Wall Street LAWYER
Securities in the Electronic Age
October 2012 ■ Volume 16 ■ Issue 10

Unaddressed Consequences: Decisions, Mindsets & Risks in a Complex Network of Interconnected Systems

BY CHARLES J. HESS & KENNETH R. HEY

Charles J. Hess is Co-founder and Managing Partner and Kenneth R. Hey is Managing Partner and Writer at Inferential Focus, Inc., a New York City-based consulting firm that offers corporate, institutional investor, private equity, and government clients business intelligence and change-detection services. Contact: charles.hess@inferentialfocus.com or key.hey@inferentialfocus.com.

Prediction is very difficult, especially if it's about the future.

—Nils Bohr, Nobel Laureate in Physics

Poor Humans

Science, a product of the rational human mind, has over the years undermined traditional human self-imagery, especially as that imagery represented an elevated status in the universe. Copernicus, by proving that the world revolves around the sun and not the other way around, cast humans from their self-created role as the center of the universe. Darwin, who pieced together the great evolutionary theory that explained the "origins" of human beings in other life forms, discredited the popular view that humans were made in God's image. Freud, who noted that subconscious yearnings and biological needs drive human actions, suggested that humans were not actually in control of their own behavior. More recently, the Human Genome Project, which outlined the genetic structures of life, revealed that humans were not that different from "lesser" forms of life. And finally, modern brain research has shown that conscious decisions actually follow decisions made by the subconscious brain by as much as 1.5 seconds, leaving the conscious brain to rationalize the decision by highlighting this or that piece of information–which is to say, we are not truly rational beings with outright free will.

That is quite a series of comeuppances for the one-time supreme creature of the Great Chain of Being. So it comes as a kind of historical irony that the same scientific and technological advances that have so often undermined human egocentrism have also given rise to a contemporary spurt of narcissism, if recent studies are to be believed. That is, the very capabilities that created the information age, which has in turn overwhelmed the brain's ability to assimilate or even understand what is being generated, should support a level of confidence that defies that same reality.

What gives? More to the point, what unforeseen risks lurk where human perspectives on reality are blinded by inaccurate human beliefs? What are the unanticipated and unaddressed risks, legal and financial, that can result when humans, who cannot effectively manage the flood of information their machines are generating, nonetheless believe they are in control? Plenty, as it turns out.

Perhaps looking backward again might be helpful. While the average human being might not like what he reads in Darwin's *On the*

Origin of Species (1859) or Freud's *The Interpretation of Dreams* (1899), he or she can at least grasp most of what was written. But the average human cannot read and understand Einstein's essays on relativity or subsequent scientific papers explaining things like quantum mechanics, string theory and the genomic code. An entire category of scientific information went off in a direction inaccessible to the average human being. In its place started emerging a pile of data about this and that, billions of bits (or bytes) of new information that surface daily. With the combination of growing ignorance about an entire category of knowledge (encouraging simplistic answers in response) and with a tidal wave of information both trivial and meaningful (with little differentiation), humans, whose self-image has already been set back by scientific discoveries, were becoming victims again, this time drowning in data of their own creation.

And then came the search engine, databases, apps and so on—software illusions encouraging a feeling of control. Soon, digital natives felt back on top of the world. If desired, they could gather only the information that complemented what they already knew; entertain themselves only with content they cared about; and communicate only with whom they chose (the so-called *Daily We*). Far from being cast from the center of the universe, which Copernicus did to their ancestors, the digitally adept felt they were at the center of their very own creation. Far from being creatures shaped by their environment, as Darwin had intimated, Internet masters were creating their own environment, and it was evolving as they dictated. Unlike Freud's postulation that humans do not control their own behavior, users' virtual selves seemed to be under their complete control. No matter what the genome suggests, humans with the Internet were once again unique in this new digitally enabled "second life" world. And so the narcissism arises, and the human ego seems to be off its life support and free to roam a world of its own making.

