VISUALIZING HUMAN NETWORKS
by Valdis Krebs

We first met Valdis Krebs in mid-1988, when he responded to our musings on groupware with his thoughts on visualizing organizations and work flow (see Release 1.0, 9-88). At the time, he was an IS project manager during the day and a UCLA grad student at night. For a school project consulting to Toyota's then-new Lexus division on organizational design, he developed some software to help make explicit and measurable some otherwise fuzzy concepts. Since then, he has started a consulting practice and further developed InFlow, the software tool (with Prolog programmers in England and algorithm experts in Latvia).

This issue of Release 1.0 contains Valdis' advice on making sense of the torrent of alliances, mergers, acquisitions, layoffs and corporate divorces we see each week, as well as the personal relationships within and between companies that make everything else happen.

-- Jerry Michalski

The edge of chaos

Over the past decade, companies have been downsized, rightsized, restructured and reengineered -- often with mediocre results. In the process, managers frequently view informal, emergent organizational structures as problems that need fixing. They often blame the webs of relationships and activities that occur outside the lines of the official org chart for gumming up the works of their otherwise well-designed organizations.

Nothing could be further from the truth today. Studying the emergent organization reveals how the organization is adapting to its turbulent environment. It provides valuable insights and feedback to managers, who can then make changes -- or simply leave things as they are, with better knowledge of what not to damage through overt action. Rather than be the focus of removal, the emergent organization should be the focus of learning and support.   ===>

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In today's business environment, companies that operate more like jazz ensembles than classical orchestras will fare better. Instead of one person controlling a piece's execution, teams and managers share responsibilities. Participants improvise. Instead of setting up boundaries and rules to produce a predictable result, they start a theme, then listen and respond to each other, looking for the "groove." Sometimes it sounds quite messy. Good work groups, like good jazz groups, operate on the verge of chaos.

An engineered organization relies on rule books and procedure manuals; an informal one relies on personal talents and relationships built over time. The two are not exclusive: The key is finding the right balance. Another balance to watch is that between human systems and technologies such as the Internet, which tend to change the nature of human relationships.

Visualizing emergence

Emergent systems can be modeled as networks of interdependent objects. Network nodes can represent people, groups, organizations, cities, computers or other resources. Network links can model relationships, information or resource flows, alliances, or routes between destinations.

What networks reveal about the structure of complex human systems was not fully appreciated until the 1930s when German sociologists started to study human group behavior. Soon anthropologists started mapping networks in primitive societies to aid in their research. During the 1960s and 1970s, with the availability of mainframe computers, social scientists began to model and measure social networks mathematically.

Networks contain rich information about the structure of human systems. Unfortunately, this information is usually hidden from the untrained eye. Network diagrams and their underlying mathematical analyses can reveal many invisible dynamics -- at the individual, group and system level. For example, they can reveal:

- emergent groups such as communities of practice and self-organizing networks of interest,
- the degree of correlation between the formal and informal organizations,
- emergent leaders and experts,
- "underutilized" people,
- the informal power of individuals or groups (the old-boy network),
- resource or information bottlenecks,
- key linking roles between groups,
- gaps in communication or flow,
- the reality of how work gets done and how learning happens, and
- the degree to which organizational groups are insular or open to each other and the environment.

Comparing snapshots of the networks over time can reveal their evolution and adaptation.

Figure 1, a map of important Russian cities in the 12th century, contains much information about the future of the nodes it models. The links that

connect the cities model the trade routes at that time, most of which were along navigable rivers.
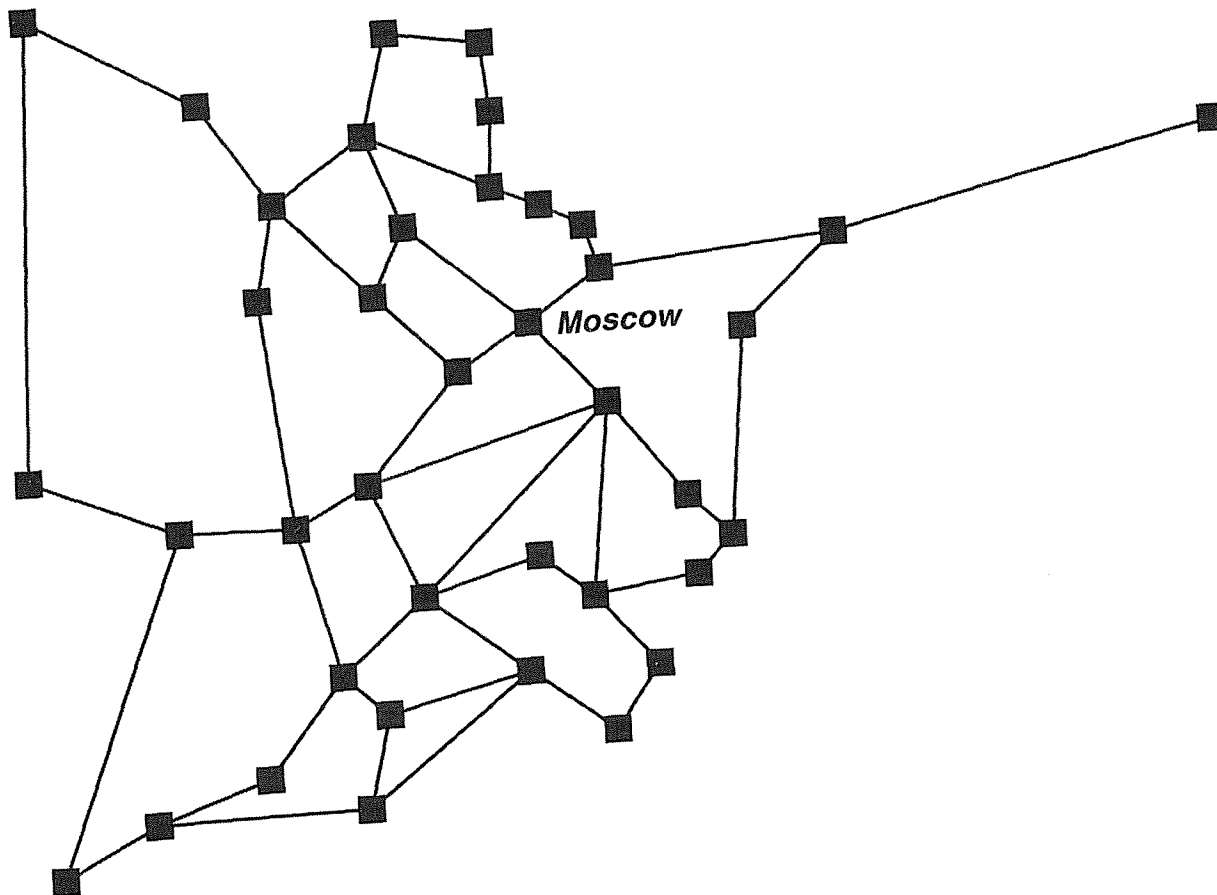

Figure 1

By the 15th century, Moscow had emerged as the capital of Russia and the hub of trade in the region. From the diagram alone, it is hard to see Moscow's centrality in the graph. When we measure the network (using a process and software tool described on page 11), Moscow pops out at the top of the list in centrality -- it is between[1] the most cities. Moscow is well placed because it connects two major river systems in the middle of the network, and it seems to be on the route between many cities. A structural advantage becomes a social and economic advantage.

NETWORK PROPERTIES

Human networks are built on trust. Trust is the glue and the grease that ensures networks operate at their peak. Trust is the foundation of three known advantages of networks.

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1 *A node is considered "between" when it is an intermediary along the shortest paths that link other nodes in the network.*

- Transaction costs are low in networks because trust mitigates the need to limit opportunism on the part of network participants. All unforeseen situations and their consequences do not need to be specified ahead of time (see **Release 1.0**, 3-95).

- Problem-solving is more efficient in networks built on trust. In an atmosphere of trust, participants share a common context and base of knowledge; they exchange rich information more freely; and they explore solutions to a given problem more efficiently and effectively.

- The network survives attack. Relations that feature personal trust are more adaptable and will survive greater stress.

The key job for the manager and entrepreneur is to build links based on trust within the organization as well as with customers, suppliers and partners outside.[2] Creating trust is as fundamental a management skill as controlling costs. People don't need to like each other to trust each other, as people who have dealt with ethical competitors know.

Tie strength

Network ties are generally grouped into two categories: strong and weak. The strength of a tie depends on the level, frequency, and reciprocity of interactions between two people. Ties can vary from simple, one-purpose relations to multiple, all-purpose relations. In business, tie strength is usually estimated by frequency of contact (since determining actual intensity is intrusive and time-consuming).

Strong ties are high-trust ties -- ones that you can count on. The likelihood that information will flow from one person to another is directly proportional to the strength of the tie between them. Very sensitive or valuable information typically flows along the strongest ties or is paid for. The advantage of strong ties is that communication along them is faster and easier. The messages they convey are more believable. People find strong emotional and social support from their strong relationships.

Unfortunately, strong ties can lead to a homogeneity of outlook within clusters of strongly linked individuals. With everyone connected to everyone else in a cluster there is little room for dissent and little time or motivation to nurture ties outside of the group. Everyone in this cluster knows what everyone else knows at the same time. Information can become trapped within these social boundaries and grow stale. If the group doesn't have a few boundary spanners (people connected outside the group that bring in fresh information), it will lose touch with its environment. Respecting boundaries too much leads to missed opportunities and less innovation.

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2 *Two people may have low trust between them, despite a strong prescribed tie connecting them. For example, the VP of sales and the VP of marketing may have strong ties in the work network but no ties in any of the voluntary networks, such as the grapevine. An imbalance of roles or expectations can be quite destructive.*

Weak ties are usually sporadic, superficial, casual and have less emotional investment. They may not provide you the information you seek -- there may not be enough trust built up. A weak tie may pass you only "safe" information. Strong ties are more likely to provide you information when you need it -- they are more dependable.

Weak ties can be deceptive. They have a hidden strength:[3] the ability to connect clusters within a network. Strong ties are usually found within clusters, whereas weak ties are found between clusters, connecting them. In most networks of any size, weak ties greatly outnumber strong ties. In fact, it is their frequent appearance that makes up for their lower propensity to transmit information compared to strong ties. The strength of weak ties is found not in their individual efficiency to transmit information, but rather in their overwhelming numbers.

