Building A Resilient Organization

Yossi Sheffi, MIT

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The 9/11 attack, the SARS epidemic, Katrina and scores of other natural and man-made disruptions have increased companies' awareness of the need for active risk management. Governments in the West also have realized that more than 85% of the infrastructure in their countries is owned and/or operated by the private sector. At the very least this means that governments need to better understand how resilient private sector enterprises are, and how these organizations manage risk. This article is based on ideas described in my recent book The Resilient Enterprise that outlines some of the ways in which companies can and do prepare themselves for the inevitable large disruptions. Most of the lessons are relevant to government, non-profit, and any other organization.

A Fire in the Desert

On Friday night, March 17, 2000, a bolt of lightning struck an Albuquerque factory of Philips NV, the Dutch electronics conglomerate. The furnace in Fabricator No. 22 caught fire. It did not seem to be a major event. The automatic sprinkler systems were activated and Philips-trained staffers put the fire out in less than 10 minutes. By the time the firefighters from Albuquerque Fire Station 15 arrived, they had nothing to do but to verify that the plant was now safe. What the firefighters did not realize, however, was that the blaze's location had once been one of the cleanest places on earth. Philips's plant was a

semiconductor fabrication plant, or fab, making special chips for cellphones, and two out of its four cleanrooms were damaged.

Philips immediately notified the two largest customers of the plant – Ericsson LM and Nokia Corp – both of whom were in the process of launching a new generation of cellphone, relying on the special chips to be produced in the Albuquerque plant. The reaction of the two Scandinavian firms could not have been more different. Ericsson was not overly alarmed. The original message from Philips estimated a one week delay in the supply of chips and Ericsson had safety stock to cover such delays. Nokia was not perturbed by the news either, however, it placed the affected chip on a "special watch" which called for daily discussions between Nokia and Philips engineers regarding the affected parts. Very quickly Nokia discovered that this was not a one-week delay; it would take several months to bring the Albuquerque plant back to full production and Nokia would miss the launch of a new generation of cellphones. The company sprung into action on two fronts: it pressed Philips to find alternative supply in its other fabs around the world - even though this involved outsourcing some of the chip manufacturer's own production - and it looked for alternative suppliers, around the world, paying extra for quick setup and testing and expedited production.

In sharp contrast Ericsson did not react fast enough. By the time it realized the magnitude of the problem, the worldwide supply of the special chips needed for cellphones was sewn up by Nokia. At the end of 2000, Ericsson announced a staggering 16.2 billion kronor (US $2.34 billion) loss in the company's mobile phone division. The company blamed the loss on a slew of component shortages.[i] About a year after the fire, Ericsson retreated from the handset production market. In April of 2001, it signed a deal with Sony to create a joint venture to design, manufacture, and market handsets. Sony-Ericsson would be owned 50-50

by the two companies.[ii] Ericsson's inability to ship quantities of its high-end models removed one of Nokia's major competitors from the marketplace. Within six months of the fire Nokia's year-over-year share of handset market increased from 27 to 30 percent.

Although both Ericsson and Nokia were hit by the same disruption, one recovered while the other exited significant parts of the business. This example illustrates many of the concepts that are the focus of this article.

First, risk management is not a company issue to be handled "within the four walls" but rather a supply chain management issue. Every company is a citizen of its supply chain. The company depends on the web of suppliers, logistics providers, brokers, port operators, and many other facilitators to get parts to plants and distribute products to customers. A company can suffer a serious business interruption not only when one of its own facilities, distribution channels, or work force is disrupted, but also when any one of the elements in its supply chain or, more expansively, its eco-system, is disrupted. The damage to the Philips plant was about $40 million, which was mostly covered by insurance. The damage to Ericsson was orders of magnitude larger – the loss of its handset manufacturing business.

The question is: how could this happen? Why the same disruption, affecting two large and sophisticated companies in the same business, caused one to exit the market and the other to increase its market share?

The Nature of Risk

In modern times, corporate risk management is approached in one of two ways: (i) based on model and numbers, and (ii) based on subjective beliefs about the future. When there is a reason to believe that the patterns of the past will be repeated - data, probability distributions, and models can be used to forecast

future patterns. These forecasts are the basis of strategies which can account for the expected variations in the future outcomes. But other future outcomes are more difficult to treat in this manner – they are known as HILP – High Impact Low Probability events. Such events are difficult to forecast since their type and nature are very much outside past experience and they have a significant impact on an enterprise.