This self-satisfaction with what humans have wrought, however, has created its own huge problem: a belief that risk has been conquered. Humans can tempt nature's imbalance, create amazingly innovative financial instruments, push profits over and against stability and focus exclusively on near-term gains rather than long-term problems, all because risk has been controlled. Yet even while clinging to the idea that risks are now under control, humans have been experiencing a series of crises—financial, agricultural, economic and environmental—each one seemingly larger and more damaging than the one before. What are the risks of believing in a risk-free environment? What are the consequences of believing that humans are in control of the risks that abound around them?

I Give Up. Who (What) Is in Charge?

In this amazing rise in technological confidence, one small problem remains: The sense of control is an illusion. Information tidal waves never crest; they only get larger and larger. In doing so, they force changes in human behavior. The Internet is now part of the human environment, and true to Darwinian logic, the ever-expanding, digitized environment is forcing human adaptation and thereby altering human beings. Nicholas Carr in *The Shallows: What the Internet Is Doing to Our Brains* (2010) outlines the many changes taking place in the human brain because of its interaction with the Internet. Where does that lead? Carr, who originally set out his ideas in an article for the *Atlantic Monthly* entitled "Is Google Making Us Stupid?" says this kind of constant distraction leads the human brain back to pre-civilization days, when alertness to interruptions in sight and sound were part of a survival skill set. Chinese scientists who have actually located substantive physiological changes in the brain because of connection to the Internet have suggested creating clinics for those whose overuse has made them Internet dependent.

Darwin might be surprised at Carr's suggestion of negative evolution, but Marshall McLuhan, who insisted that every step forward in technology represents two steps backward in other areas, would not be. Last year, when individuals with affluent lifestyles were asked how their lives had changed in the past decade, the most frequently cited change was how their lives had become "infused with technology." The next two changes the survey participants cited were that their lives were "more complicated" and "more stressful"—one step forward and two back.

Systems, including the Internet, have made the contemporary world more sophisticated and more complex to the point that humans cannot actually control the way systems interact and what they can cause. As a result, additional technology is necessary to monitor

and guide increasingly complicated digitized systems. And so it goes: more speed and sophistication in the technology mean more complexity, which results in more dependence on that technology, which, then, requires more technology to operate and monitor the original technology. In August, the Knight Capital Group, a market-making financial institution faced an enterprise risk when its autonomous, high-speed trading system went awry with no input to call a halt to the erroneous trading that the software was generating. In the end, Knight lost more than $400 million in less than an hour.

Machines are becoming necessary to monitor what other machines are doing, essentially because what some machines are doing is taking place too fast and at too sophisticated a level for mere humans to keep pace. Consequently, humans seem to have been cast out of their self-centered, always-in-control Eden, a world of control created by their own imaginations, and thrown into a world where risk management depends on machines and software, all prone to glitches and more human errors.

Braden Allenby and Daniel Sarewitz, professors of science and engineering, respectively, at Arizona State University, describe three levels of technological complexity, and suggest those levels are little understood or appreciated in contemporary society. Level One is simply a technology and its purpose—say, a nuclear reactor and the energy it creates. Level Two involves the integration of that technology with various other systems—that nuclear reactor linked to a massive electricity grid that spreads across a region, linking, in turn, to other systems, such as those in manufacturing, transportation, information and communications. Level Three involves the intersection of the integrated complex systems with a further array of systems, man-made and natural, say, tectonic plates, weather systems, cultural and social networks, and economic development. Somewhere in the middle of Level Two and across all of Level Three, human control loosens, which increases the likelihood of problems in one system triggering troubles in connected systems, often unanticipated and therefore unaddressed prior to a crisis. For instance, the Japanese disaster at the Fukushima Daiichi nuclear power plant started with an offshore earthquake, which triggered a tsunami that swamped the nuclear plant, overwhelmed its backup systems and caused a meltdown, which broke down the electrical-grid system, disrupted social systems, nearly collapsed the economic system, overloaded the healthcare system (which has yet to reach the peak of its troubles) and destabilized Japan's political system.