The Net's effects

The Internet and online services are creating an explosion of new ties through the variety of tools they make available, including electronic mail, mailing lists, Usenet newsgroups, Internet Relay Chat and other, newer ones (see **Release 1.0**, 6-95 and 11-95). In the forums these tools offer, new social networks form and dissolve, often around people's common interests.

An early study of computer-mediated communications noted the startling power of such tools at bringing groups together. The 1984 study[4] measured whether and how quickly a group of North American social scientists went through four stages of relationship: lack of awareness (the parties are total strangers), awareness (possibly one-sided, as when one person lurks while another posts); mutual awareness (both sides know of each other but haven't met) and contact or acquaintance (one party sends the other direct e-mail).

The group was first studied without electronic communication tools, then with them. Without the e-mail and conferencing tools, no member of the study group got through all four stages of relationship in the seven-month study; with them, 31 percent quickly became mutual acquaintances and very few participants remained in the first stage. This and other studies indicate that online connectivity may lead to social networks that are an order of magnitude larger or more than has been common up until now.

How many hops?

Network ties are also direct or indirect. Direct ties are your immediate contacts -- with strong *and* weak ties -- but they only take you so far. The real power in networks is the "multiplier" effect of indirect ties, which enable network members to increase their reach substantially, gaining access to new information and resources in distant parts of the network. Indirect

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3 *Mark Granovetter, "The Strength of Weak Ties," American Journal of Sociology, 1973.*

4 *Linton Freeman, "The Impact of Computer-Based Communication on the Social Structure of an Emerging Scientific Specialty," Social Forces, June 1984.*

ties multiply by many times what is available through direct ties. Social scientists have discovered that visibility and influence drop off precipitously after the second link (your contacts' contacts). They refer to this as one's "horizon of observability."[5]

All indirect ties do not provide additional network benefits. A redundant tie (one that leads back to the same sources of information you already have) may not be worth cultivating. Left to normal evolution, networks grow fat with redundant ties. Contacts introduce you to their colleagues, who introduce you to their colleagues. Your tie count grows quickly, but many of these contacts point back to each other: These are all colleagues of colleagues of colleagues who know each other. Your business network is less efficient when you cultivate redundant ties that lead back to your current connections.

On the other hand, redundant ties are worth cultivating within your "home" cluster or any other key cluster. These clusters may be your immediate work group or for a senior executive the board of directors. Here the drawbacks of redundancy do not outweigh the benefits of integration with the group.

Non-redundant ties are critical in business networks -- especially in a fluid environment such as the current marketplace. Non-redundant ties bring new network benefits and information access; they provide access to parts of the network that you currently have no connection to. With proper planning, every new direct connection includes indirect ties that bring you added benefits. Your network's efficiency and effectiveness increase.

Given two networks of equal size, the one with more non-redundant contacts provides more benefits. As more individuals and groups expand the reach of their network, the company can benefit. Research has found that ties across internal and external organizational borders result in greater diffusion and adoption of innovation. Distributed ties are key to operating well on the edge of chaos.

Figure 2 shows how non-redundant ties can lead to greater access to network resources. The left-hand diagram shows a person with four ties to a rather closed group of 15 nodes that is replete with redundant ties. Since ties take time to maintain, the person might use three of the four ties to link to less redundant resources. In the right-hand diagram, the same person now reaches 28 nodes with four ties.

Non-redundant ties increase your reach into the network. You have a broader perspective on what is happening. You may also have more influence. Reach is measurable. For human networks, it is defined as the number of non-redundant nodes that you can reach in two steps. This not only defines one's horizon of observability but also affects one's sphere of influence. If node A and node B share multiple alternate paths of strong ties, within the two-step limit, they can probably exert considerable influence over each other. In contrast, few paths of weak ties between the two nodes would not support the flow of influence.

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5 Noah Friedkin, "Horizons of Observability and Limits of Informal Control in Organizations," Social Forces, September 1983.
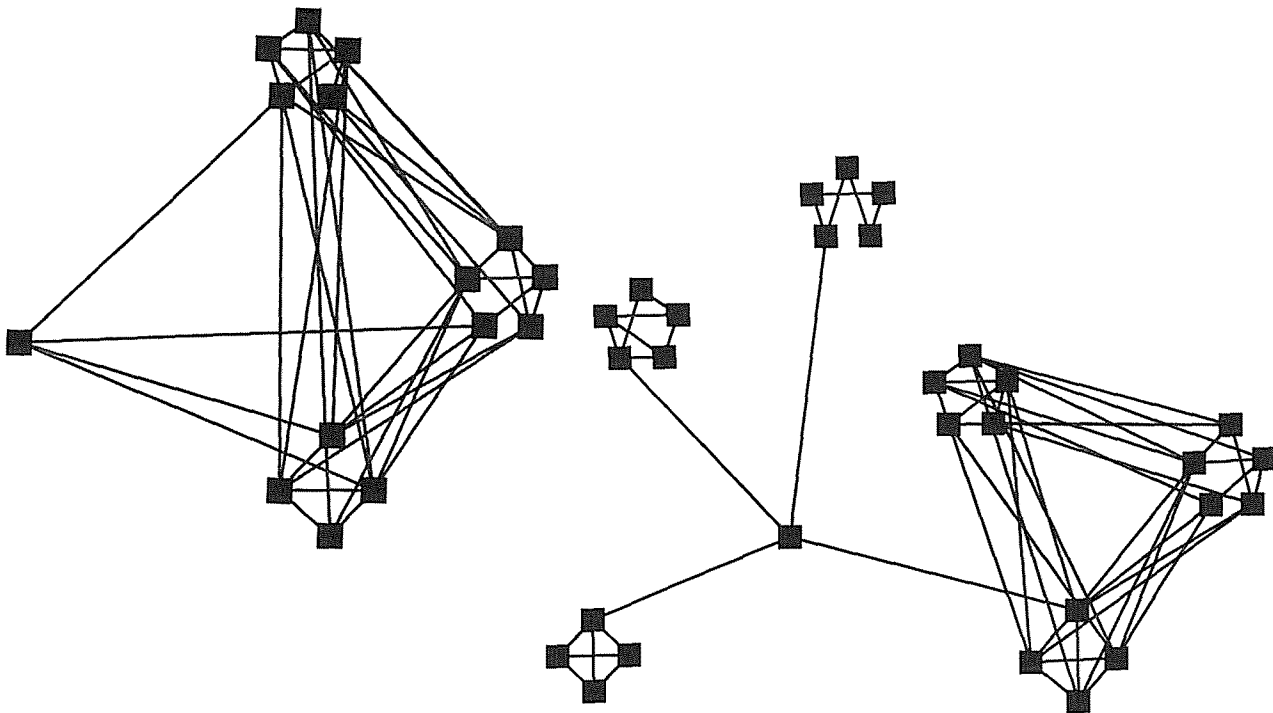
Figure 2

Control: measuring betweenness

As a network measure, control is defined as how often a node falls on the shortest path between all possible pairs of nodes on a network. In other words, how often do you have to go through node X to get from any point in the network to any other point? If node X is frequently *between* other nodes on the network, node X can *control* what flows between these nodes, as Moscow's merchants did in the 12th century.

Nodes receive high control scores when they connect parts of the network that were not previously connected. If getting from any node in group A to any node in group B requires that you go through node X, node X is in a position to be a broker or a bottleneck. A broker brings together unconnected parts of the network for mutually beneficial endeavors; a bottleneck plays the position of control for all of the power that it provides. The player with control demands high tolls to pass through his booth on the network, leading to monopoly profits in the extreme case.

In stable economies, control was the ticket to market dominance: Find the bottleneck, reinforce it, squash all new comers, charge higher tolls. IBM held sway for quite a long while this way. Microsoft and Intel have since replaced IBM in that role, but with the increased pace of industry change, they may not rule as long. All of them are masters of network control. Any newcomers to their markets had to connect to the dominant node -- it was often the only way in. Each new connection increased the dominant player's centrality even more. This was lock-in by control.

In a highly networked world, controlling bottlenecks may no longer work. With the Internet and other technologies providing room for self-organization among all players large and small, it may no longer pay to control. Adaptation may be the death of control. Those that attempt to control may face a self-organized backlash. Is Java popular just because it is great and timely technology? Or is some of the fervor behind Java a backlash against Microsoft's software dominance?

Yesterday's strategy: be between.
Today's strategy: be among.

Another approach

Access is the ability to reach other nodes in a network quickly. It's a function of path length and traversal cost. A node that has to traverse many links and pass many bottlenecks will have poor access; the information it receives will be late and distorted. Access is a great asset to offer potential partners.

Netscape appears to be trying a new approach: the access school of network benefits. First, Netscape provided smooth access to the Web by giving away its browser. Next, it provided other vendors access to the Internet marketplace and to the Netscape customer base through its plug-in architecture. The vendors writing plug-in modules for the Netscape browser will continue to support Netscape as long as Netscape provides them a pipeline to the marketplace they could not get on their own. Instead of gaining lock-in by controlling access to resources and the market, Netscape is gaining lock-in by providing access to the market. It has chosen to be a broker instead of a bottleneck. As long as Netscape is seen as the link to the market, newcomers will want to hitch their wagons to Netscape, thus increasing Netscape's centrality even more. This is lock-in by access.

Sun Microsystems seems also to be following the access philosophy with its Java language. Java is seen as a Web tool, but its potential to run on a broad variety of networks and devices expands its horizon tremendously -- again, so long as Sun does not become a bottleneck.

VISUALIZING ORGANIZATIONS

Self-organization, emergent structures, knowledge exchange, network dynamics -- all these concepts drive organizational designers crazy. They are difficult to detect, measure and map. This section and the following one explain how to visualize the emergent dynamics within and between organizations using examples from firms in North America and Europe (some of which have requested anonymity).

