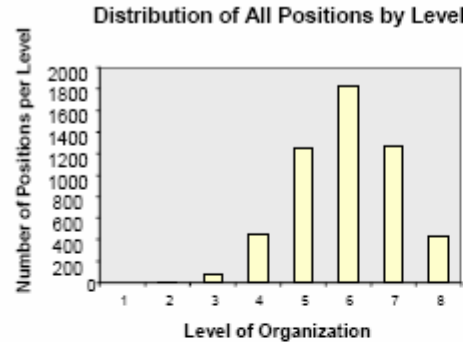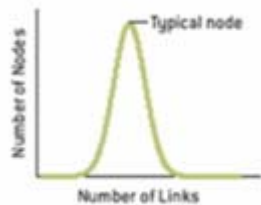
In our pilot analysis, we expected that plot of positions by level would form slope, that shape of hierarchy was **pyramid**
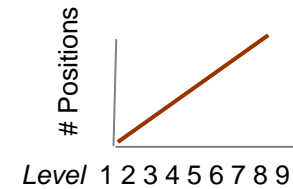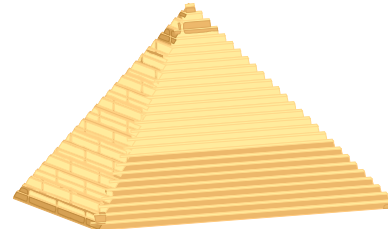
Instead, we found more "normal" shape, with bulk of positions centered around middle. When bell-shaped graph is oriented vertically, this organization has **diamond** shape

Graphs from the 1st dataset, unnamed company, but used with permission

Is there an "average" manager?

When we ran HR data for organization of 5000, we found:

• About 20% of manager positions had 10 or more reports, at all levels and in every function

• Graph of reporting span looked like exponential ski-jump slope

• Expected averages for span were nowhere to be seen
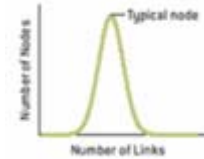
In our pilot analysis, we expected that plot of manager span would be normal curve as one could expect from seemingly **random** nature of detail in large organizations.

Distribution of span in whole organization

Distribution of span by level
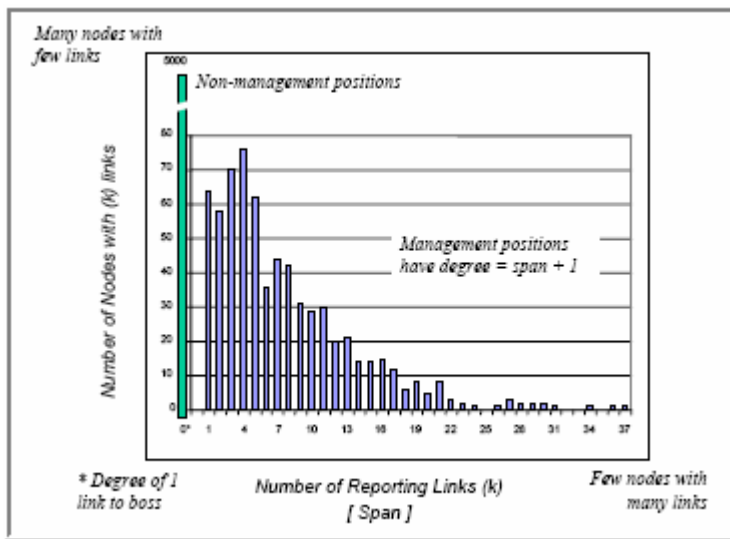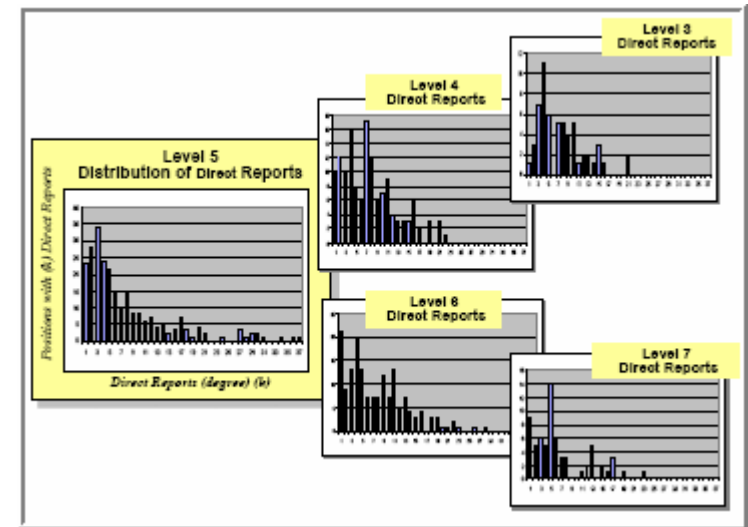
Span looks more "normal" at the top (levels 1-3) than the middle levels (4-6)