The cascading effects brought about by disrupted or failing systems spreading consequences to connected systems can get brushed aside in risk conversations as "unintended consequences" or "low-probability, high-impact" events. Often, that characterization encourages an indifference to such monumental consequences as in the Japan example—and so, systems have effects that have not been thought through. The complexity can defy simple rational thought; or, to put it in the context of levels of technology: The basic human rationality that seems to have control in Level One and some parts of Level Two is insufficient to comprehend, let alone manage, the interactions at Level Three.

Yet, systemic interactions at Level Three complexity are increasingly integral attributes of everyday operations, and to push them aside as remote possibilities can be costly. Witness the effects of the BP Plc oil-rig failure in 2010. The effects of the disaster spread from a weakened safety-shutdown device to the larger oil-retrieval system, which connected to a surrounding ecosystem that touched economic and ecological systems on shore, to where it ultimately destabilized local political systems. Were tourist networks onshore even aware of, let alone sufficiently prepared for, such an eventuality? Did they consider themselves systematically connected to the kinds of safety devices being purchased and installed on Gulf oil rigs? As they discovered, their insurance policies were not as helpful as they would have liked to redress the consequences of having not made such a connection.

In decision making, these complicated and little-understood cascading effects are typically labeled **long-term** (and unlikely) effects, while "real world" decisions, those most likely to land on an executive's desk, tend to be **short-term** effects. When short-term thinking is applied to a system that is interlinked with other, perhaps more complicated systems, risk exposure can become much more extreme. With systemic complexity reaching levels that rational minds cannot control on their own, the prospect of more and perhaps greater decision-making errors becomes possible. Structurally, that is what sets the stage for deep and significant Unaddressed Consequences. Most companies need to assess how the systems they routinely

depend on are connected to systems over which they have little control. What assessments processes are in place to consider endemic risks from interconnected systems and networks?

When Actions Turn Back on Themselves

In the area of sovereign covert operations, Blowback is a kind of Unaddressed Consequence and relates to actions taken for a positive effect that eventually trigger actions with unanticipated negative effects on the people who took the original action. The classic example involves the U.S. Central Intelligence Agency (CIA) supplying sophisticated weapons and training to Afghan insurgents fighting against the occupying forces of the Soviet Union in the 1980s. Eventually, those weapons became part of an arsenal managed by the Taliban and al Qaeda, with the Blowback effect of American weapons and tactics being used against American troops when they invaded Afghanistan a decade later.

Unaddressed Consequences and even Blowback are not the same as the effects attributed to so-called Black Swans, huge catastrophes that befall society from time to time. Such extreme events, according to Nassim Nicholas Taleb in *The Black Swan: The Impact of the Highly Improbable* (2007), are "unpredictable," are part of the "randomness in empirical reality" and relate to "what you don't know far more than what you know." Unlike Black Swan events, Unaddressed Consequences and Blowback result from not thinking through the likely chain of effects from human actions far enough. In essence, thinking only of near-term positive effects when deciding on an action can lead directly to negative effects in the long run; those effects are not the products of unpredictable, random events.

The wider term Unaddressed Consequences, beyond Blowback, refers to actions taken for short-term reasons that have negative long-term consequences—but not necessarily for those who received the short-term benefits. Consider this one example:

> **Part of the great increase in farm productivity in the U.S. over the past few decades is due to the application of chemical fertilizers to the soil to make plants grow faster and larger. Two of those chemicals, nitrogen and phosphorous, filled run-off troughs in the Midwest and eventually found their way to the Mississippi River and then to the Gulf of Mexico, where they fed an ever-expanding algae bloom, which when dying and decomposing feeds a wealth of bacteria that consumes all the oxygen in the area, starving life and creating Dead Zones—areas where no life exists. Essentially, fish leave the area and bottom-dwelling life dies off. This year's Gulf of Mexico Dead Zone covers a record 24,000 square kilometers.**

From enhancing crop yields across the great Midwest to killing all marine life in an area the size of New Jersey in the Gulf of Mexico, the agricultural system—via contact with the river network—creates devastating long-term effects on ecosystems (and related industries) far from the site of positive near-term effects. This is how Unaddressed Consequences can work.