For example, Figure 3 below shows the emergent work flow within a small firm. It shows individuals (the nodes) in their departments (the larger boxes). The two nodes not inside a departmental box are senior executives. The links represent emergent work relationships, with the thicker lines indicating strong ties.
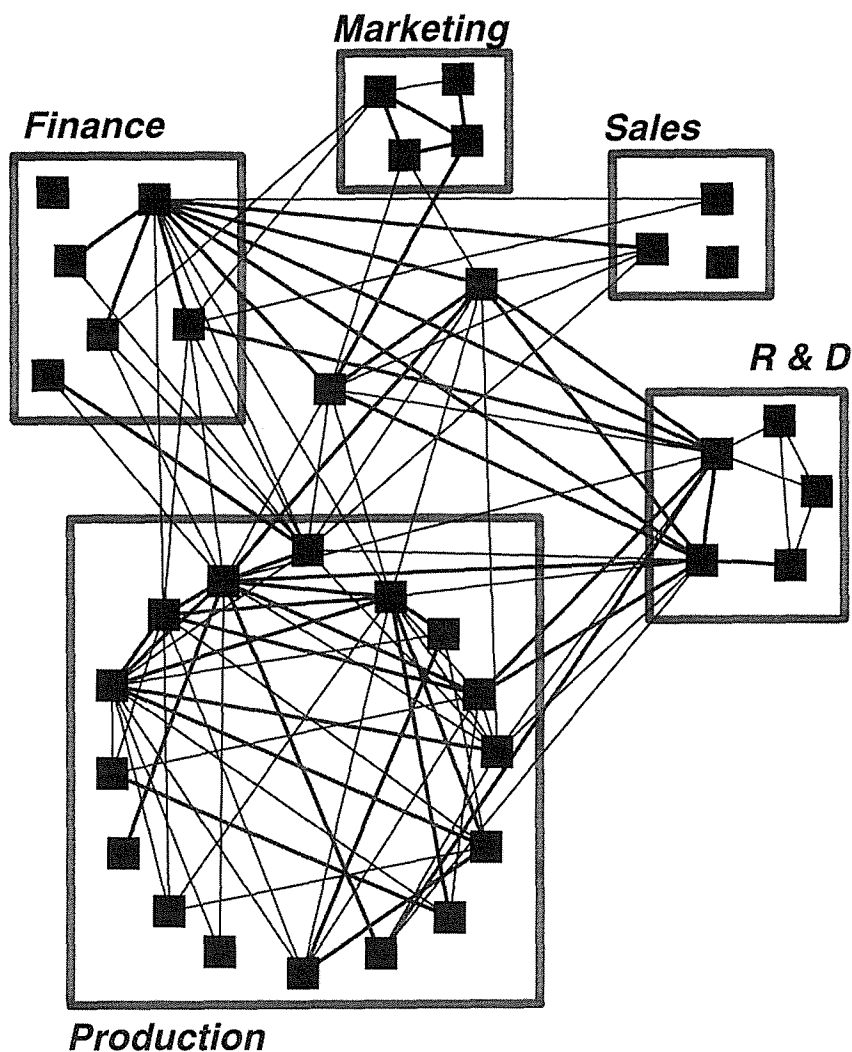

Figure 3

The diagrams and the corresponding measures usually contain both surprises and confirmations for organizational leaders. When reviewing these diagrams with our clients we ask them to keep two questions in mind:

- What activity/pattern is expected but absent?

- What activity/pattern is not expected but present?

In this case, it was obvious to everyone that direct links between Marketing, Sales and R&D were missing. These three departments worked together only through intermediaries in the executive ranks and in Finance and Production. Sales had no internal links at all; Finance and R&D had very few internal ties. Can this company respond quickly to sudden changes in the marketplace? Probably not.

The client was shocked. "How can we compete!?" he exclaimed. "They are not working with each other!" He knew he had a problem delivering products on time, but he did not realize how fragmented his organization was. Once he saw the gaps, he realized that just hiring great people was not enough. His talented employees had to be well interconnected to be able to react quickly to market changes.

Before we examine other organizations, let's back up a bit and walk through the whole process of visualizing the emergent organization.

Data collection

Data for these analyses is usually collected in one of three ways. The most popular method is a survey that asks employees whom they interact with on various job-related topics. For example, the question we asked to generate the emergent work flow in Figure 3 above was: "With whom do you work [exchange information, documents and resources] to get your job done?"

In some cases, we ask more specific questions such as, "With whom do you work to accomplish your tasks in the product development process? ...the product marketing process? ...product support?" and so on. Participants can usually complete the surveys in 20-40 minutes. The main benefit of the survey approach is its minimal interference with the organization. Surveys provide good (not great) data without great effort. To minimize false reporting of data, software matches both sides of a link: Do Person A and Person B agree on their interaction?

Another method, often used by ethnographers and anthropologists, is to gather the social and work data through direct observation. This takes longer but the data accuracy is better. There is also some concern about whether direct observation interferes with the system being observed.

The third method of individual data collection is the use of activity logs. During the work day, each participant logs whom they interact with, about what and for how long. This method is rarely used because it interferes with the normal flow of things and the data gathered is judged to be not much better than that collected through surveys.

It's also possible to gather data from existing databases or e-mail and Web server logs. This data needs to be translated and filtered to indicate which nodes are related and the "value" of those relationships -- usually measures of frequency or probability. Research to discover patterns of use, resource sharing and emergent communities of shared interest on the

Internet is helping social scientists understand the sociology of the Net. This method has obvious ethical implications: **Unless observers notify** participants that they are monitoring activity, participants' privacy is all too easily violated.[6]

For inter-organizational studies, such as the analysis of business alliances, data can be gathered from standard news sources. Most alliances and partnerships are announced publicly. Different kinds of ties can indicate different types of arrangements. For instance, industry alliances can be organized and viewed by these categories: joint ventures, technology sharing agreements, equity participation, etc. Each category might reveal a different network. In Japan and Korea, government agencies track all publicly announced partnerships at home and abroad (we do not know how they analyze the data). In the US, the SEC, FCC and sundry security agencies have interest in tracking relationships between individuals and organizations.

For our analyses, we use an application we have developed called InFlow, which finds patterns and relationships within the data. It also calculates network measures at the individual, group and system-wide levels. It has a flexible clustering algorithm that can identify emergent groups according to user-set parameters, and it allows the interactive manipulation of organizational scenarios and network analysis. Clients and consultants can collaborate on what-if exercises in organizational design.[7]

The feedback loop

Once the preliminary analysis is complete, we share the results with the client management team. These feedback sessions usually involve a few printed diagrams that show the most interesting structures and patterns. After the clients have examined and discussed them, we let the managers steer the meeting by showing them whatever views of the organization they want to see (projected on a large screen from a laptop PC). We follow the clients' lead and usually can't react fast enough to all of the requests they shout out.

The employees not only provide the data, they also help analyze it. We have found that this method of interactive feedback is not only useful for the deep analysis it provides but is also absolutely necessary for buy-in of the results presented -- not to mention follow-through. Once motivated, managers and employees are more accepting of organizational changes that come out of this process.

The group uses this initial x-ray of the organization as a baseline. It can track the effects of any planned interventions by taking regular snap-

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6 *In 1993, University of Colorado professor Mike Schwartz created an experimental system that derived connectivity graphs from Internet e-mail traffic by reading message headers (see Release 1.0, 4-93).*

7 *Telephony is a major consumer of such analytic tools. Some phone companies use another network-visualization product, Alta Analytics' Netmap, to detect toll fraud. AT&T Bell Laboratories has developed a wide range of visualization tools for network management and other uses.*

shots. Repeated surveys will show the organization's adaptive behavior, as teams, departments or the whole organization move through project phases, product development and launch, or into new markets and environments.

Doing it wrong

The pictures produced of how their organization works have a strange attraction to members of the organization. There is a voyeuristic appeal of looking behind the scenes of the place where they work. Also, they see all their warts, rolls of fat, knobby knees, etc. Unfortunately, this attraction quickly leads to unfounded "expert opinions" about what the diagrams reveal. It often begins with good-natured bantering. Comments such as, "Aww, why is no one talking to Johnny?" quickly spread through the meeting. The banter acts as a stress release; most people are somewhat nervous about what the diagrams will reveal about them. We frequently present the diagrams without the names of the individuals visible. This helps orient the gathering to focus on group and organizational dynamics.

One of our major tasks in presenting this data is to keep the clients grounded in reality when analyzing the diagrams. There is a tendency to
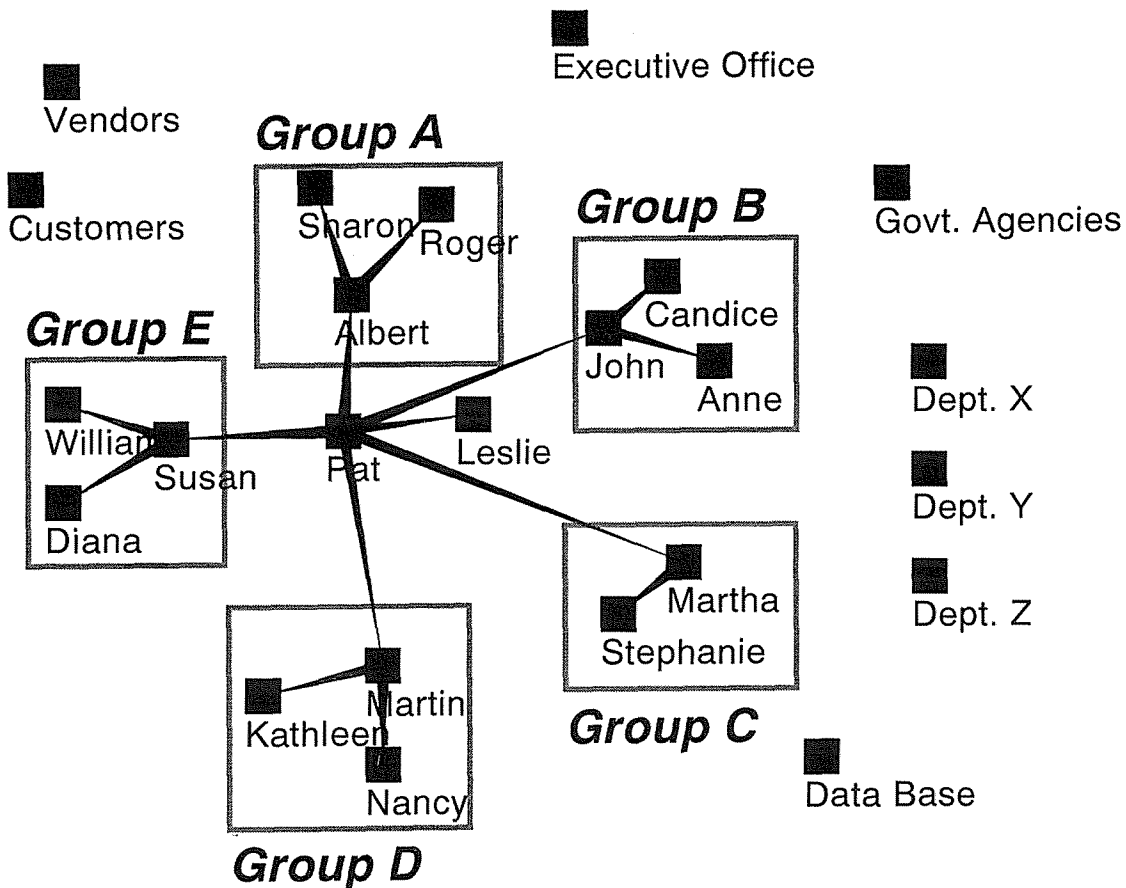
Figure 4a

jump to quick, erroneous conclusions. "Oh, look, that node is not con-
nected; maybe we don't need that person!" is a common snap judgment.
Closer inspection reveals that the diagram shows the work relationships in-
volved in processing health benefit claims, and the unconnected node is the
Director of Benefits, who should not be involved in this paper processing.