Graphs from the 1st dataset, unnamed company, but used with permission

Here, our plots looked more like power curve of scale-free networks with a heavy tail of few managers with many links (direct and indirect reports) and many managers with few reports
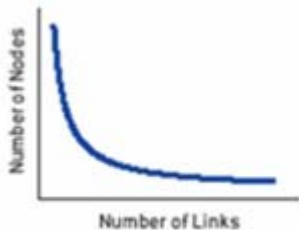
• Direct and indirect links to all nodes
• Command authority over everyone in reporting chain

The story of 6°…

Six Degrees of Separation .. Stanley Milgram, 1967, Boston to Omaha

The Mystery: Clustering .. If family and friends talk to one another, how do you reach around the world in 6 steps?

The Strength of Weak Ties .. Mark Granovetter, 1973, showed that people more often find their jobs through acquaintances or friends-of-friends, rather than through their close circle of connections

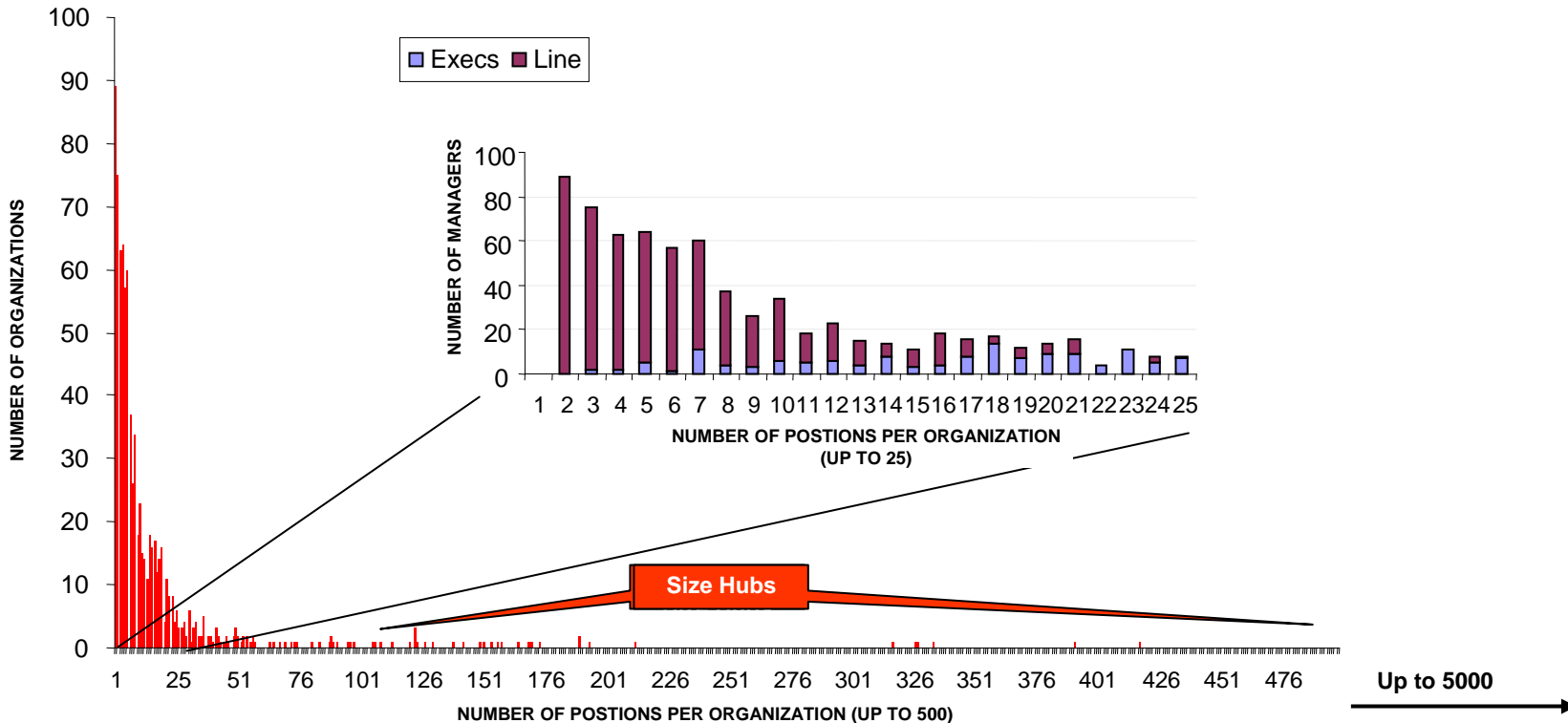**Small Worlds Solved -** Duncan Watts and Steven Strogatz, discovered a general solution to paradox— shortcuts (reported in *Nature* in 1998)
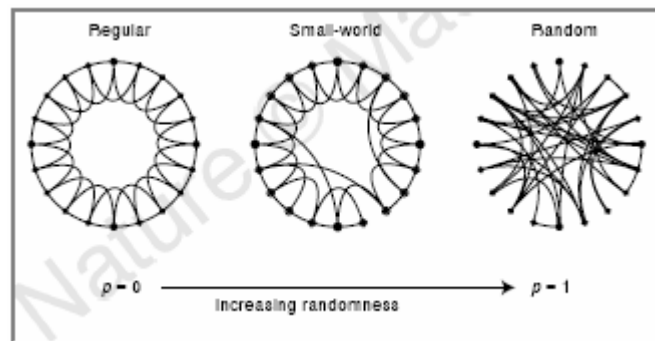
(A) Matrix reports as organizational shortcuts

- Matrix reports represent co-managers, "second" boss typically at same level as "first" boss

- In nature and social networks, these cross-links are shortcuts, creating "small world" effects

- In organizations, this translates into alternative, sometimes conflicting decision-making pathways

  - Each reporting shortcut adds element of management stress

  - Nature finds few shortcuts have big shortening impact, but quickly reaches point where more shortcuts don't increase overall shortness

  - There is probably point where too many matrix reports stop adding value while accumulating high organizational design stress

"I hope this blows your socks off.."

Stuart Kauffman's focus has been on point of tension between too much rigidity and too much flexibility in complex systems seeking to live "in the ordered regime, near the edge of chaos"

The metric he discovered simply divides total nodes into total links

"Whence cometh the order? The order arises, sudden and stunning, in K=2 networks…. I hope this blows your socks off. Mine have never recovered since I discovered this almost three decades ago. Here is, forgive me, stunning order… Order for free."

Stuart Kauffman, *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity*, Oxford University Press, 1995, page 83.