When trying to manage risks, most companies first classify possible risks along two axes: One axis denotes the likelihood of a particular disruption, while the other axis denotes the impact (or severity) of this disruption once it hits. Figure 1 depicts a simple example of placing possible risks in such two axes. The space in which threats are placed can be divided into four quadrants, as depicted in Figure 2. Clearly one does not have to worry too much about rare insignificant event (in the lower left hand quadrant). Events with high probability and light consequences are also not a particular concern – these are the usual "fire fighting" events that operations managers deal with all the time and for which their data, statistical distributions and models give them ample warnings and tools. Even high probability high impact events are not of particular concerns. While not dealt with by line operations managers, special groups within each company have processes for dealing with such disruptions. For example, BP suffers substantial losses every time a hurricane moves through the Gulf of Mexico. Deep water platforms have to be buttoned down and evacuated. Many times these platforms are damaged and have to be repaired at very high costs. BP, however, has a well-honed

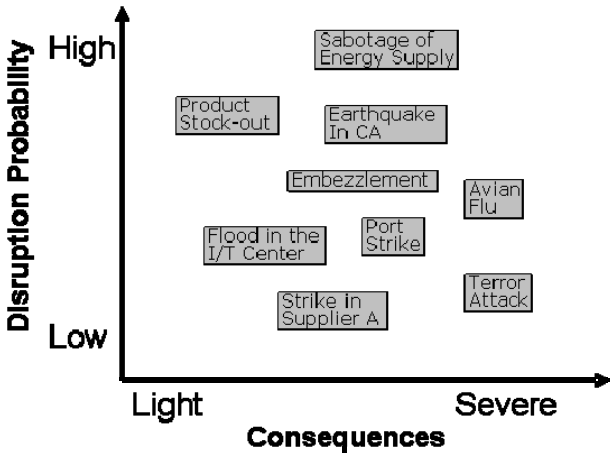

Figure 1 Example of Classification of Threats

process for dealing with such disruptions since hurricanes in the Gulf of Mexico are an annual phenomenon. Low probability high consequences events are different. (The drawing in the low right hand side quadrant in Fig. 2 is supposed to symbolize the Titanic – the ship that was unsinkable…). These are disruptions that companies or governments cannot imagine, are not prepared for and have devastating consequences. Examples include the 1984 disaster in Union Carbide's Bhopal plant; the 1986 Chernobyl nuclear accident, the 2003 SARS outbreak, the 9/11 terrorist attack, hurricane Katrina in 2005, etc.

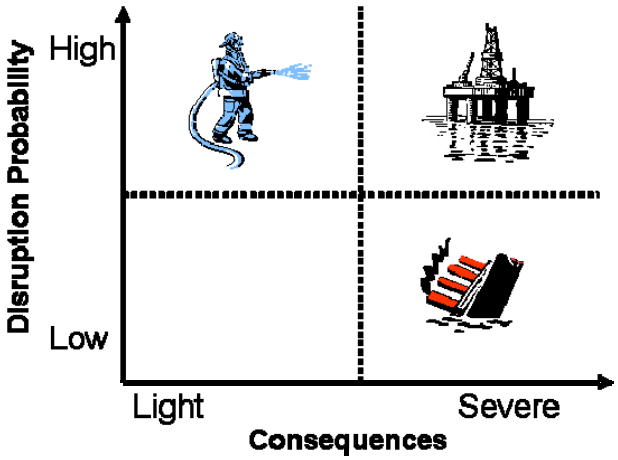

Figure 2 Four Quadrants of Risks

One immediate consequence of this classification is the understanding that the expected damage (the product of probability and consequences) is not a good measure of risk! Frequent small disruptions have little in common with rare high-impact disruptions, even though the expected value of both types may be similar. The former are dealt with by operations managers in the course of their job, while the latter can devastate an enterprise. And disruptions that have the highest expected value (the product of high probability and high impact) should not get the highest attention from risk managers since it is likely that the organization is ready for them and has processes in place.

Government Actions in HILP Events

HILP events involve, in many case, fear and confusion. Under such circumstances, governments feel that they have to act quickly even before all the

information is available. And in many cases Governments' reaction exacerbates the problems.

For example, after the September 11 terrorist attacks, the U.S. government closed the borders and shut down all flights in and out of the country. The impact on many supply lines was immediate. Ford Motor Co. had to idle several assembly lines intermittently as trucks loaded with components were delayed coming in from Canada and Mexico. Ford's fourth-quarter output in 2001 was down 13% compared to its production plan.[iii] In fighting the 2001 outbreak of the Foot and Mouth Disease (FMD) the British Government not only slaughtered 6.5 million cows, pigs, and sheep, but they also closed the countryside to tourism. The damage to the tourism industry turned out to be significantly larger than the damage to the agricultural industry – and it was caused clearly by the government's actions.