You cannot analyze the pictures without the statistics that support them.
Most clients want only to look at the pictures, which is fine. But the
consultants must make sure that any conclusions drawn in the analysis are
supported by the numbers that measure the emergent structures. (We train
licensees of our methodology and software to read the diagrams and reports
together and to provide only data-based conclusions to their clients.)

Visualizing real emergent structures

Figures 4a-c are several views of a department inside a division of a Cali-
fornia financial institution. Figure 4a shows the formal organization
structure. The hierarchy is displayed as a network, the nodes are grouped
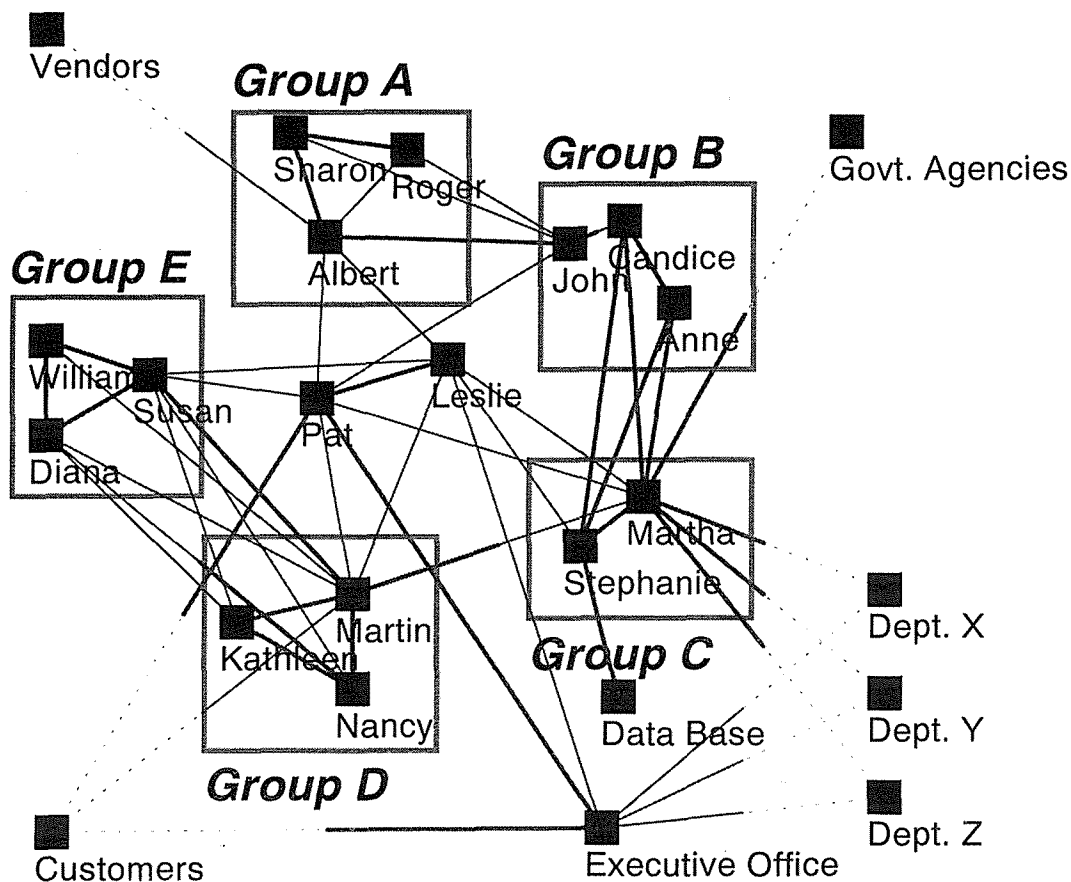into their prescribed work units.

Figure 4b

Pat has been the department manager for a year; Leslie is the department
secretary. Figure 4b shows the emergent work flow for this department.
Note that much work is done outside of the official hierarchy. Although
the boss is always central in the hierarchy, she is rarely central in all
other emergent networks. We have had embarrassing situations where we have
to show clients how "out of the loop" they really are.

Since much of the work is done outside the hierarchy and across formal bor-
ders, Pat wanted to see the emergent structure of her organization. "What
do we really look like?" she asked. In Figure 4c we see the organization
redisplayed into its three emergent clusters. All of the nodes and ties
are the same in Figures 4b and c -- only the arrangement of the nodes is
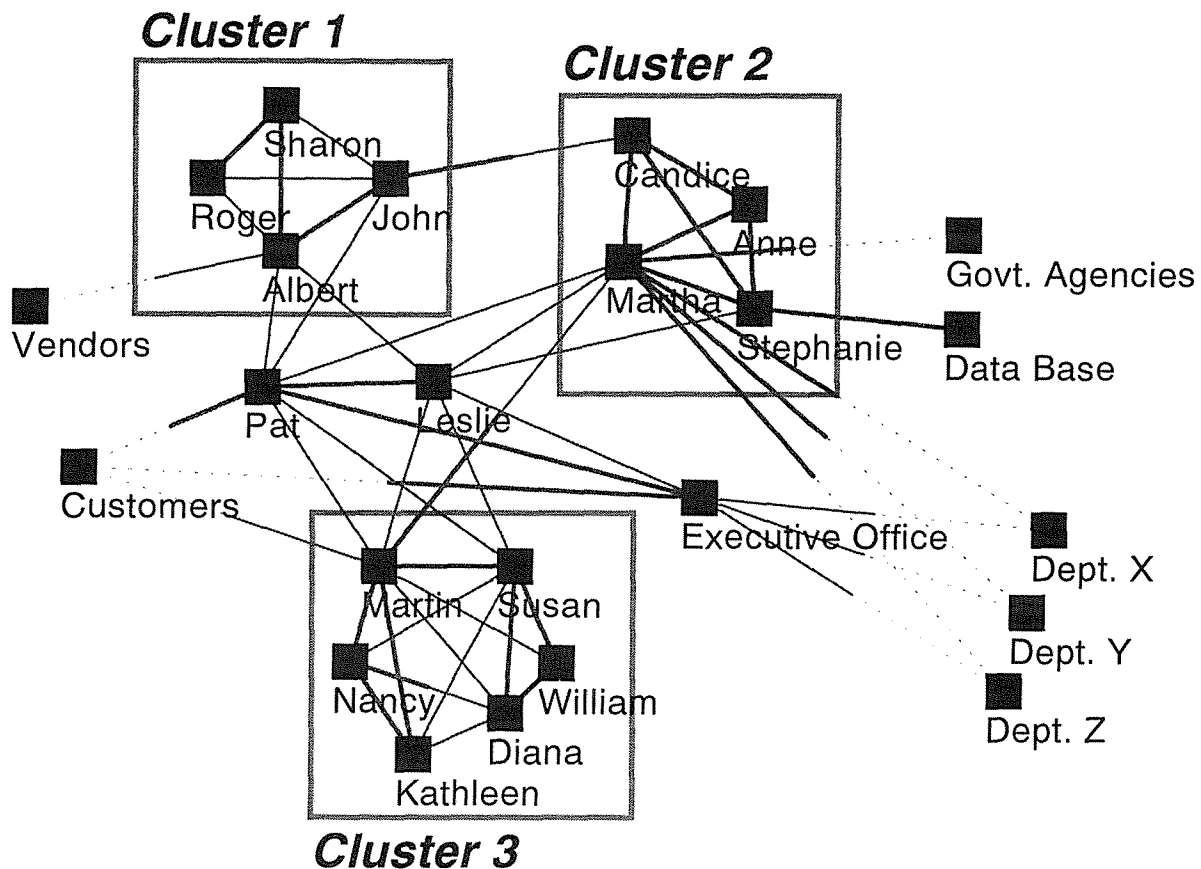different.

Figure 4c

Now Pat has a problem. Her department is organized in five prescribed work
teams, but the people actually work as three emergent teams. Should she
reorganize so that the formal organization resembles how work really gets
done? Or is she better off leaving the organization alone, but understand-
ing how it really works? Much of the decision will be based on the flui-
dity of the emergent structures. If they can be expected to change on a
weekly or monthly basis, then formal reorganization would be futile. On

the other hand, if this new structure is more permanent, then matching the formal to the informal is reasonable. In either case, the hierarchy and the work flow should not be so precisely defined and inflexible that they interfere with the natural interactions of the unit in its environment.

