Environment and Planning A 2002, volume 34, pages 1523 – 1533

DOI:10.1068/a35176

Report

Crisis, recovery, innovation: responsive organization after September 11

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Received 30 June 2002

Abstract. After the attack on the World Trade Center on September 11, many firms, directly affected by the attack, resumed trading when markets reopened less than a week later. How were these companies able to respond, working under conditions of fear and grief, so quickly and effectively? Drawing on conversations with executives and employees in financial service firms with offices in the World Trade Center and adjacent buildings, this report documents the importance of strong personal ties, lateral self-organization, and nonhierarchical relations in the recovery process. As a response to uncertainty, organizational factors that explain recovery are similar to those that generate innovation.

> "Without that human element of commitment to task, commitment to each other, preparedness wouldn't have done anything. The best plan never would have been opened up."
>
> A World Trade Center firm manager

In a process that started on the awful day itself, and will continue, September 11 poses a knot of challenges and lessons that the business community must strive to untangle. What does it mean to be prepared for uncertainty? How can we protect our information technology infrastructure? How can we decentralize our locations and intellectual capital? How can we adjust our risk exposure so we are protected, and yet remain competitive? Technology experts were deployed to solve the infrastructure problem, management specialists convened to look at organisational issues, and risk gurus huddled to discuss the implications for risk management. Without the luxury of being able to wait for direction from experts, men and women in World Trade Center (WTC) and other downtown New York firms worked under conditions of unimaginable stress to recover their businesses and steel themselves for the future. In a great many cases, their achievements in the days and months after 9/11 have been staggeringly impressive.

What we did in those first two weeks was absolutely outstanding. I just wish we could repeat it going forward.

People in the trenches see things up-close and everyday that clusters of specialists often put on a pedestal they keep over in the corner somewhere. The challenges of technology and management innovation are complexly intertwined, as are long-term preparedness and the day-to-day ability of staff to work well together. In learning from 9/11, it pays not to keep social (management) and technical challenges in different columns, but to consider both as aspects of the complex *sociotechnical* networks that define the contemporary firm.

Our work in the last few years has approached similar questions from complementary directions, looking at how technology is designed to facilitate human and organizational needs as well as how people and organizations adapt to and shape technology. On September 11, one of us (David) was working on an ethnographic

study of the trading room of a major financial firm in the World Financial Centre (adjacent to the WTC). After the attack, we saw how the management team coped with the crisis.

When they regrouped in New Jersey on the night of September 11, the consensus was that it would take between three weeks and three months to be ready to trade again. Six days later, when the equities markets opened on September 17, they were trading. This kind of "crisis achievement", in the words of an executive of another major financial firm, was characteristic of firms that were able to get back on their feet quickly while suffering from the worst forms of duress imaginable.

How did this happen? And not just for international securities firms, but for so many others who suffered major loss, whose places of work were destroyed, and whose employees were displaced and often dispersed?

As researchers at Columbia University, we've studied many groups in downtown New York City, including some in the WTC. The attack gave somber urgency to seemingly academic issues, and we began speaking with people from firms in or near Ground Zero. That anyone in the center of the maelstrom could possibly find time to talk to us in the days and months after 9/11 was remarkable. The fact that many really wanted to speak, and did so in a spirit of openness, candor, and contribution to the general good, was stunning. We cannot overstate our admiration for them.

We talked with people in numerous firms, individually and in groups. We talked with people in large companies, as well as small and medium-sized firms. We made extra efforts to speak with people responsible for technology and people responsible for contingency planning, preparedness, and continuity management.

And what did they tell us? No one said, "Our technology saved us", or, "Our plan really worked." To a person, they said, "It was people."