K = Links / Nodes

Astonishing if true. The trick, of course, is counting *right* nodes and links. Taxonomy of strong and weak links is designed in part to map and model complex systems, with strong A+B links of structure (reproduction) and process (work) to test Kauffman hypothesis on organization networks
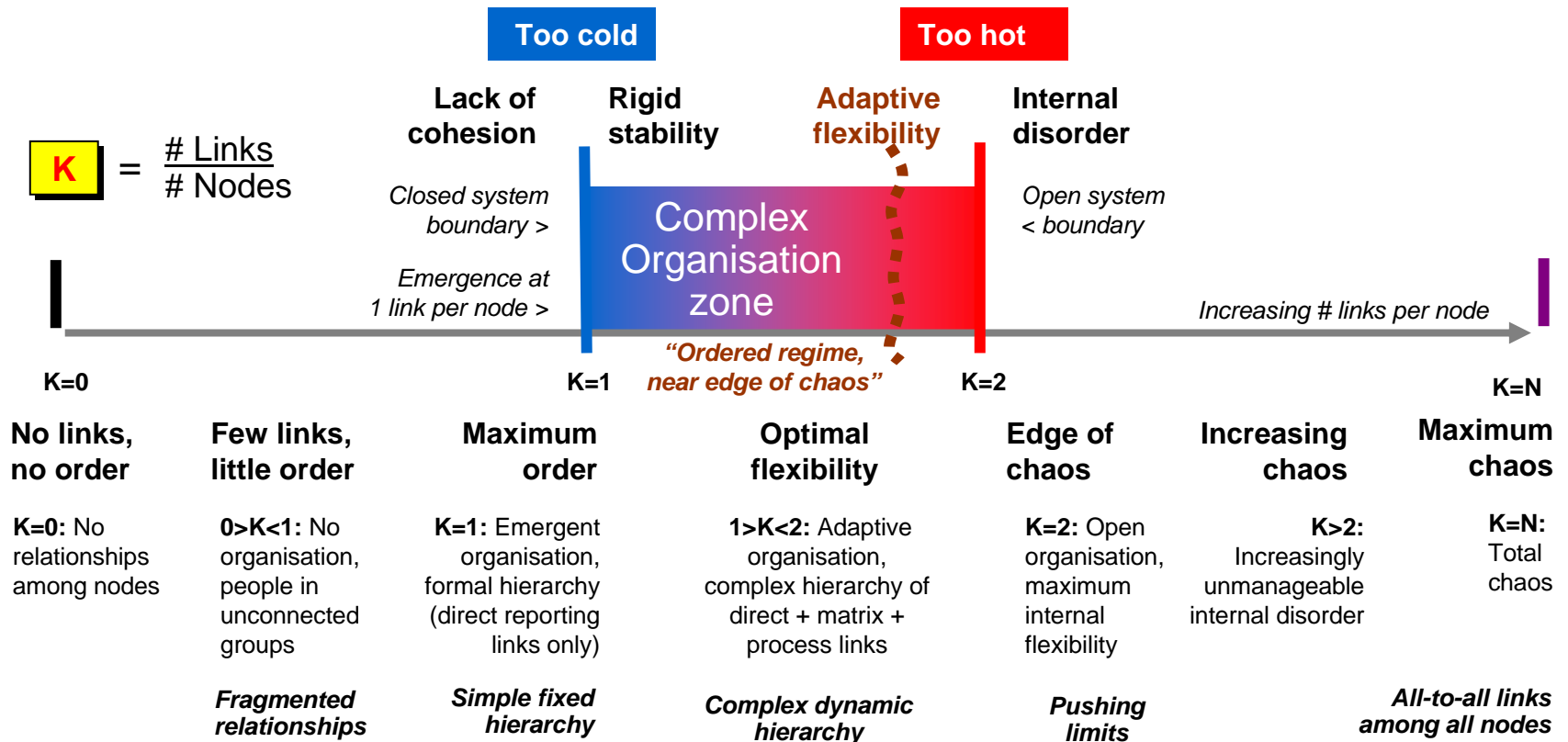
- K=1, one link per node, is point of maximum order and minimum flexibility. This is equivalent to formal hierarchy