For enterprise managers this means that government actions have to be regarded as part of the disruption. For example, if a container will explode in a US port, it is likely that the Government may close all ports causing significant economic damage. If this seems far-fetched, one only has to examine the congressional actions in the 2006 Dubai Ports fiasco, where ignorance and narrow interests succeeded in hurting the security interests of the US in order to "score" politically.[iv]

The High Likelihood of Low Probability Events

On Thursday, May 8, 2003 a powerful tornado hit the General Motors assembly plant in Oklahoma City, Oklahoma. The extensive damage lead to GM's second quarter charge of $140 to $200 million. A particular HILP event such as this is rare. The probability that a specific disruption will hit a given

element in a company's supply chain in a particular week is negligible. For a global enterprise like General Motors Corporation, however, the probability that a significant disruption of some type, will take place somewhere in its vast supply chain, sometime during a given year, is not insignificant.

This observation gives rise to the concept of resilience. Resilience is the ability of material to retain its former shape after a deformation. Similarly, enterprise resilience measures the ability of an organization to "bounce back" to its pre-disruption level of manufacturing, level of service to its customers, or whatever other performance metric is relevant to it. There are two basic ways for en enterprise to build in resiliency: through redundancy or through flexibility. Regardless of the general strategy, early detection of a disruption is important and the right corporate culture is a major determinant of resilience.

Early Detection

Among many terrorism professionals, the real nightmare scenario is not a nuclear or dirty bomb but rather an attack where the organization under attack does not realize it until it is too late. An example may be a lethal biological agent that takes weeks to show the first symptoms yet can spread quickly. Recognizing this, the Centers for Disease Control (CDC) in the US started looking on a daily basis into geographical clusters of respiratory infections and small rashes accompanied by fever, symptoms that may signal a bio-terror attack in progress.[v] As this article is being written, the World Health Organization (WHO) and local health authorities are spending significant resources in trying to detect the onset of the Avian Bird Flu (ABF). ABF, if mutated and transmitted among humans, can be even deadlier than the 1918 Spanish Flu which reportedly killed 30 – 60 million people worldwide. The best defense against such pandemics is early

detection and quarantine while the correct anti-viral drugs as well as vaccines are being developed for the active flu strain.

But in many cases early detection involves not only receiving the warning signs but making sure that the organization receiving them can process, understand and act upon the signals. A clear failure of such an organizational response took place during hurricane Katrina while the world was watching. The City of New Orleans started the evacuation too late, the State of Louisiana did not call in Pentagon resources early enough, and much has been written about the meager response of the Federal Emergency Management Administration (FEMA). And this was a disaster which the country has been warned about days in advance…

Just-in-Time or Just-in-Case

A resilient enterprise can be built by creating redundancies throughout the supply chain. An enterprise can maintain low capacity utilization, hold extra inventory, have many suppliers for the same part, etc. For example, the Postal Service was able to withstand the Anthrax attacks very well. Even though several of its main faculties had to be shut down, the mail was not delayed. Over the last two decades as fax, e-mail, and on-line payments reduced the volume of physical mail, the USPS did not adjust its capacity and thus had a built-in redundancy which proved useful in that situation. Very few commercial enterprises can afford to keep redundant capacity ready to be activated in case there is a disruption.

The most common type of redundancy is safety stock of parts and finished products. While most companies do it in order to protect themselves against "normal" day-to-day fluctuations in the global flow of commerce, it is very

expensive to use safety stock as protection against HILP events. Such events require a lot of inventory to be kept for a long time. Keeping large inventory is expensive for two reasons: (i) first, inventory carries costs – it has to be maintained, financed, warehoused and attended to, while the value of the product may be going down daily, and (ii) excess inventory leads to sloppy operations – it is simply too easy for managers to "take another one from the inventory pile" in case there is a quality problem with a part to be used or a defective product ready to ship. It avoids the necessity to identify and correct quality problems at their source, as Toyota has proven with its superior manufacturing system based on quality principles and just-in-time inventory management.

In the last two decades leading manufacturers, distributors and retailers worldwide have made tremendous strides in developing "lean," tightly coupled supply chains. These supply chains are frighteningly efficient and lightning fast, based on advanced information technology applications, electronic data interchange standards and finely honed processes. The lack of built-in redundancy, however, makes them more vulnerable to disruptions. Yet no company can afford to "fatten" its operations since its costs will increase and both Wall Street and the competition will punish it.

So if redundancy is not a feasible solution, enterprises have to build in flexibility.