On December 5, 2001, we held a roundtable discussion with senior IT and communications executives from key WTC firms, as well as major consulting and technology firms. The companies included Merrill Lynch, Cantor Fitzgerald, Deutsche Bank, Sun Microsystems, SunGard, Fred Alger Associates, and other medium and small-size firms. We include here quotations from that conversation (anonymously, as per the agreement with our participants). Among the most memorable stories we heard was the following, from one WTC executive:

> "We had 47 hours to get [ready for] September 13th, when the bond markets reopened and there was one situation that our technology department had that they spent more time on than anything else.... It was getting into the systems, [figuring out] the IDs of the systems because so many people had died and the people that knew how to get into those systems and who knew the backup... and the second emergency guy were all gone. The way that they got into those systems? They sat around the group, they talked about where they went on vacation, what their kids' names were, what their wives' names were, what their dogs' names were, you know, every imaginable thing about their personal life. And the fact that we knew things about their personal life to break into those IDs and into the systems to be able to get the technology up and running before the bond market opened, I think [that] is probably the number one connection between technology, communication, and sociology."

In the months after September 11, we saw a lot of attention paid to the key infrastructure issues of communications and information security. Lower Manhattan is an important center for American telecommunications as well as the global financial system, and the terrorist attack revealed the vulnerabilities of both. Financial giants and small firms alike faced the loss of critical information and communications systems. These are the nervous system of the contemporary organization.

But consider the case of this participant's firm. Despite the destruction of their offices in downtown Manhattan, vital information systems were fully protected. Almost. They had adopted a strategy of concurrent computing after the 1993 bombing of the WTC, with their systems mirrored in two distant locations, one overseas. In the event of failure in one location, another could take over. Their business, under incredible stress, was at stake. Their information infrastructure was challenged, but essentially good to go. They could get New York ready, but they needed critical passwords that were lost with the colleagues they now mourned. And what saved the day, and perhaps the firm, was how well they knew each other.

And it was not how well they knew each other in a professional capacity that made the difference. It wasn't knowing who always gets work done on time, who is a strategic thinker, or who is good at handling the boss. The key in this case was how well they knew each other personally—all the details of private life that are, in the strict sense, irrelevant to their status as coworkers. With so much attention on how to create resilient, self-healing technological networks, here was compelling testimony to the resilience and self-healing capacity of *social* networks. And we heard similar things from many representatives of directly affected firms—about the importance during crisis of personal commitment, feeling like a family, individual empowerment, and 'lateral teams.'

Many of the issues now facing large firms were not created on September 11, but this tragedy has given them heightened salience. Firms seek to protect themselves from dangerous uncertainties. They understand that deep organizational issues exist at every level, from the boardroom to the work group. They feel the pressure to decentralize their locations, disperse their intellectual capital, and yet maintain the strong bonds of trust and mutual dedication that many saw as the foundation of success in their own firm's crisis response. And they are very concerned about the classic problem of risk management, how to negotiate the trade-off between security and profitability, between preparedness and competitiveness.

In facing the challenges of the future, it is helpful to ask whether we can find connections between the qualities that promote successful crisis response and other characteristics of businesses, things we already understand pretty well. Recovery is a response to extreme uncertainty. We know that successful businesses innovate in the face of the normal uncertainty of the marketplace. Perhaps crisis recovery can be seen as a form of innovation. And perhaps the factors that explain success in both are similar. Viewed this way, it is possible that metrics to measure preparedness could look very similar to metrics for innovation.

Could this way of looking at things point to another way through the risk-management dilemma? Are there strategies that can make organizations both more prepared for disaster and more competitive in the long run? What role do communications technologies play? Some of the central assumptions about using technology as a lever for organizational innovation may be inadequate, even potentially harmful.

Infrastructure to interface

All of the US employees of the company were either on MSN messenger or in ICQ, inside their little instant messengers, talking to each other…

Firms, baseball teams, families, nations, virtually any form of human association can be viewed as networks. Today, these networks are heavily mediated by technical systems. It would be difficult to run even a children's soccer team without phone calls to organize carpools. Try running a multinational corporation without electronic communications. Our organizations—firms, governments, almost everything—can

be viewed as *sociotechnical* networks, wherein human practices and technological affordances negotiate an evolving structural equilibrium.