- K=2, two links per node average for the network appears to be boundary condition between order and chaos, i.e., "blowing socks off" point of free order. This seems to be outer limit for balance between flexibility and stability

Chart highlights progression of increasingly higher ratio of links per node from left side of "no links, no order" to right side "maximum chaos" of all-to-all links

It places complex organizations in zone between K=1 and K=2

$$K = \frac{\text{\# Links}}{\text{\# Nodes}}$$

Too cold

Too hot

Lack of cohesion

Rigid stability

Adaptive flexibility

Internal disorder

Closed system boundary >

Complex Organisation zone

Open system < boundary

Emergence at 1 link per node >

Increasing # links per node

"Ordered regime, near edge of chaos"

|						
K=0		**K=1**		**K=2**		**K=N**
No links, no order	**Few links, little order**	**Maximum order**	**Optimal flexibility**	**Edge of chaos**	**Increasing chaos**	**Maximum chaos**
K=0: No relationships among nodes	**0>K<1:** No organisation, people in unconnected groups	**K=1:** Emergent organisation, formal hierarchy (direct reporting links only)	**1>K<2:** Adaptive organisation, complex hierarchy of direct + matrix + process links	**K=2:** Open organisation, maximum internal flexibility	**K>2:** Increasingly unmanageable internal disorder	**K=N:** Total chaos
	Fragmented relationships	*Simple fixed hierarchy*	*Complex dynamic hierarchy*	*Pushing limits*		*All-to-all links among all nodes*

Our hypothesis is that organizations can be analysed as complex adaptive networks using whole/part and input-output relationships in the same model

Diagram represents actual organization, albeit with different functional names

We suggest that organizations are self-organizing networks of people-in-positions (nodes) linked by structure (whole/part) and process (input-output) relationships that exist "in ordered regime, near the edge of chaos," a dynamic state with link/node ratio between one and two (1>K<2), point of "combinatorial optimization"

K = Links / Nodes

This leadership team in "ordered regime, near the edge of chaos"

A + B
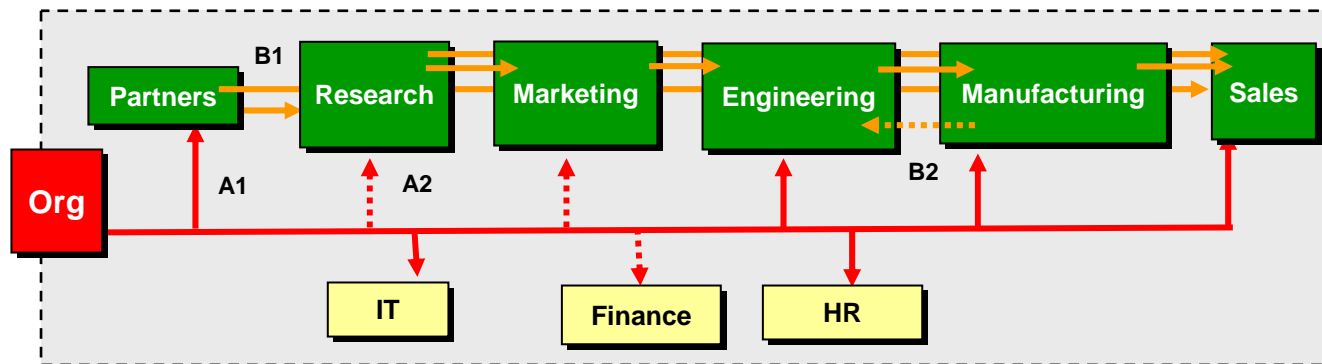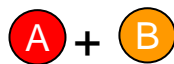
Nodes = 10
Links = 17
K = 1.7