Flexibility

Unlike redundancy, increasing supply chain flexibility can help a company not only withstand significant disruptions but also better respond to demand fluctuations and therefore be a stronger competitor. The notion of

flexibility is based on interchangeability – developing the ability to interchange elements in the supply network quickly, as the following examples demonstrate.

Standard Facilities and Processes

Intel plants around the world are all identical, using their Copy Exact! Philosophy. When the SARS epidemic hit Southeast Asia, Intel was able to move production from its stricken Indonesian plant to other plants around its system with relative ease. Similarly, when a severe ice storm shut down UPS's main air hub in Louisville, Kentucky in 1986, the Package delivery giant was able to keep the facility operating even though nobody could drive on the icy roads and employees could not get from home to the airport. Instead, UPS flew workers from other parts of their system to work the Louisville hub. Since UPS uses standard terminal design and standard process throughout its vast system, it was able to bring in workers from other parts of the system to operate the Louisville hub.

Interchangeable parts and products

When different products can use the same parts, especially commodity parts which are widely available, product availability will be less susceptible to a supplier failure or a production problems since other sources will be on hand. Following this logic Intel has reduced a mix of 2,000 different types of resistors, capacitors, and diodes to only 35 types.[vi] For the same reason, Southwest Airlines uses only one type of airplane – the Boeing 737. Airlines are always disrupted due to weather, crew shortages, airport congestion and many other reasons.

Making sure that every crew can fly every aircraft gives Southwest Airlines the flexibility to respond to such disruptions faster than other airlines.

Concurrent processes

Overlapping sequential processes can speed up the recovery phase after a disruption and provides collateral benefits of improved market responses. Lucent Technologies achieves concurrency through a single supply chain organization that spans multiple company functions including engineering and sales. Aligning these different activities under the supply chain umbrella means that the company can view each operational area concurrently, and quickly assess the status of each activity in an emergency situation. It also "socializes" the people working in the different organizational units to working together.

Postponement

Designing products and processes for late value addition and late customization offers another layer of flexibility. Keeping products in their semi-finished form offers opportunities to move products from surplus to deficit areas. It also increases fill rates and improves customer service without increasing inventory carrying costs because the products can be completed when more accurate information on what the customer wants is available. Italian clothing manufacturer and retailer Benetton re-designed its manufacturing processes so that selected products – particularly those that are subject to extreme demand variability – are made as generic, un-dyed items that are finished later on when more accurate demand information is known or even after orders are placed.

Alignment of procurement strategy with supplier relationships

In response to 9/11 and other disruptions some observers advised companies to maintain multiple suppliers for essential parts. Business-wise, however, there may be very good reasons to have a single supplier even for some critical parts. The single-supplier option provides several benefits such as (i) access to the supplier's innovation - since the supplier is less worried about seepage of its intellectual property to a competing supplier, (ii) dealing with each supplier involves substantial costs, which are minimized when dealing with a smaller number of suppliers or a single one, (iii) with a single supplier for a particular part the company concentrates its buying power, leading possibly to lower purchase costs and (iv), with a single supplier, the company becomes a more significant customer of this supplier, thereby getting more attention.

But when relying on a single supplier, an enterprise has to commit to deep relationships with each such supplier – it does put all its egg in a single proverbial basket and thus it has to make sure it knows intimately the supplier's strategy, its financial conditions, who the supplier's suppliers are, etc.. This strategy is depicted in the top left hand quadrant of Fig. 3. It is expensive to develop such deep relationships with any supplier and a company may decide not to do so. In that case, however, the company is less

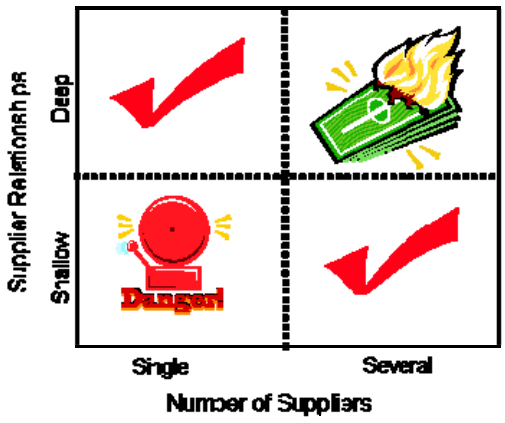

Figure 3 Alignment of Procurement Strategy

knowledgeable about its trading partners and therefore less likely to be forewarned of supply problems. In such cases, it is necessary to spread the risk by maintaining a network of suppliers (see the bottom right hand quadrant in Fig. 3).