The problem this team of coworkers solved was not strictly a technical problem—their computing infrastructure was functional. Nor was it strictly a human problem—there were plenty of these to be sure, the firm had lost a lot of people. This problem was about the *interface* between people and their technology. There was a breakdown at a key point of this interface, the use of passwords to regulate human command and control of the technical systems.

Interface is not a *boundary*, separating us from our technology, but a border that is usually traversed transparently in our practices of using technology to mediate our social behavior. Normally, an interface is working best when we are not aware of it. Once basic skills and tasks are sedimented in muscle memory and cognitive models, we are mainly aware of our social objectives rather than all the button-pressing we have to do to manage them. When interfaces break down we really notice them and see how they are working.

There were people that didn't have laptops or machines at home that went down to Internet cafes...

In speaking with people from affected firms we expected to hear a lot of observations about how people used technology in the 9/11 aftermath—which technologies succeeded, which failed, where technology investment would likely go in the future, etc.

In fact, we did hear a lot about these things. From the time the planes hit, until the restoration weeks later of stable telecommunications services and working environments, new communications technologies played an especially large role. E-mail, the web, virtual private networks (VPNs), Instant Messaging, mobile communicators (like Blackberries), online chat rooms, cybercafes, and other technologies we have adopted over the last decade were essential to many of those struggling to weather the crisis.

If you empower people to think outside the box, you give them the authority to solve a problem, they will solve it. I can't stress that enough.

And yet, in the eyes of our witnesses, the story was not the technologies themselves, but what they allowed people to do. The lessons were largely organizational. We heard a lot about teamwork, motivation, cross-training, and managing decentralized organizations. In marked contrast to the mood just a few years ago, new technologies in themselves, viewed from a corporate investment standpoint, were more a source of wariness than optimism.

One participant summed up this skepticism nicely:

> "Large corporations right now feel as if in a lot of ways they have really been violated by technology and by the business of technology and the capital market's power of technology... . That their obsolescence or absence of preparedness was sold to them in exchange for this proliferation of this technology, that technology, this solution, that solution, this license, that license... . It's time to yield a return before anybody continues to spend more prolifically.

It is important to note that some of the technologies that were most critical in the early hours and days—like Instant Messenger (IM) and hurriedly prepared, information-rich but design-poor websites—were not the products of strategic corporate investment. Rather these now-common innovations derive their value from the network effects of mass cultural adoption over the last decade. It was clear that some core corporate systems—like data backup, remote network access, and automated call systems—had proven their value as well.

What made the difference ... for every company that came back successfully [was] that kind of touch, high-touch, low-tech solution.

There was little interest (though some) in the relative merits of different technological solutions. On the corporate level, Firm X used concurrent computing to protect data and functionality, firm Y used remote server backups—both worked. On the individual level it became truly interesting. The e-mail is down, use phones. The phones aren't working, use Instant Messenger. Your office is gone, find a cybercafe or dust off an old laptop and log in from home. It wasn't always easy, but finding the working channel and innovating around it looked like second nature for employees at some firms.

This was significant to us because it has bearing on the long discussion within the social sciences about how technology and organizational change are related. In one extreme, the standpoint of *technological determinism*, the causal arrows point from technology to social structure, that is, technologies themselves contain the seeds of particular organizational adaptation. In the other extreme, the arrows point in the opposite direction, social needs and cultural assumptions are 'inscribed' upon technologies during their development and predetermine their use.

We didn't even think about what was going around us ... .We had to do what we knew how to do, which was communicate.

What we have heard supports a more nuanced, dynamic view, in which people work to accomplish their objectives within an ecology of technologies available to them. In this view, the active structure of an organization and its technology evolve reciprocally. The key questions, to which we will return later, are about the details—especially the unintended social consequences of particular technologies, their design, and the practices of their use. These questions center on the interface of organizations and technology. Answering them can help provide essential guidance for managers seeking to use technology to support organizational change, and for technology designers creating the next generation of systems.