But such negative feedback can be more direct. For instance, the U.S. government provided subsidies for the production of corn-based ethanol, thereby lessening carbon-based pollution and, in theory, decreasing dependence on imported oil. Yet the subsidies attracted so many farmers, who committed so many acres to ethanol-intended corn, that the market price for edible corn skyrocketed, affecting food supplies around the world and making tortillas, for instance, unaffordable for some in Mexico. More than likely, when decisions were being made about ways to reduce oil imports, the price of tortillas in Mexico never came up. The effect in Mexico, however, was substantial and triggered public demonstrations of discontent.

Higher corn prices can also create higher gas prices because oil-exporting countries are major importers of grains, and when corn and wheat prices increase, those countries need more revenues to buy the grains, which means they need higher oil prices. At some point, the interaction of food and energy systems with economic systems takes on a pace and a momentum of its own, or so the leaders of several Middle Eastern countries came to learn over the past two years.

Other kinds of Unaddressed Consequences occur so frequently that observers have become immune to their effects. For instance, the U.S. Centers for Disease Control (CDC) has reported that nearly 100,000 Americans

die each year from hospital-acquired infections, and another study shows that roughly 1.5 million patients are harmed by medical errors, costing the country $19.5 billion per year. Some healthcare managers claim that as long as their own hospital's mistakes do not exceed the national average, they are satisfied.

Systems interacting with systems make decision-making inside a "nest" of interlinked systems, complex and seemingly intractable (although some critics insist that it is entirely avoidable). In the medical example, for instance, the human body—a complicated system on its own—comes into contact with a product of an American education system (doctor), who is operating within a massive healthcare-providing system (hospitals, insurance/financial systems) and counting on care-giving systems (nurses, facilities) to work well with drug-dispensing systems (pharmaceutical companies, hospital distribution networks). Everything must go right, not only within each system but also at each of the contact points between systems, for healthcare to get delivered without errors. Moreover, errors anywhere can get magnified as those errors move through and affect other systems (from the wrong diagnosis all the way through the wrong drug administration). According to the CDC, something goes seriously wrong in hospitals thousands of times each day, and substantially wrong hundreds of thousands of times per day.

Fixing a problem in interlinked systems can trigger other Unaddressed Consequences. For instance, when Internet-security teams at the U.S. Federal Bureau of Investigation (FBI) broke through the Coreflood botnet computer virus, which at its peak had infected millions of computers worldwide, including more than 1 million in the U.S., they decided to send "kill" signals to those infected U.S. computers, thereby dismantling the embedded viruses. FBI officials planned to do so without informing the owners of the infected computers. The problem, however, was that officials did not really know what might happen should the kill signals themselves take an unanticipated path. "If it doesn't work," explained one security adviser, "we can't say where it might lead." Is that a reasonable tactic?

Officials with the Southern Company, an electricity provider to several southern states, plunged headlong into the deployment of home-based "smart meters" which enable both the homeowner as well as a central office to monitor and adjust energy usage in real time. The company envisioned increased efficiency, fewer outages and greater business continuity. What it failed to see were likely outlier effects that would result when the energy-providing grid system came into contact with a massive communications network (*i.e.*, the Internet). After installing more than 3.3 million devices, the company learned that such a system would make a cyber attack through the electrical grid much easier to execute. Southern decided not to switch on the smart meters while the company tries to configure a solution to a problem created by digitally interlinking systems.

Even when the interaction of complex systems is integrated into risk models, the possibilities can still get misrepresented. For instance, the Fukushima Daiichi nuclear plant was designed to withstand potential tsunami waves up to 19 feet high. The wave that hit the plant March 11 probably exceeded 45 feet in height. Planners knew something like a tsunami could reach the plant, which was built near the ocean, but they could not grasp the size or scope of such an event.