In a different engagement, IBM wanted to improve one of its key divisions' market responsiveness. At the time, client/server computing was just becoming hot, and division managers wanted to make sure that the unit could adapt to and eventually lead in this marketplace. One of their goals was to find any and all experts in client/server computing within the division. In Figure 5, IBM uncovered an unofficial expert in client/server computing (the circled node), whose knowledge was already being tapped by others in the division. IBM managers did not reassign the emergent expert to a client/server group; instead, they told him he was a key asset to the company, assigned him to lead a short-term task force and helped connect him to a broader audience within the company.
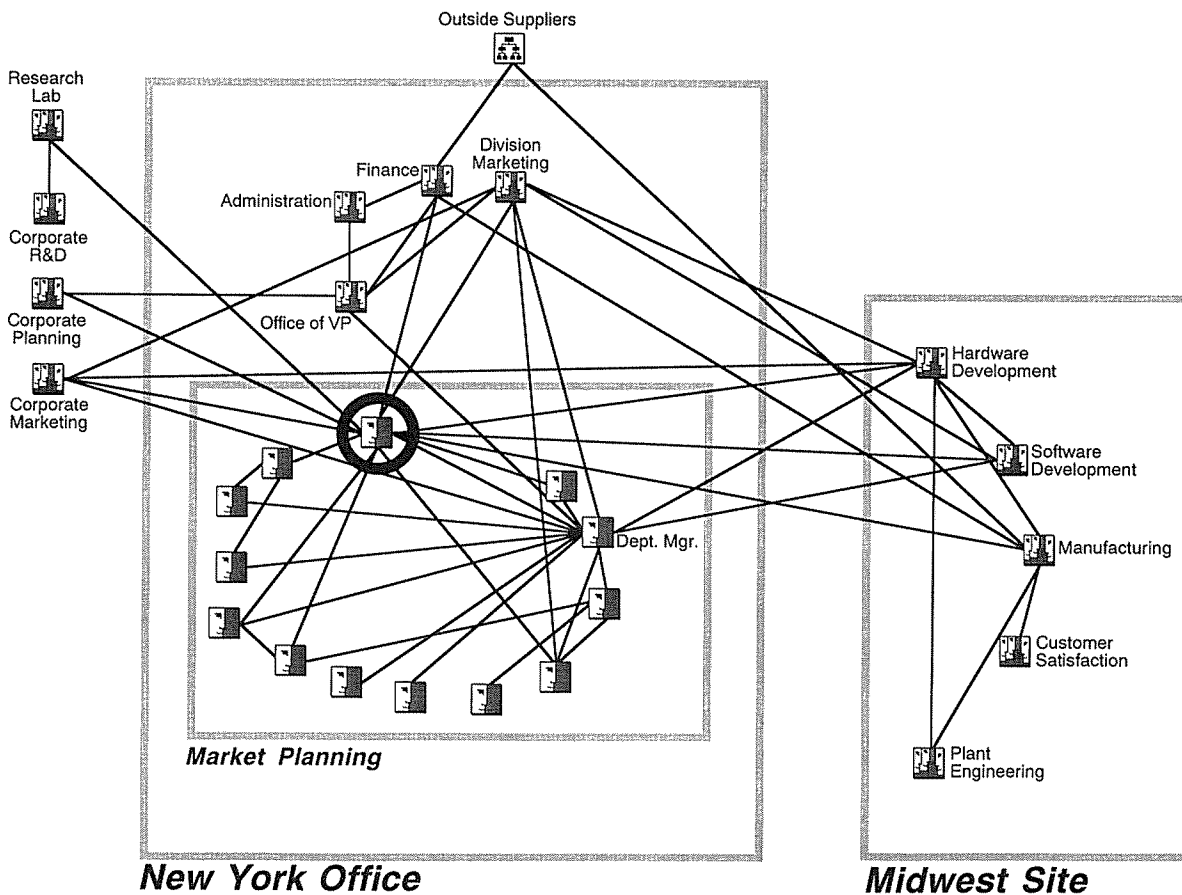

Figure 5

A major aerospace firm in Los Angeles was in downsizing mode, just like the rest of the aerospace and defense industry. It was losing senior engineers

to early retirement programs, and its managers wanted to make sure that the organizational memory did not walk out the door with the senior people. They wanted to see if knowledge and expertise was being passed on to the junior engineers who were the future of the firm.   Figure 6 shows how engineering expertise flowed between the various engineering levels.
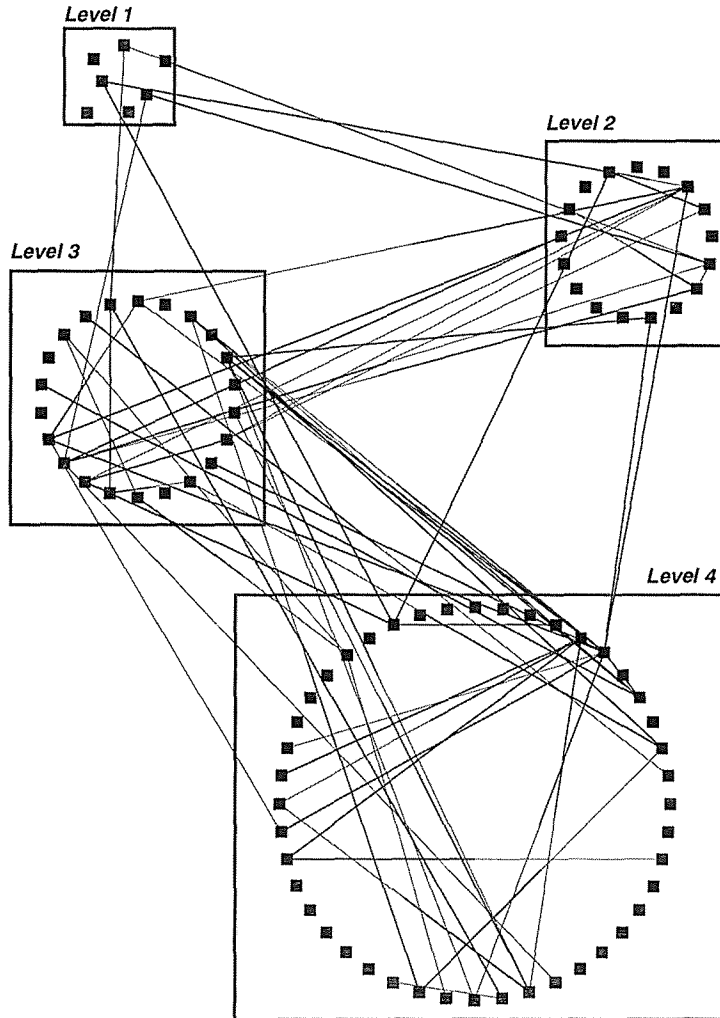
Figure 6

Figure 6

Unfortunately, little direct knowledge was passed from the most senior engineers in the bottom box to the younger engineers in the top two boxes. Most junior engineers had no direct ties with the senior group.   With the help of Human Resources, management devised a strategy to improve knowledge transfer from the senior levels to the junior levels.

An emerging industry

During 1994 and 1995 we tracked the alliances that companies announced to build the so-called Information Superhighway.   Since then, the Internet has

changed the 500-channel future considerably. However, examining the industry's structure in 1994 and early 1995 offers interesting glimpses of network dynamics and emergent processes.

When we first started to map this industry, it was composed of scattered, unconnected clusters that formed a sparse, fragmented network. By early 1995, we were tracking over 90 companies in this industry and their key alliances in North America. The network seemed to be getting denser by the day. In April 1995, the Superhighway alliances started to show an emergent pattern -- more pronounced clustering, with three emergent groups.

The first we call Cable-Soft, because it consists of Microsoft and the cable TV service operators, among others. The other key player in this group is Tele-Communications Inc. (TCI). The second group we call Bell & Co.; its key players include AT&T, the Baby Bells, IBM and Oracle. The third group includes the fence sitters, which have approximately equal ties to both Cable-Soft and Bell & Co. These companies showed no real preference. Some of the key players in this group include Time-Warner Entertainment, General Instrument and Sega. Figure 7 below is a diagram showing the two emergent clusters and the in-betweens as of April 1995.
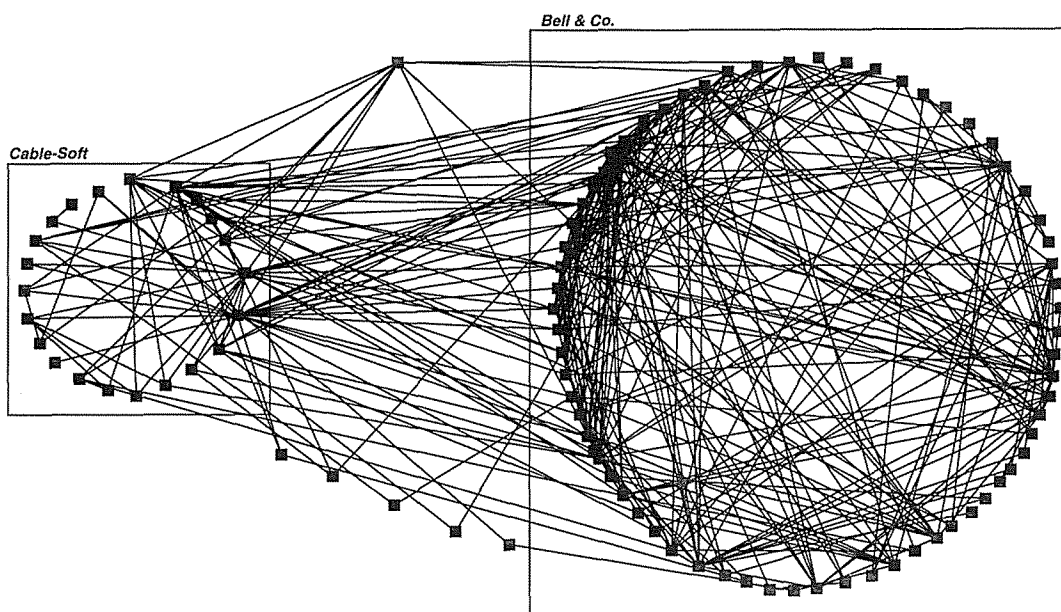

Figure 7

The information and control benefits of well-positioned companies free the firms to try diverse ways of getting higher rates of return on capital invested. They have more options for action. They have first choice at entrepreneurial opportunities. They receive a constant flow of diverse information and can learn faster than firms on the periphery of the alliance network. Good position equals high autonomy in the industry and vice-versa. Central players can call the shots -- they are positioned to lead the industry. Peripheral players with low autonomy conform to the demands of the central players for survival.