Prepared vs competitive... Or, prepared = competitive?

One senior banking executive told us:

> "Going forward, companies are going to be valued on something that I would call preparedness. I think that that is going to become an integral part of how investors, employees, fiduciaries, everybody, counterparties, everyone looks at a company's worthiness".

If you're talking about measuring preparedness, how effectively can they work and collaborate?

What would it mean to rate a company for preparedness? Redundant information systems?—of course. Thorough disaster planning?—yes. Cash in the bank and sufficient insurance?—OK. But what about assigning metrics for corporate governance, geographic dispersal, or management structure? And how would you value intangibles like employee motivation, work-group cohesion, or corporate culture? Judging from our conversations, the latter are as critical as the former to surviving disaster.

Central to understanding the challenge is a consideration of the complex nature of *redundancy*. Redundancy in the workplace is usually thought about in *replicative* terms. We replicate our data and infrastructure to achieve the protections of redundancy, just as we cross-train employees and sometimes maintain multiple folks who can do the same job. All of these replicative strategies have a price tag, and are thus part of the risk-management calculus.

But we should also consider another, *generative*, form of redundancy. Just as we have multiple channels of communication in our technological ecology, some organizations feature similar redundancies of ties among members. If a link in the org chart is broken, there can be several ways around it. This is not a redundancy of more people or tools, but one of more complex patterns of organizational ties. It is *generative* in the sense that the network can *regenerate* around blockages, and that organizations with these structures can be more innovative and adaptable to changing circumstances.

Risk management versus shareholder and profit interest are eventually going to be very, very critical issues.

For those outside a firm, a preparedness rating could be a welcome data point for investment calculus. Within the firm, it would help with the problem of maximizing shareholder value and competitiveness (tied to efficiency) on the one hand, and minimizing risk on the other, by pushing the compromise point in the direction of enhanced risk protection.

But even with this, there would still be a trade-off between efficiency and risk protection. In the conventional wisdom, this would continue to act as a brake on efforts to enhance the protection of intellectual capital and corporate knowledge, insofar as achieving the latter is understood to require spending money on things like redundant personnel, cross-training employees, and advanced technology solutions.

Another piece to the puzzle now is that it is hard to assess risk for terrorist attacks of horrendous proportions. Risk management requires identifying the probabilities of an array of measurable outcomes. We face uncertain probabilities and incalculable outcomes. In this environment, we are tempted to talk in terms of *uncertainty* rather than *risk*. And how can you prepare a company for uncertainty? Or worse, how can you measure preparedness for uncertainty?

As one participant noted,

> "We're never going to have this happen to us again when another bomb goes off in the basement or garage of the World Trade Center, but you know there are so many different levels of what happened in this tragedy that how do you prepare yourself for something that is truly the unseen?"

Consider another trade-off faced by firms seeking efficiency. This efficiency is usually sought by taking what is known to work, and streamlining the organization to do these things at a minimum cost. Generally, this efficiency is achieved at the cost of organizational diversity.

I know many companies ... . They've gone through the motions. They really don't have a viable plan, but they have a piece of paper that says they have a plan.

Many firms are familiar with the problems of a rigidly 'efficient organization'. A firm that has translated its operational knowledge into an efficient structure often finds it needs to accomplish forward thinking and innovation outside of this structure, via a range of mechanisms such as task forces, project teams, and 'skunkworks' programs. There is a tension between efficiency and innovation, between short-term adaptation and long-term adaptability, and potentially, therefore, between short-term and long-term competitiveness.

We can distinguish between two extremes on the organizational spectrum. Hierarchies, the form of the traditional firm, are characterized by relationships of *dependence*. Power and knowledge flow vertically through a hierarchy of fixed positions, determining action. Markets, on the other hand, are characterized by relationships of *independence*. Action is determined by comparative evaluation of a free range of options. In the tradition of organizational ecology, at the level of the economic system adaptability is gained through a diverse 'gene pool' of competing organizations

locked in a Darwinian contest. Those with the most efficient structures will outcompete others in the free marketplace. The greater the variety of organizational forms in the marketplace, the more robustly adaptable the system.