In these examples, human conceptualization of effects failed to grasp what kinds of consequences to anticipate and plan for. All of the examples share an interest in positive outcomes and have good intentions at the front end—whether that front end involves increasing crop yields, decreasing carbon-based pollution, providing good healthcare, being a more efficient energy supplier or generating needed electricity. Yet bad things resulted. When systems interact, a more sophisticated and extended assessment of potential risks is required. In today's environment, effective models developed in the era of discrete systems can lead to enterprise risk.

The "Backfire Effect" Doesn't Help

In 1954, a group of UFO devotees in Chicago awaited what they had predicted would occur on December 21: The world would end in cataclysm. When it did not, Leon Festinger, a psychologist from Stanford University, studied the cult leaders' responses. The leaders did not back down from their assertion, insisting, instead, that they had merely miscalculated the dates. In his report, Festinger concluded: "A man with a conviction is a hard man to change. Tell him you disagree and he turns away. Show him facts or figures and he questions your sources. Appeal to logic and he fails to see your point." Later researchers came to call this the "backfire effect," a mentally

strong, negative reaction to new information that challenges that person's viewpoint.

The backfire effect could be one of the biggest obstacles to acknowledging the range, depth and variety of consequences that can occur when actions within interlinked systems go awry. Thus, one of the biggest barriers to grasping the scope of Unaddressed Consequences could well be acknowledging that they exist in the first place, and that one's decisions related to them means culpability—that is, admitting vulnerability, recognizing the fact that the risks are higher than believed and accepting responsibility for addressing such effects.

The second-biggest barrier might be getting a handle on what kinds of systems could become involved, especially at Level Three complexity. For instance, the size of the earthquake and tsunami might have been influenced by melting icecaps, which are creating unclear kinds of weight shifts on relevant tectonic plates, which moved, in the Japanese instance, in extraordinary ways. Did planners and contractors of the Fukushima Daiichi plant consider climate change as a distorting system intersecting with the already complicated connections between oceanic and tectonic forces and the country's highly complex nuclear-energy system?

In *Zombie Economics: How Dead Ideas Still Walk Among Us* (2011), economist John Quiggin looks at why most economists have not adjusted their models, despite the collapse of several markets in different national economies, despite one of the worst economic events in the post-World War II era and despite the fact that actual events invalidated many of those very models. "It became apparent," he writes about his research into the economists' resistance to change, "that even the most dramatic evidence could not kill ideas that are embedded deeply enough in academic, popular and policy thinking."

The economic idea embedded in many managers' mindsets involves short-term thinking and a drive for more profits in that short term. But the bases for that quest for near-term profits are likely no longer dependable. Structural changes are altering social and economic dynamics. For instance, Robert Shiller, who helped create the Case-Shiller indexes of U.S. home prices, was forthright in his assessment of how today's reality had challenged his models and what that has meant for his work. When asked about the future of home prices, he admitted: "There's no precedent for this [current situation] statistically; so no way to predict [prices in the future]." That is, his models, all developed in the context of economic conditions that no longer exist, cannot be trusted.

Because many leaders have not been quite so honest, either with the public or perhaps themselves, and because some executives actually become more stubborn when confronted with these kinds of realities—that is, they succumb to the backfire effect—we anticipate more Unaddressed Consequences surfacing in the future. We can see many areas where such problems could yet erupt: nuclear reactor spent fuel, diet and childhood obesity, education cuts, "fracking" for natural gas, stem-cell research, genetic engineering, government financial obligations, water use, distribution and pollution, food production, energy, digital-technology vulnerabilities (cybercrime, cyberwar), infrastructure failures, high-frequency trading, nanotechnology, climate change, governmental strategies (or lack thereof), new financial instruments, nationalism, protectionism, have/have-not disparities, and higher structural unemployment... among others.

What's a Poor Leader to Do?