Organization maps where both type A (reproduction) and B (work) relationships are made explicit can potentially be analyzed for complexity

"We are born

to work and play together in teams,

but we have to give enough

of ourselves

to let the filaments connect"

Paul F. Levy, soccer coach;
CEO, Beth Israel Deaconess Medical Center;
and blogger: Running a Hospital

HERE'S ONE WAY TO
TELL IF SOMEONE'S SERIOUS
ABOUT NETWORKING…
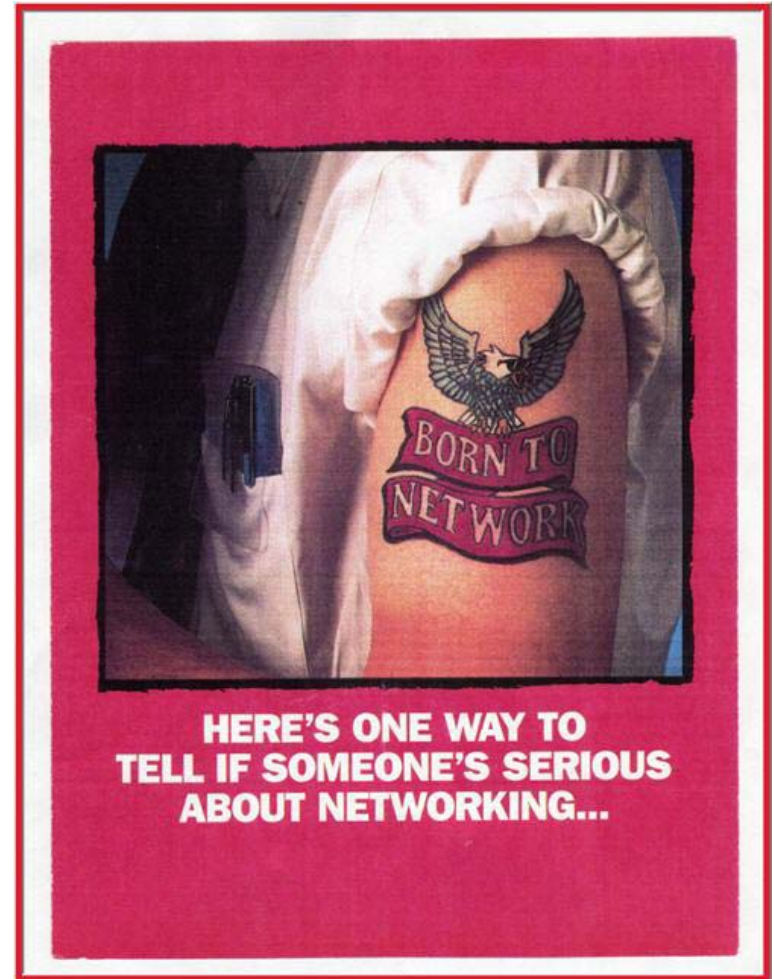
BORN TO NETWORK

Decide to Network

Decide to network
Use every letter you write
Every conversation you have
Every meeting you attend
To express your fundamental beliefs and dreams
Affirm to others the vision of the world you want
Network through thought
Network through action
Network through love
Network through the spirit
You are the center of the world
You are a free, immensely powerful source
of life and goodness
Affirm it
Spread it
Radiate it
Think day and night about it
And you will see a miracle happen:
the greatness of your own life.
In a world of big powers, media, and monopolies
But of six billion individuals
Networking is the new freedom
the new democracy
a new form of happiness

ROBERT MULLER

Robert Muller, former Assistant Secretary-General of the United Nations and Chancellor Emeritus,
UN University for Peace, wrote this poem for Jessica Lipnack and Jeffrey Stamps
in honor of their first book, *Networking (Doubleday, 1982)*

Contact Us

NetAge Inc.
505 Waltham Street
West Newton, MA 02465 USA
+1.617.965.3340

info@netage.com

www.netage.com