But increasingly well understood is another form of organization. 'Heterarchies' are characterized by relationships of *interdependence*, by lateral and distributed authority, and an internal diversity of organizational forms. Heterarchical networks also exhibit qualities of emergent self-organization, strong lateral ties, and a diverse distribution of knowledge and empowerment at lower levels of the organization. Case studies of British advertising firms, the trading rooms of international investment banks, and American biotechnology ventures, among others, indicate the adaptive advantages of heterarchical organizational forms under conditions of uncertainty.

An overwhelming message is how resilient, creative, innovative people are in a crisis, and that's the hardest thing to measure.

In fact, much of the crisis-response behavior so critical to the success of many WTC firms looks much like the normal behavior of heterarchical systems. Lower level employees were given broad responsibilities and empowered to act outside the normal command structure. Work teams self-organized to find solutions. Networks of firms, reaching across the boundaries of client and vendor, worked together with unprecedented levels of collaboration to recover together as a group.

After September 11, firms are adjusting their risk management calculations to come to grips with new uncertainties. A critical component of assessing uncertainty is understanding your 'strategy horizons', and then thinking in terms of a 'fitness landscape' that stretches in front of you. Success in this landscape requires long-term competitive robustness. Understanding the dynamics of heterarchical systems could point to strategies for achieving greater preparedness as well as greater long-term competitive adaptability.

Information technology design and organizational change

Clearly new information technologies are central to organizational innovation. We have come a long way from the days of the telegraph, when hierarchical bureaucracies were themselves seen as solutions to the problem of efficient communications. Whatever ongoing virtues traditional organizational structures possess, they cannot claim to maximize the benefits of current information technology. Quite the opposite, new technologies are generally seen to undermine traditional hierarchical authority, short-circuiting vertical lines of communication, and promoting strong lateral ties. Indeed, some interesting research looks at the many ways that hierarchically organized staff react to the socially flattening medium of e-mail by struggling to reintroduce 'positioning protocols' readily available to them in the meeting room.

We all know the technology, what it can enable a company to do. The management of the organization, I keep seeing that as a major obstacle.

During the technology boom of the 1990s, the idea that new technologies and do-or-die organizational adaptations go hand-in-hand was a powerful marketing tool for technology vendors, design firms, and e-consultancies. Internet technologies promised new ways to structure corporate communications, allowing more decentralized and location-independent operations. Telecommuting, videoconferencing, and online collaborations were seen as key tools for the innovative organization. Corporate intranets were designed to collect a firm's knowledge, make it available to individuals, provide effective communication and collaboration tools, and build a sense of community that could knit far-flung staff into a more seamless team.

Extranets tied the firm's members to a burgeoning external universe of information and communications. Mobile wireless devices kept everyone connected, wherever they were.

That, at least, was the idea. In the minds of many, however, this vision succeeded more by stoking fears of falling behind than by laying out a clear roadmap to new modes of organizational efficiency. In the aftermath of the dot-com collapse there was understandable skepticism about the promises of the 1990s. Is telecommuting a way for employees to get more work done, or avoid doing more work? Is your team of heavy travelers more efficient staying geographically dispersed and working together in an ongoing online collaboration, or working more independently on the road but getting together in-person at regular intervals for face-to-face meetings? Are knowledge management systems essential new tools for creating smart organizations, or an expensive ticket to employee frustration and low morale? It is natural to wonder which innovation concepts should be carried forward, and which ones should go the way of the boardroom football table.

We have decidedly rethought our strategy of having all mission critical applications and functions ... in one location, and that just is not restricted to buildings but geography.

The attack on September 11 has provided a clear basis for considering many of these issues. Major firms now face pressure to decentralize their organizations and disperse key operations and intellectual capital among enough locations to survive any conceivable terrorist threat. How can they do this and not sacrifice efficiency, morale, and organizational cohesion?