Historian H. W. Brands in *The Age of Gold: The California Gold Rush and the New American Dream* (2002) explained that the 1849 (and ensuing) rush to great riches in the hills of California presented Americans with a different perspective on work and reward. Benjamin Franklin's *Poor Richard's Almanac* (1732) and preachments from the Puritans had developed the idea that hard work, thrift, good character and long-term perseverance would eventually yield success and wealth. Brands' work explains that the gold rush taught Americans a different lesson: that character and hard work do not matter and that by expending energy in the short term and with considerable luck, great wealth can just fall into one's lap. Since that mid-nineteenth-century change, Brands suggests, Americans have lived with that cultural dichotomy—steady "progress to wealth" (the Franklin model) versus high-risk "get rich quick" (the gold rush model).

The Internet's effect on those involved with its development has favored the *Age of Gold*'s perspective of getting rich quick, despite the costly collapse of the dot-com bubble early in the twenty-first centu-

ry. The "New Economy" mindset created in the late 1990s did not disappear with the 2001 crash. Rather, the New Economy's belief that great wealth can come in a short period of time, whether with a piece of real estate, a hot IPO or a creative financial instrument, has spread across much of society, the damage from which is still being summed up as the housing/financial instruments crisis continues to waylay America's (and parts of the world's) economy. The current iteration of the digital gold mine involves applications, or apps, small pieces of software that execute one service, are created by individuals and then posted for sale around the world. Make the right app, and the gold rush becomes real.

That kind of thinking becomes a greater and more expansive risk when guiding increasingly complex networks of systems that comprise contemporary operational realities. In 2005, employees of several small towns in Norway did not know their pensions depended on real estate sales around Las Vegas, which, in turn, counted on curious financial instruments cranked out by Wall Street. The collapse of significant parts of the interlinked financial systems eventually made those connections clear.

Short-term thinking can bring immediate returns but can leave a large area of Unaddressed Consequences. We have identified a few significant responses to the risks involved in interlinked, complex systems. First, change the decision maker's mindset, and second, construct a different operational paradigm.

Changing the Decision Maker's Mindset

The general change needed is from a mindset that clings to all-knowing, clear, direct logical analyses to one that accepts its ignorance and seeks patterns and implications in a multi-dimensional dynamic field. The "can do" mindset with complete confidence in one's perspective increases the risks in the new complex, interconnected environment. This change of mindset is more difficult than it sounds, in part because interaction with the Internet itself is slowly rewiring the way the brain operates and is encouraging immediate, short-term responses: Do a search, get the answer. But that can be problematic when operating in a complex, interactive network of systems. Here are some reasons why:

- *Linearity Is So Nineteenth Century*–When systems intersect, straight-line reasoning no longer applies. Systems become geometric, multidimensional and multidirectional in their connections and their effects, which means...
- *Cause-and-Effect Analyses Are Insufficient*–Actions in and around systems have their own internal logic. As a result, consequences of systems' interactions do not always have a clear and direct *if-then* logic, which means...
- *Multiple Interlinked Systems Generate Seemingly Nonlinear Actions*–Systems in place touch systems that might not be part of a planning scenario and generate unanticipated consequences, which means...
- *Things "Under Control" Never Include All the Forces That Affect Outcomes*–This is what makes systems interactions so complex.

Constructing a Different Operational Paradigm

When the leaders' mindsets have shifted, then the way an institution operates has to change as well. Here are a few examples of what needs to be altered:

- *The Longer, the Better, the Further Afield, the More Complete*–Build processes that reward long-term thinking and that identify possible linked risks; or said another way, construct ways to mitigate the impact of short-term thinking. Netherlands' officials have realized that climate change represents a large risk–with the threat of rising sea-water levels potentially submerging whole sections of the country–and they have put in place a 100-year plan for dealing with those eventualities.
- *Do It Again, Do It Again*–Redundancies are highly inefficient, until one section of an operation goes down and another section–an otherwise redundant section–springs into action. Europe is reworking its electrical grid, building in redundancies that can replace systems blown out by cyber or physical attack.