On closer inspection, we see that some firms are within the clusters, while others are like satellites orbiting on the periphery. Since these satellites have weak connections to the cluster (they are in distant orbits), they could easily be pulled into the orbit of the other cluster just by forming several new partnerships. The firms deeply embedded in each cluster will require more profound changes in order to be released from their current webs. We see the more tightly integrated nodes within the gray boxes below in Figure 8.
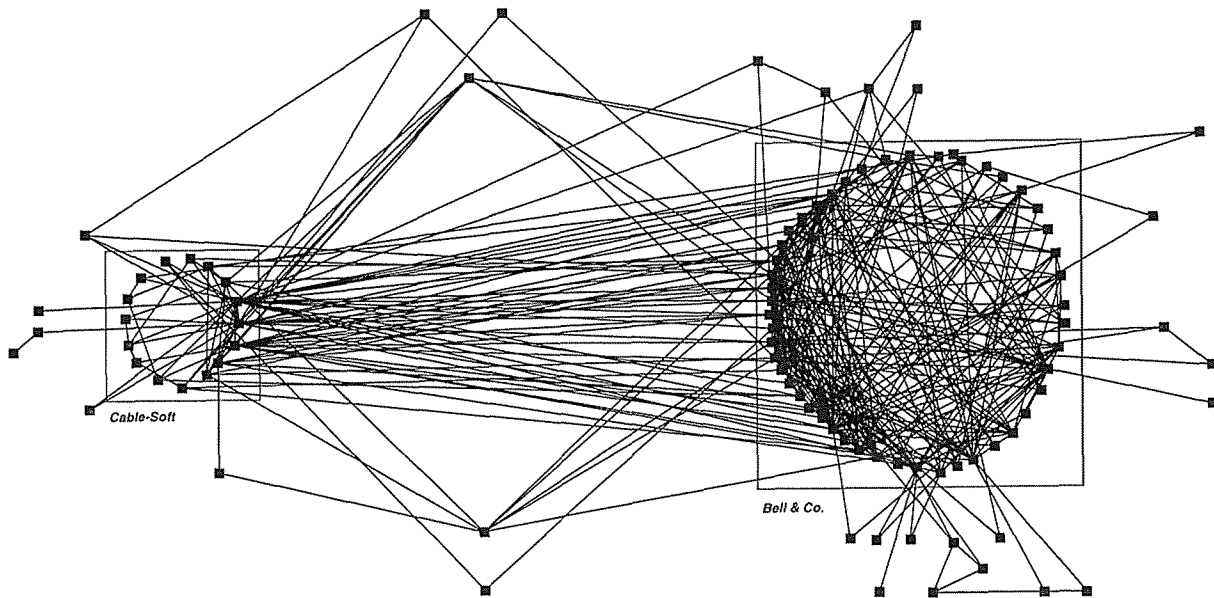

Figure 8

So, which players are well located? It is hard to tell by looking at the complex diagrams. Examining network metrics reveals the well positioned players in each cluster and in the web of alliances overall. First we look at which firms are influential in each emergent cluster. In April 1995, the best positioned firms in the Cable-Soft alliance are:

1) TCI
2) Microsoft (a distant second)
3) HP

This cluster of firms is made up of mostly the builders of the network, with two software firms, one hardware firm and DreamWorks SKG as the main content provider. TCI is far more central than any of the other companies and dominates this group.

The firms best positioned in the Bell & Co. cluster are:

1) Oracle
2) Bell Atlantic
3) AT&T
4) Microware

    5) IBM
    6) US West

This group is made up of mostly hardware and software vendors, with a few
network builders in the mix. No single firm dominates this cluster; net-
work centrality scores are more evenly distributed. Interestingly, content
providers are not very central in either group.

Next we look at the whole network -- all alliances throughout the industry,
which reveals which firms have the best location in the industry's informa-
tion flows and knowledge exchanges. The top players, from the overall net-
work view, may not necessarily be in the same order as in their local
clusters. The key locations in the overall industry network (again, in
April 1995) belong to:

     1) TCI
     2) Bell Atlantic
     3) Oracle (a close third)
     4) Microsoft (a very close fourth)
     5) AT&T
     6) U S West
     7) General Instrument
     8) Time Warner Entertainment
     9) Microware
    10) IBM

Note that you can't sum the local results and get the global list: Net-
works are non-linear. Global behavior is built on local interactions, but
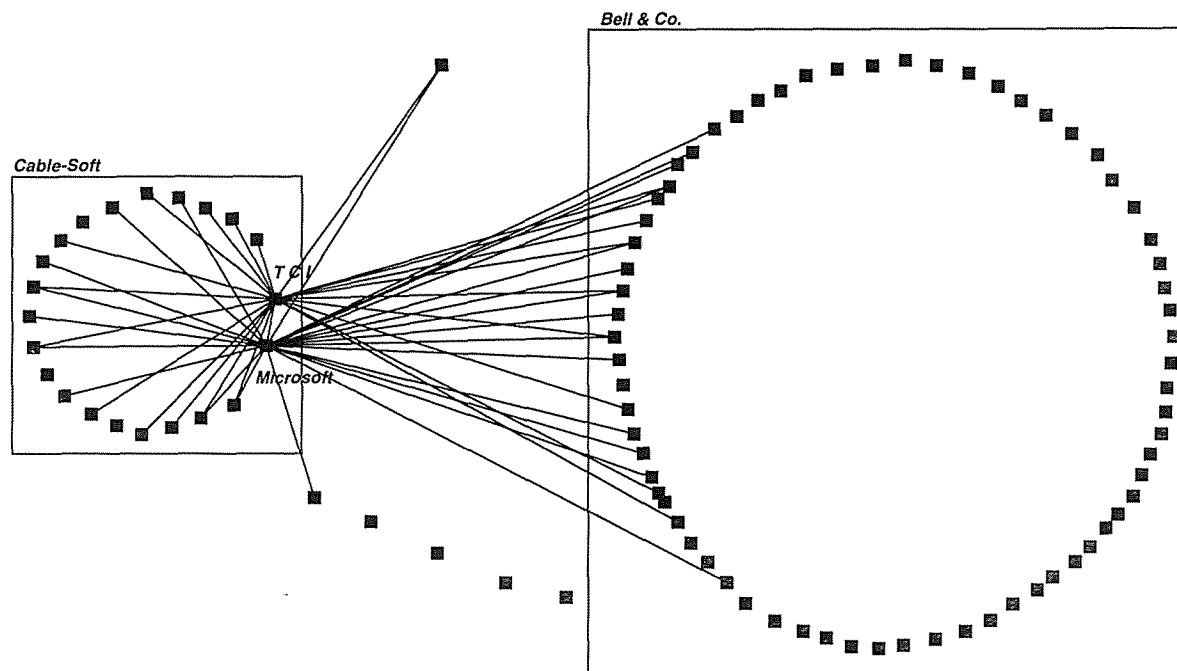it has its own characteristics.

Figure 9

Which cluster of alliances has the advantage? It appears from pure size that the Bell & Co. cluster has the advantage. It also has higher overall network location scores: 75 percent of the most central players come from this group. The best-located firms in Cable-Soft (TCI and Microsoft) have many ties to the Bell & Co. cluster. Bell & Co. seems to be where the action was in early 1995.

On the other hand, Cable-Soft has only 58 percent of its total ties within the cluster. Was this cluster being pulled slowly into the dominant cluster? Or were these two strong players (see Figure 9) trying to pull in a few of the fence sitters and maybe a partner or two from the other cluster? The industry was in constant flux during this period.

InFlow allows for multiple views of the same connections. Figure 10 below shows the same nodes and connections in Figure 9, but now organized by industry sector.
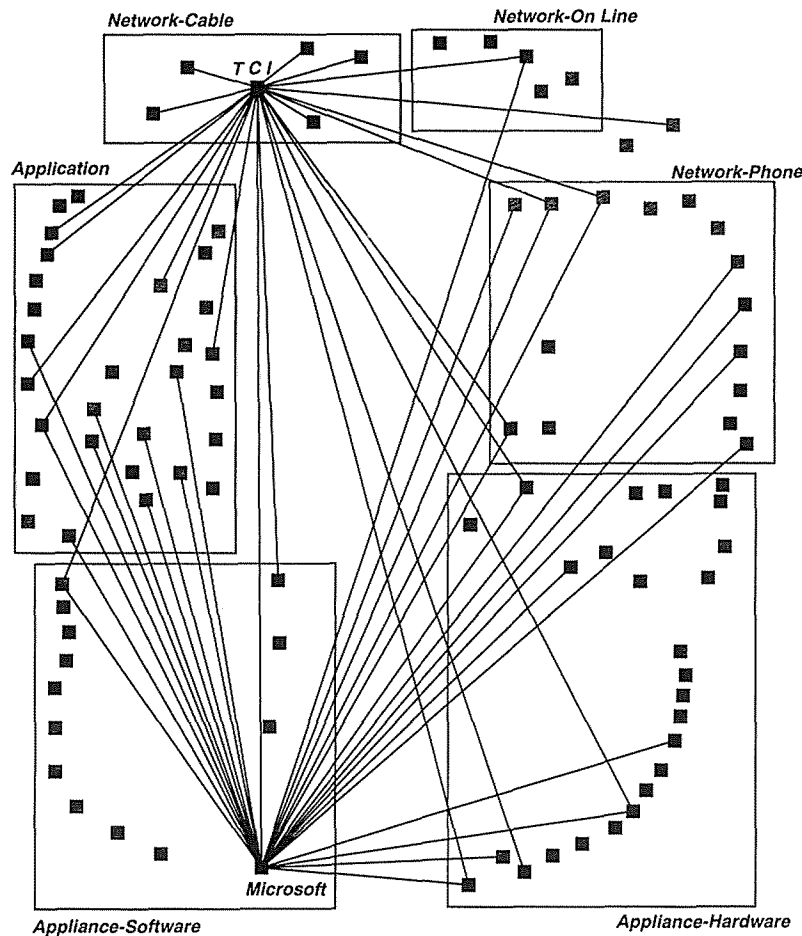

Figure 10

Notice how TCI and Microsoft have connections to every part of the industry. Also notice how they have very few redundant ties between them. This is smart networking: The two companies are obtaining maximum diversity and reach from their ties. Also, each offers the other additive network bene-

fits. Both TCI and Microsoft appear to have learned the lesson that it is better to have a dispersed, diverse network than a closed network of redundant ties. Two financially powerful firms that are also well-positioned are tough to compete against.

At the time, Microsoft had many ties, but was not in many cliques (small, tightly knit groups usually with less than ten nodes). Also notably, Intel was in more cliques with phone companies than with Microsoft.

As we tracked the formation of these alliances over time, we noticed an interesting phenomenon: *It pays to take care of your friends*. Smart networkers see to it that their friends are well connected. As a firm's partners formed new alliances and became more central in the overall network, that firm's network centrality also improved, although not always predictably. The overall structure of the network (masked by the uneven distribution of ties) governed which events caused big changes and which were barely perceptible. TCI benefited noticeably from its partners' continuous alliance building.