It is tempting to pose the question as many have before, asking in essence how we can use technology to replicate in several locations the same interactions we formerly had in one. There is a tradition of viewing face-to-face (F2F) communications, that is, talking to someone physically present, as a medium itself. Talking across a desk, meeting around a table, gossiping by the water cooler—these examples of F2F interactions are seen as rich in the exchange of meaning, and able to take full advantage of the human communicative bandwidth. When thusly collocated, we have facial expressions, vocal subtleties, body language, and indeed a whole range of social cues available to us. Face-to-face is in one sense our 'perfect' medium.

In this tradition, technologically mediated communications comprise a grab bag of less-perfect mediums, each with its own set of limitations on the natural 'bandwidth' of human F2F communications. The telephone can carry vocal emotion, but not facial gestures. Emotional context doesn't carry well in text, so avoid being sarcastic in e-mail unless you deploy a ;-) to let folks know you are joking. Online forums can generate fascinating discussions, but because social gestures essential to conversational command and control are not available, these may always be more chaotic and unfocused than discussions around a table. In fact, by looking closely at the use of different mediums, we see everywhere how people attempt corrective strategies to reintroduce control, status, emotional clarity, and other social features that are natural in face-to-face communications.

The problem with the tradition of viewing communication media this way is not with the validity of these kinds of observations, which are indeed fascinating and reveal a fertile research terrain. At issue is the fundamental conclusion drawn by many about how to solve this 'problem'. If we see our communications media stripping out social cues and otherwise compressing our naturally 'broadband' F2F human communications down to modem speed, how do we get the bandwidth back? The assumption, from designers of advanced virtual collaborative environments to managers investing in expensive video conferencing systems, has been that this state of affairs—limited 'social bandwidth'—represents a problem to be overcome the way one overcomes a slow dialup

connection by installing a T1 line. What we need, the thinking goes, is to develop mediated communications that are capable of replicating the full social presence of F2F communications, and beyond that, to design online environments around interaction metaphors that mimic the ways we behave socially in our work environments.

Simple human contact is something we shouldn't design out of the solutions at all.

While intuitive, this way of thinking about the problem masks a number of assumptions that should be questioned. Have we confused *technical* efficiency and *social* efficiency? Is F2F actually more socially efficient than other modes of communicating? Are social efficiency and work efficiency the same thing, and how do they correlate? How would you tell? Are the kinds of social cues and behaviors we can, even in theory, load back onto electronic media the principal basis of trust and cohesion within working groups? And why do we assume that the team or work group is the level of organization that must be addressed when designing advanced communication and distance collaboration strategies?

Once we start asking these kinds of questions, we open a Pandora's Box. Consider just three common assumptions.

Common assumption 1: *Face-to-face is the most efficient mode of communication.*

Are face-to-face environments the most efficient for getting things done? The answer is a resounding 'it depends'. There are some types of collaborative work that appear in many ways to proceed best at a distance, over a long period of time, and with only occasional face-to-face encounters—scholarship being one example. Even for types of intensively collaborative, time-critical group work, research suggests that face-to-face interaction is the most efficient in certain respects only, and in ways that may confer advantage only during certain phases of the project at hand. One study of three modes of project collaboration between architects—face-to-face, videoconferencing with virtual whiteboard, and online text chat with virtual whiteboard—found that in some respects, text chat was 'superior' to face-to-face, though in other dimensions face-to-face won out. Surprisingly, given 'social presence' concepts discussed above, text chat outperformed videoconferencing in all measured respects. Even a cursory look at repeated consumer rejection of commercial videophone trials going back to the 1950s demonstrates how the opportunity for transmitting enhanced social cues can entail more obligatory social 'overhead' than communicative benefit. People hated having to do things like comb their hair and put on a shirt before having a phone call. Today among early adopters of NTT's FOMA cellular videophones, recently released in Japan, a lot of (expensive) time is often spent 'bowing' at the camera.