- *RTR, or Rebalance the Risks*–The balance for short-term thinking is an adequate assessment of long-term results. With the balance currently weighted heavily toward short-term results–the *Age of Gold*'s perspective–reworking inputs to reflect new systems' realities is needed. During one recent year, nearly 1,000 tornadoes hit the U.S. heartland, killing 500 people and inflicting $9 billion in damage; the Midwest had the wettest April in 116 years, which still continues; Texas had its worst drought in a century, which also still lingers; heat in Russia killed nearly 15,000 people; floods in Australia and Pakistan killed 2,000; and China had both drought and floods with thousands killed, billions of dollars in damage and nearly one million acres of farmland destroyed. Overall, 2010 was the world's hottest year on record, and nine of the hottest years on record have occurred since 2000. Clearly, the climatic system is in disarray, and maintaining old risk models in the presence of this increasing chaos would be unwise. Yet, in the United States only 14 states have even started thinking about how to prepare for and respond to these new realities. Moreover, outside of some insurance companies, which are now requiring corporate policy holders to assess their exposure to climate risk when renewing policies, many corporations have paid little attention to these realities.

- *Meta-Control Is Much Better Than the Illusion of Control*–Something or someone needs to see beyond the fringes of any one institution's operations, and under current perspectives that responsibility often falls to regulators, but such a responsibility needs to be part of every company's risk assessment. Consider the reach of effects for the global positioning satellite (GPS) system. GPS is used for navigation, as most people know, but it is also critical for ATM interactions, aircraft takeoffs and landings, time-stamping financial transactions and a host of other services. Yet a $30 device, sold over the Internet from Asia, can block GPS signals, rendering a system impotent, as one recently did to the landing-and-takeoff system at Newark international airport. The risks inherent in a dismantling of the GPS system become more advanced as dependence on the system increases. How many GPS-dependent systems know about this $30 device? Who is watching across all manner of enterprises to anticipate such risks? Better understanding of GPS vulnerabilities should have been thought through before such a blocking device became available to the public. If something is digital, it can be disrupted, corrupted or made inoperable from afar. Security systems can retard the possible invasion but can hardly stop it. How seriously are such risks being taken by corporations?

- *Collaborate and Share*–Another needed practice that flies in the face of traditional managerial models involves collaborating with competitors came forward to share a solution. When the BP oil-spill disaster occurred in the Gulf of Mexico, no competitor had an answer for the problem, or at least, no competitors came forward to share a solution, if they did have a solution. Had oil companies been working together on the low-probability/high-impact events to find solutions that would benefit them all, rather than each company working on its own solutions in private, they might have had a solution beforehand. That would have been beneficial for the entire industry. A 2011 report from the Organization of Economic Cooperation and Development (OECD) explained that "never before have global risks seemed so complex, the stakes so high and the need for international cooperation to deal with them so apparent." The report suggested the need for global data sharing, open stress-testing of institutions, collaboration on model building and contingency planning. Who is doing this?

- *Ponder the Unknown Consequences and Assume That Low-Probability/High-Impact Events Will Occur*–Develop an effective method for weighing the larger risks involved in linking–intentionally or unintentionally–to multiple systems, and assess the advantages and disadvantages of this connection.

Above all these changes, one further need arises: Be aware of the risks endemic in the system and arising constantly from the interaction of systems. Benign changes can evolve into catastrophes. Staying abreast of high, medium and low risk requires an

assessment of horizon risks and a constant monitoring of those risks.

The series of scientific discoveries that wounded human egos could well have a new item, and it might be a rewrite of the infamous line about Internet privacy: "You have no privacy; get over it." The new item on the blow-to-the-ego list might be stated like this: "Humans are losing control of their own creations; get over it." Or said from a different perspective: *Perfect control of complex, interlinked systems is an illusion intended to make humans comfortable in a world existing on the edge of chaos at all times*.

That does not mean that no action is possible or that all actions are doomed to fail. But it does suggest that the typical way of preparing for breakdowns—that is, wait until a disaster occurs and then react—is becoming way too costly a practice. Perhaps leaders should all start by leaving behind all their "zombie" risk models (to recycle the term used by economist John Quiggin) and become aware of how higher levels of technology, involving more and more complicated systems interacting in ways that are not completely understood, can enhance the likelihood of Unaddressed Consequences.