We investigated two other dimensions of this emerging industry. One was its overall "brittleness." If a few key players suddenly withdrew, would it fragment the network so much that information would not flow between the remaining clusters? We found that this nascent industry was anything but brittle. All of the alliances, equity investments and technology sharing created a very dense web of ties between most of the 90 firms we were tracking. We removed key nodes iteratively to see at what point the network would fragment into isolated clusters. Had the network been dependent on a few nodes to keep it together, it would have fragmented quickly as those nodes were removed. We had to remove 20 of the 90 nodes before we saw any fragmentation. After we removed the 26th node, the network finally fragmented into 10 small, unconnected groups. A richly connected network can survive much damage before nodes can no longer reach each other.

We also investigated structural equivalence: How similar two nodes are in the network -- whether they provide the same network benefits. Specifically, we compared the network structure surrounding two nodes to gauge their structural equivalence. It is rare to find two nodes in a real network that are 100 percent equivalent, but companies with similar alliance strategies will have similar network structures. Structural equivalence helps managers identify which companies are following unstated yet similar strategies. It helps answer questions such as: Who is like us? Who provides equivalent information or resources? Who can be substituted for us? Nodes that are structurally equivalent are often potential competitors -- they provide the same resources and benefits to the network. The financially or organizationally weaker party of a structurally equivalent pair should be wary. In the Superhighway-construction industry network we found the following parties to be fairly equivalent:

- Bell South / Ameritech
- Pac Bell / SBC Communications
- AT&T / US West
- CAA / Disney
- Intel / General Instrument

Microsoft was interesting to watch from 1994 to 1995. It started out with a fairly average network location in early 1994. By mid-1995, it had maneu-

vered itself into a very advantageous location in the Superhighway industry's information flow. Microsoft's alliance with NBC had an interesting added dimension. In order for NBC to provide content to the new Microsoft Network, Microsoft stipulated that NBC would have to dissolve its alliances with America Online and Prodigy. By forcing new partners to prune old network ties, Microsoft was looking to control, not provide access.

BUILDING YOUR OWN NETWORK

We have looked at emergent dynamics and structures within and between organizations. But how do you make the right things happen in your organization? Do you have to sit tight, let evolution and adaptation take over and hope for the best results? There are action steps that organizational leaders can take to allow self-organizing networks and communities of practice to flourish. Some of these steps may seem obvious, but they're critical; others are more subtle.

Step one is to make sure that everyone knows the mission, vision and goals of the organization. It's not enough that people have an intellectual understanding of the guiding values -- the values need to be internalized and drive everyday decisions and behaviors. When that happens, and when managers empower workers to respond to local conditions, the teams will self-organize and adapt to whatever competitors and the marketplace throw their way. Instead of sending every problem up the hierarchy,[8] they will figure out what to do through their communities of practice and networks of knowledge exchange.

Next, managers ought to determine the current state of their organization's internal communications. These baseline measurements and diagrams help focus everyone's attention to get the organization working together better. Think of it as a corporate CAT-scan before potential organizational surgery. Managers should also track and analyze alliances and partnerships in their industry. It will help them identify upcoming leaders, nascent clusters, potential competitors (or replacements for current allies) and companies that are unexpectedly well positioned.

Heuristics

Here are some rules of thumb to help executives encourage employees and build networks inside and outside of their companies.

- Diverse, far-reaching networks provide more information benefits. Maximizing the number of non-redundant ties offers the most reach. Work to expand your horizon of observability into areas of the network that you need access to.

- Build strong ties to critical areas of the network. Information you desperately need will travel more quickly and reliably along a

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8 *Hierarchies will remain an integral part of most organizations into the foreseeable future, but organizations competing on knowledge and innovation need to balance the hierarchies with looser, more adaptive structures.*

strong tie. Establish weak ties to those parts of the network that contain less essential information.

- When looking to connect to new parts of a network, look for established brokers that lead to that area. Linking up with a broker is the quickest and most efficient way to gain access to information you need but do not already have. Just be sure this person, group or organization is a true broker and not a bottleneck.

- Can't find a broker? Ask your weak ties whom they recommend as an expert in an area you seek. When the same name comes up several times, you have located your contact. You ask your weak ties because you are seeking information outside of your immediate cluster (which has mostly strong ties).

- Prune all bottlenecks from your network. Establish direct or indirect paths around them to the resources and information you need. In most cases there are many routes between two points.

- Remember that networks behave in non-linear ways. You can't predict an event's global effects by extrapolating local analyses. Actions that "distant" nodes take, such as changing their network ties, can affect your network benefits substantially.

- Don't try this at home! These concepts are useful ways to allocate resources and decide among potential alliance partners, but telling your kids you need to spend less time with them because they are redundant links won't get you far.

Creating a formal framework that isn't stifling (such as the official company hierarchy) *and* encouraging adaptive, self-organizing activities (internally and externally) will create an organization that is ready to compete in the new economy that places emphasis on knowledge, flexibility and innovation.

A little social engineering

You can't engineer informal networks and communities the way you can other prescribed structures. Executives have to set initial conditions and expectations, then allow things to happen. Encouraging self-organizing behavior is an important step. Leaders must also behave the way they are expecting others to behave.

The financial organization shown in Figures 4a-c was mired in the "everything must pass through the boss" mentality that the previous manager had ingrained in his 12 years at the helm of the department. Its new manager practically pleaded with his organization to search out new ways of working together. Being that bottleneck in the day-to-day work flow did not allow him to spend time with the customer base that his department served.

Setting the initial conditions usually means getting the right people together. This can be done in many ways. Formal teambuilding programs often work well. Co-location is a remarkably simple yet effective solution. Put the people who need to work together near each other. Studies continually show that proximity aids in network and community building.

Even in these days of cyberspace, face-to-face communication is still the richest form of communication available (see **Release 1.0**, 6-93). Face-to-face (F2F) meetings really help in situations where information is complex and nebulous, from problem solving and deep learning to making sense of the environment with others. F2F meetings are also key to building trust. Once relationships are started and things are more structured, other kinds of communication can keep things moving forward.

Some companies bring people together by sending key people on business trips or to seminars and training. Sometimes it does not matter what the trip is for. What is important is that these people are together getting to know and trust each other. Situations where there is known animosity between parties require more formal interventions. But where two or more people need to be brought together to establish new work ties, the informal approach is often successful.

Another way to foster network building is to encourage managers to set time aside for random activities such as meetings or social events they don't normally attend or events and places that arise serendipitously -- InFlow was born from such random activity. (Nature uses randomness and variety very effectively.) Going beyond familiar boundaries may lead to chance connections that grow weak-tie networks and bring useful information into established communities and groups. Random activities are also likely to generate non-redundant ties. It is often these new and different ideas and concepts that stimulate innovation. To organizational engineers, this informal "poking around" sounds like inefficiency to remove. But this joining of previously unconnected information flows and the intersection of previously unconnected communities leads to knowledge generation and innovation that is critical to compete effectively in today's environment.

Herbert Simon, winner of the Nobel Prize in Economics, was once asked by a colleague how he happened to know something about practically everything. He answered that it was real easy -- he kept his vast knowledge in his network of friends and colleagues. He simply knew which expert to go to when. Remember, what you know depends on whom you know.

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|                                               |
|   ● Networked object graphics.                |
|   ● Avatars: motion and emotion online.       |
|   ● The analog world.                         |
|   ● Collaboration tools.                      |
|   ● And much more... (If you know of any      |
|       good examples of the categories listed  |
|       above, please let us know.)             |
|                                               |
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RESOURCES & PHONE NUMBERS

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RELEASE 1.0 CALENDAR

February 13-14	*The Online Advantage - Bellevue, WA. Sponsored by Digital Media Alliance and the Washington Software Association. With Esther Dyson, Ted Leonsis and Stanley Marcus (chairman emeritus of Nieman-Marcus). Call Michelle Ruegg, (206) 450-9965; fax, (206) 889-8014; mruegg@aol.com; to register call (206) 889-8880; www.wsa.com/wsa/events/ola96.
February 13-15	Virtual Reality world '96 - Stuttgart, Germany. Sponsored by IDG. Call Caroline Dattner, 49 (89) 36086-390; fax, 49 (89) 36086-274; vrw.idg@iao.fhg.de.
February 13-15	Networks Expo Boston '96 - Boston. Organized by Blenheim Group. Call Annie Scully, (800) 829-3976 x145; fax, (201) 346-1532; ascully@blenheim.com; www.shownet.com.
February 13-16	Wireless Technologies Mexico '96 - Mexico City, Mexico. Organized by E.J. Krause & Assoc. Call Tobey Sommer, (301) 986-7800; fax, (301) 986-4538.
February 14-20	1996 ACM Computing Week - Philadelphia. Sponsored by ACM. Events for all interests from the oldest surviving computing association. Call Donna Baglio, (212) 626-0606; fax, (212) 302-9610; baglio@acm.org.
February 18-20	Mobile Insights '96 - Phoenix. Organized by Mobile Computing Insights. Jerry Purdy's show. Call Julie O'Grady, (408) 777-4868; fax, (408) 253-6608.
February 20	*A Nation Connected: Defining the Public Interest in the Information Superhighway - Rancho Mirage, CA. Organized by American Library Association. With Esther Dyson. Call Barbara Macikas, (312) 280-3201, fax (312) 280-3256.
February 20-22	Digital Hollywood: The Media Marketplace - Los Angeles. Organized by American Expositions. With Glenn Jones of Jones Intercable and Charlton Heston. Call (212) 226-4141; fax, (212) 226-4983; www.digitalhollywood.com.
February 21-24	*Interactive Newspapers '96 - San Francisco. Sponsored by the Kelsey Group, Editor & Publisher and INMA. With Esther Dyson and speakers from Reuters, Hearst, Digital Ink and I/Pro. Call Natalie Kaye, (609) 921-7200; fax, (609) 921-2112; www.kelseygroup.com/kelsey.
February 21-24	*TEDSELL - Monterey, CA. Organized by TED Conferences. With Esther Dyson. Call David Sume, (401) 848-2299; fax, (401) 848-2599; wurman@media.mit.edu.
February 26-28	Consumer Online Services III - New York City. Organized by Jupiter Communications. Call David Schwartz, (212) 780-6060; fax, (212) 780-6075; www.jup.com.
Feb 28 - Mar 1	SuperCarrier '96 - Washington, DC. Sponsored by Telecommunications Reports and the Yankee Group. See what happens when local-exchange carriers, interexchange carriers, wireless services and cable operators collide. Call Tony Johnson, (800) 822-MEET or (202) 842-3022 x317; fax, (202) 842-3023.
March 2-6	1996 Spring Symposium - San Francisco. Presented by the Software Publisher's Association. Call Nadia Kader, (202) 452-1600 x339; fax, (202) 223-8756; nkader@spa.org.