Neither strategy is right nor wrong; the issue is to choose the approach that aligns corporate supplier relationships with the company's procurement strategy. Inadequate monitoring of its supplier base almost cost Land Rover its business when its sole supplier of chassis for the Discovery vehicle went bankrupt unexpectedly in December 2001. The auto manufacturer was totally unprepared for the bankruptcy, and eventually had to pay off some of UPF's debt to resume chassis supplies. (This is the dangerous situation depicted in the low left hand quadrant of Fig. 3.) Having close relationships with many suppliers may be simply too expensive and therefore impractical.

Collaboration

By developing close and collaborative relationships with trading partners, these companies are to be loyal allies during a crisis situation. Such relationships allowed Toyota to recover very quickly, with the help of dozens of suppliers, from a fire that gutted the sole plant of its main P-valves supplier in February 1997.[vii] And loyal customers were the key to the recovery of bond trader Cantor Fitzgerald after losing more than a third of its employees and headquarters in the 9/11 attack. Such relationships can also be crucial when responding to demand fluctuations, when the entire channel has to ramp production up or down.

Cultural Change

The factor that clearly distinguishes companies that bounce back from disruptions quickly and even profit from them, is their corporate culture. While on the surface, Nokia, Toyota, UPS, Dell, and the US Coast Guard may not seem to have much in common, a closer look shows these resilient organizations share several common traits, especially within their corporate culture. These include the following:

- *Continuous Communications among Informed Employees*. Resilient companies communicate obsessively, keeping all managers aware of strategic goals, tactical factors and the day-by-day and even minute-by-minute pulse of the business. Dell employees, for example, have continuous access to product manufacturing and shipment information as well as to the company's overall state. Thus, when disruption occurs they can react based on up-to-date knowledge even when the normal lines of communications are broken.
- *Distribute power*. Resilient organizations empower teams and individuals to take drastic actions when necessary, without the delays associated with getting approvals. Toyota assembly line workers can halt production by pulling a special alarm cord. This causes a team of engineers to descend on the work station in question and fix whatever problem caused the disruption, rather than continue manufacturing defective automobiles. The US Coast Guard moved assets into Louisiana before Katrina hit and was operational in life-saving, round-the-clock missions without any specific instruction from the Department of Homeland Security to which it belongs or even from the national headquarters in Washington DC. It relied on its operating principle of "On Scene Initiative."[viii] In all these

organizations individuals who are encouraged to take action are celebrated when they are right and never punished when they are wrong.

- *Passion for work*. Successful companies engender a sense of the 'greater good' in their employees. As a Southwest Airline executive puts it: "The important thing is to take the bricklayer and make him understand that he's building a home, not just laying bricks." Similarly, navy sailors do not think about their job as driving big ships but rather as defending freedom.
- *Conditioning for disruptions*. Resilient and flexible organizations appear to be regularly conditioned to be innovative and flexible in the face of low-probability/high-impact disruptions through frequent and continuous "small" operational interruptions. As a UPS executive says "disruptions are really normal *[at UPS]."* Since the company's operations are subject to adverse weather conditions, traffic congestion problems, road closures and many other delays, the company's recovery processes are tested daily. Companies with relatively predictable environments can interject uncertainty for training purposes. A special Intel team, for example routinely visits plants anywhere in the world, introducing a simulated disruption such as the failure of a critical supplier. The team runs the plant through a complete drill of finding and qualifying alternative suppliers, arranging transportation changing production schedules, etc., just to avoid managerial complacency.

Culture is difficult to define and even more difficult to change; but this is far from impossible. The success of the quality movement in the 1980's is an example of how a cultural change can become "everybody's" issue rather than the exclusive domain of a group of experts or vested interests.

Resilience Enhances Competitiveness

The rewards for building a resilient organization are substantial. Not only will the enterprise be "hardened" to withstand disruption of all kinds, but it will be more competitive day-to-day. The reason is that supply disruptions create shortages which are not dissimilar to the demand spikes caused by supply/demand imbalances. Resilient enterprises can thus react to changing market demand ahead of their competitors. Furthermore, resilient enterprises can look at disruptions as opportunities rather than problems. In most cases large- scale disruptions affect a whole industry or an entire region. In such situations the resilient enterprise is likely to bounce back ahead of its competition, winning market share and customer loyalty.

Yossi Sheffi is a professor of Engineering Systems at MIT, where he heads the MIT Center for Transportation and Logistics. His book "The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage" (MIT Press, October 1, 2005) covers these topics in depth. The book is based on four years of MIT research and offers not only recommendations but also the business case for investments in security and resilience (see www.theresiliententerprise.com).

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