This is not to say anything as drastic as 'videoconferencing is a bad idea', just that communications tools have complex implications, and often unintended social consequences. One investment bank executive reported that, although some kinds of decisionmaking go more smoothly in a videoconference, the technology increasingly causes problems of trust across firm boundaries. Folks from firm Y have problems trusting folks from firm X in a teleconference when they suspect their opposite numbers are signaling each other with video.

Common Assumption 2: *Rich social communication is the foundation of trust and cohesion within work groups.*

There is little doubt that people who trust each other in the workplace often maintain a strong layer of personal, emotive interaction beyond their strictly professional dealings. We expect that the sharing of personal information and experience,

and the accumulation of many small, informal interactions, go hand-in-hand with trusting, collegial relations. But we should be careful not to confuse cause and effect. Do we trust those with whom we share personal information, or do we share personal information with those we trust? There is a reciprocal relationship between these things clearly, but consider that some research indicates that the key to establishing trust is in how you handle *presence unavailability*, rather than *presence availability*. In other words, your coworkers choose to trust you or not mainly on the basis of how you indicate to them that you *don't have time to talk right now*, rather than your behavior when you do have time to talk. How can you replicate that interaction in electronic communications, which you engage with only when you have time?

Common Assumption 3: *The design of advanced communications environments should focus on supporting efficient collaborative work groups*

How are they going to be as effective or perhaps more effective as they get more and more fragmented?

A dominant tradition in the development of computer-supported cooperative work (CSCW) is the focus on designing solutions for the work group. From Lotus Notes to advanced, 3D simulated virtual environments, a lot of funding and effort have gone into finding ways to enable work groups to collaborate at a distance as effectively as they can in the same location—often to the exclusion of investment in other communications design strategies. And yet it is not clear that small work groups are actually the organizational unit most in need of advanced, specially designed support. Consider the experience of many firms in the crisis. Routine communications were disrupted, major systems were often unavailable or constrained, and yet physically separated teams were quite capable of using whatever technology they had at hand to coordinate, plan, and execute with superb efficiency under great duress. Even looking at normal operating experiences, one must consider the degree to which motivated people working together need highly designed products to help them do what they seem naturally adept at doing anyway. Problematically, the designs of some systems may be built upon assumptions that are not universally applicable, and can artificially constrain group behavior in ways potentially detrimental to its performance. The focus on social cues, overt representations of individual status and work processes sometimes force us to manage again on the screen what we are already very good at managing in our heads. Do we really benefit from taking transparent cognitive representations and turning them into mediated visualizations? It is a problem faced in using interactive media for education as well, where you must be careful not to offload to the hard drive things that you really want to be happening in neurons.

[We were] already highly communicative and worked together very well as a team, which became the essence of how we were able to recover.

Indeed there are a great many important challenges in the design of communications technology. Advanced digital media do offer unprecedented opportunities for supporting geographically dispersed, highly collaborative organizations—the kind we need to build if we seek protection from the risks of concentration. But the key questions are more complicated than often assumed.

Final thoughts

The organizations that had a culture of dispersed employees ... functioned a lot better during the emergency than those that were traditionally organized ...

The terrorist attack on the World Trade Center challenged a number of firms to cope with extreme difficulties. We saw the threatened breakdown, and remarkable healing capacity, of our networks, human and technological alike. We also saw the breakdown of the *interface* between the two, where they combine as *sociotechnical* networks.

Firms ask, "How can we be prepared?" Like adding more insurance, traditional redundancy strategies can be costly. If the characteristics of firms that are successful at adapting to uncertain conditions are similar to those exhibited by firms that recover well in times of crisis, there may be nontraditional answers to the question.

Can the features of organizations built for innovation function in more traditional firms? It remains to be seen how this can be done, as either a day-to-day reality or a set of techniques kept in the back pocket until crisis breaks. But judging from the experiences shared by our direct witnesses, it did happen in many firms, during the worst crisis they had ever faced.