March 3-7	**MailCom '96** - Atlantic City, NJ. Sponsored by the Mail Systems Management Association. Remember snailmail? This is where they talk about it -- in huge volumes. Not *one* mention of e-mail. Call (607) 746-7600; fax, (908) 775-7462.
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March 4-7	**intermediaWORLD '96** - San Francisco. Organized by Reed Exhibition Companies. Hear digital content creators from Rocket Science Games to Microsoft and Viacom; includes a digital arts festival. Call (203) 840-5634 or (800) 246-8371; fax, (214) 466-4611; imworld@reedexpo.com; www.reedexpo.com.
March 8	**@The Impact of Cybercommunication on Telecommunications** - New York City. Sponsored by the Columbia University Institute for Tele-Information. With Eli Noam, Jim Kinsella, Mark Stahlman and Jerry Michalski. If you're into the economics of connectivity, drop on by. Call (212) 854-4222; fax, (212) 932-7816; www.ctr.columbia.edu/citi/register/html.
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March 17-19	**K-12 Networking** - Arlington, VA. Sponsored by Consortium for School Networking (CoSN). Call (202) 466-6296; fax, (202) 462-9043; www.cosn.org
March 17-20	****1996 PC (Platforms for Communication) Forum: The Future Now (some assembly required)** - Tucson, AZ. Sponsored by us: You read the newsletter; now meet the players. See page 21 for a preview. Call Daphne Kis, (212) 924-8800; fax, (212) 924-0240; daphne@edventure.com.
March 18-22	**BrainShare '96** - Salt Lake City. Novell's annual developer conference. Call (314) 287-5259 or (800) 833-4862 x33; http://BrainShare.novell.com.
March 19-23	**CSUN's Conference on Technology and Persons with Disabilities** - Los Angeles. Sponsored by California State University, Northridge. Call Dr. Harry J. Murphy, (818) 885-2578; fax, (818) 885-4929; ltm@csun.edu.
March 25-27	**Internet & Electronic Commerce** *(iEC)* **Strategy Conference & Exposition** - New York City. Organized by Gartner Group. With Bill Gates and Jim Clark. Call Cynthia M. Cantow, (203) 256-4700 x117; fax, (203) 256-4730; ccantow@expocom.com.
March 25-29	**Software Development '96** - San Francisco. Organized by Miller Freeman. Call (800) 441-8826 or (415) 905-2702; fax, (415) 905-2222; sd96west@mfi.com; www.mfi.com/sdconfs.
March 26-28	**Web Design & Development** - San Francisco. Organized by Miller Freeman. Call (800) 441-8826 or (415) 905-2702; fax, (415) 905-2222; sd96west@mfi.com; www.mfi.com/sdconfs.

March 27-30	*The Sixth Conference on Computers, Freedom and Privacy '96 - Cambridge, MA. Hosted by MIT and the World Wide Web Consortium. Watch hackers, feds and business folks discuss things calmly. Call Marie Seamon, (617) 253-1700; fax, (617) 253-7002; http://web.mit.edu/cfp96.
March 28-31	Canadian National Internet Show - Toronto, Canada. Produced by Motivational Strategies, Inc. Call Barry Clavir, (416) 698-2166; fax, (416) 698-3303; bclavir@inforamp.net.
Mar 30 - Apr 2	Computer Game Developers' Conference - Santa Clara, CA. Organized by Miller Freeman. Call Susan Lee-Merrow, (415) 352-5230; fax, (415) 905-2222; susan_lee-merrow@living books.com; www.mfi.com/sdconfs.
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April 1-2	International Virus Prevention Conference - Arlington, VA. Sponsored by National Computer Security Association. Call (717) 258-1816 x226; fax, (717) 243-8642; conference@ncsa.com; www.ncsa.com.
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April 1-3	New Technologies for Directory Publishers - Washington, DC. Sponsored by the Kelsey Group and the Yellow Pages Publishers Association. Call Natalie Kaye, (609) 921-7200; fax, (609) 921-2112.
April 1-3	WinHEC '96 (the Windows Hardware Engineering Conference) - San Jose, CA. Sponsored by Microsoft, EE Times, OEM Magazine and Cirrus Logic. The best place to keep up with the WinTel architecture; learn about PC 97, USB and more. Call (612) 550-6390; fax, (612) 550-6391.
April 1-3	Web World - Orlando, FL. Sponsored by DCI. Call (508) 470-3880; fax, (508) 470-0526; confreg@dciexpo.com; www.DCIexpo.com.
April 1-5	@Networld+Interop '96 - Las Vegas, AZ. Sponsored by Softbank Expos. One of the best places to catch up with networking technology. Call (800) 488-2883 or (415) 578-6900; fax, (415) 525-0199; www.sbexpos.com/sbexpos/interop/.
April 9-11	Online Marketplace '96 - Chicago. Organized by Jupiter Communications. Call Harry Larson, (212) 780-6060; fax, (212) 780-6075; www.jup.com.
April 9-12	Best Practices in Distributed Computing '96 - Cambridge, MA. Organized by Patricia Seybold Group. Making distributed applications work, with Bill Joy, Jim Allchin and Ray Ozzie. Call (617) 742-5200 or (800) 826-2424; fax, (617) 742-1028; www.psgroup.com.

Events Esther plans to attend.
@ Events Jerry plans to attend.

Lack of a symbol is no indication of lack of merit.
Please let us know about other events we should include. -- Christy Snipp

1996 PC FORUM: THE FUTURE NOW (some assembly required)

It's the day after Christmas. The children are in paroxysms of delight. The floor is littered with shiny new toys, spare parts, wrapping paper, unopened cards from well-meaning distant relatives. Overlooking it all is Teddy the Bear, who has survived many Christmases unscathed.

About all these toys: How can we get them to work? Are the parts all there? Everything looks great, but nothing works together. The batteries Dad bought on sale last summer, with great foresight, have already gone dead. No one can figure out how to assemble the kitchen robot; the instructions are inscrutable, and maybe a part is missing; it's impossible to tell. Dad is an old hand at this; he actually gets one of Junior's toys to work, but he can't figure out what it does. Junior grabs it from him; it breaks.

....now it's February. The electronics are forgotten; the video has lost its charm; the talking doll has permanent laryngitis. But Teddy stays on. He's a source of comfort, a witness to events, a steady friend in a changing world. The children are playing with Teddy and with the sled; the electronic toys are in the basement. And in the mailbox: the credit-card bills.

Sound like any business you know?

Each **Release 1.0** subscription (plus a fee!) entitles you to two registrations to the 19th annual PC (Platforms for Communication) Forum, March 17 to 20, in Tucson, Arizona.

The theme this year is "**The Future Now (some assembly required).**"

Making it work

The age of online and multimedia is upon us. Computers that aren't connected aren't part of the picture. The development platform is not the mainframe or the pc, but the network. Businesses are setting up Web sites; content companies and search services are going public at astronomical P/E ratios; companies are merging and divesting with abandon. But it's not clear that any of these pieces will actually work together, or that they're plugged into a steady power source -- profitability.

Online technology and services are opening up a new world, but like the kids at Christmastime, we face a number of questions before we can get the toys to work. What's a keeper, and what should we give to cousin Fred?

- *interoperability and openness.* Do the dolls fit in the dollhouse? Do the trains run on the tracks? How can we get all these services and products to work together? Consumers won't stand for payment systems that don't let them pay all their bills from one service. Content providers don't want to reformat their content for the standards of different services.

- *playing with the toys.* What will these toys and tools let us do? Will teenagers decorate their home pages as they now decorate their rooms? How will consumers actually spend their time and increasingly scarce attention? How will businesses operate when everyone's connected all the time, everywhere?

- *rebellious toys.* What happens when the toys get minds of their own? What will happen when agents -- some of them distinguishable from viruses only by attitude -- roam the Net? How will they interact? How can we ensure system integrity?

- *the bullies down the street.* Will we be able to keep our toys, or will the rich bully grab them away? Is the online world really a new kind of market where diversity rather than standards will reign?

- *sharing with other children.* Do all these mergers make sense? The behemoths are all buying content companies, sure such alliances will ensure their futures, while content companies are looking for distribution and access. Is it worth it to own a content company? Content wants to find its way to all consumers; delivery media want to deliver all content. Exclusives are no longer bottlenecks that allow an owner to charge a toll; they're detours that will be bypassed in the long run.

- *parental control.* Who's going to control the Net? Like it or not, the government wants a say. But commerce won't move onto the Net without strong security, and international commerce will be tough without global agreements on standards for intellectual property, authentication and the like. Meanwhile, how will governments (such as Germany!) react to a world that ignores traditional national borders?

- *lemonade stand or allowance.* Will we get paid for content or for intellectual services around content -- searching, reliable delivery (subscriptions), consulting, performances, authentication, exchange and brokerage services? Will advertisers pay for it all? Who gets to keep the revenues?

- *the bills.* Are telcos ignoring the economics of the Internet just as the mainframe vendors of old ignored the economics of PCs? In the long run, the Internet brings economies of scale down to small players -- whether customers or providers. Anyone can afford to be a provider; anyone can market his goods worldwide.

Join us next March in Tucson, where we'll consider all these questions. Seriously...

We'll have speeches and panels, debates and audience interaction. We also plan a special activities with the consumers of the future -- your children.

We'll also have presentations from interesting new companies such as Aleph, Connect, Electric Communities, the Electronic Rights Management Group, Far-Cast, GNN, Net Objects, OnLive!, Saqqara Systems and Worlds plus our own Rumpus Room full of "future now" products and services organized by Jerry Michalski.

We hope to see you there, along with the "future now" customers -- your families.

Speakers will include:

Jim Barksdale, Netscape
David Beirne, Ramsey/Beirne
Steve Case, America Online
Scott Cook, Intuit
John B. Evans, R.E.M. Productions
Bran Ferren, Walt Disney Imagineering
Bob Frankenberg, Novell
Frank Fukuyama, Rand Corporation, author of *Trust*
Will Hearst, @Home
Jack Hidary, EarthWeb
Bill Joy, Sun Microsystems
Jerry Kaplan, OnSale
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