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A Supply Chain View of the Resilient Enterprise

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An organization's ability to recover from disruption quickly can be improved by building redundancy and flexibility into its supply chain. While investing in redundancy represents a pure cost increase, investing in flexibility yields many additional benefits for day-to-day operations.

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After the September 11, 2001, terrorist attacks, the U.S. government closed the country's borders and shut down all incoming and outgoing flights. 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 with its production plan.¹ And Toyota Motors Corp., also adhering to just-in-time inventory discipline, came within hours of halting production at its plant in Indiana as it held out for assemblies from a key supplier awaiting steering sensors that usually came by air from Germany.²

Managers experience risk on many levels, but its primary source is uncertainty in the demand for products — uncertainty that has increased dramatically in recent years due to several interdependent trends such as increased customer expectations, more global competition, longer and more complex supply chains and greater product variety with shorter product life cycles. In addition, managers still must cope with the conventional disruptions of supply variability, capacity constraints, parts quality problems and manufacturing yields. Now, on top of all that, they have to cope with the ongoing unease resulting from the war on terror and the likelihood of further attacks following the March 11, 2004, train bombings in Madrid and the two July 2005 bombings of London's transportation system.

The problem is that many companies leave risk management and business continuity to security professionals, business continuity planners or insurance professionals. However, building a resilient enterprise should be a *strategic* initiative that changes the way a company operates and that increases its competitiveness. Reducing vulnerability means reducing the likelihood of a disruption and increasing resilience — the ability to bounce back from a disruption. Resilience, in turn, can be achieved by either creating redundancy or increasing flexibility. While some redundancy is part of every resiliency strategy, it represents sheer cost with limited benefit unless it is needed due to a disruption. Flexibility, on the other hand, can create a competitive advantage in day-to-day operations. Investments in flexibility thus can be justified on the basis of normal business results without even taking into account the benefits of risk mitigation and cost avoidance. (See "About the Research," p. 42.)

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Stages of Disruption

Any significant disruption will have a typical profile in terms of its effect on company performance, whether that performance is measured by sales, production level, profits, customer service or another relevant metric. The nature of the disruption and the dynamics of the company's response can be characterized by the following eight phases. (See "The Disruption Profile.")

1. Preparation In some cases, a company can foresee and prepare for disruption, minimizing its effects. Warnings range from the 30-minute tornado alert General Motors Corp. received in Oklahoma on May 8, 2003, to the several months of deteriorating labor negotiations at West Coast ports that preceded the October 2002 lockout. In other cases, such as 9/11, there is little or no warning.

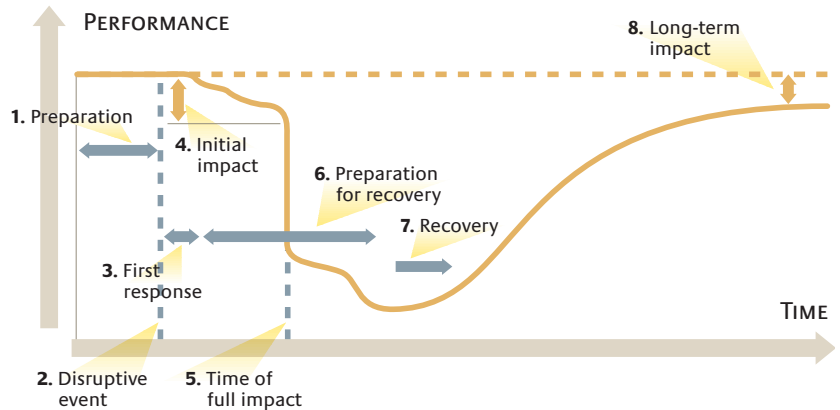
2. The Disruptive Event The tornado hits, the bomb explodes, a supplier goes out of business or the union begins a wildcat strike.

3. First Response Whether there's a physical disruption, a job action or an information technology disruption, first response is aimed at controlling the situation, saving or protecting lives, shutting down affected systems and preventing further damage.

4. Initial Impact The full impact of some disruptions is felt immediately. Union Carbide Corp.'s chemical plant in Bhopal, India, went off-line immediately after the gas leak disaster in December

The Disruption Profile

Any serious disruption will affect the performance of a company in predictable ways. A plotting of any relevant performance metric over time will reveal eight distinct phases.



1984. Other disruptions can take time to affect a company, depending on factors such as the magnitude of the disruption, the available redundancy, and the inherent resilience of the organization and its supply chain. When inventories of critical parts ran out during the 2002 West Coast port lockout, it took New United Motor Manufacturing Inc., the joint venture of General Motors and Toyota, four days to halt production. During the time between the disruptive event and the full impact, performance usually starts to deteriorate.

5. Full Impact Whether immediate or delayed, once the full impact hits, performance often drops precipitously.

About the Research

This paper draws on work on supply chain disruption that has been ongoing at the MIT Center for Transportation and Logistics since 2002 as part of the MIT-Cambridge Institute, which is funded by the U.K. government. The project, which was motivated by 9/11, has looked at numerous cases of disruption, discovering the common traits between corporations and supply chains that performed well and distinguishing them from those that did not. It involved detailed studies of many dozens of companies and follow-ups with managers who were

involved with disrupted operations.

The companies studied fell into two groups. The first group included 35 members of the MIT Center for Transportation and Logistics' Supply Chain Exchange Program, with which the Center's researchers have ongoing interactions. The research team examined their security and resilience strategy. The second group included companies that had actually experienced disruptions. They were chosen based on leads received from the first group, media reports of disruptions and contacts that the research team had

with the insurance industry and supply-chain management professionals. Not all these companies agreed to interviews on the record due to the sensitive nature of the subject. In some of these cases, the research team relied upon secondary research and public-domain sources.

In addition to telephone surveys and in-depth interviews, the research drew upon six conferences, three at MIT and three in the United Kingdom, in which many companies shared their security, resilience and disruption experiences with the MIT research team.

6. Recovery Preparations Preparations for recovery typically start in parallel with the first response and sometimes even prior to the disruption, if it has been anticipated. They involve qualifying other suppliers and redirecting suppliers' resources (as Nokia Corp. did in the aftermath of the 2000 fire in a Royal Philips Electronics NV manufacturing plant that disrupted its chip supply; *see p. 47*), finding alternative transportation modes (as NUMMI did when it used airfreight to get parts during the 2002 West Coast port lockout) and determining what parts are available and selling products built from those parts (as did Dell Inc. after the 1999 earthquake in Taiwan; *see p. 46*).

7. Recovery To get back to normal operations levels, many companies make up for lost production by running at higher-than-normal utilization, using overtime as well as suppliers' and customers' resources. After the West Coast port lockout, NUMMI made up for its one-week plant closure and posted record sales by year's end despite the work stoppage.

8. Long-Term Impact It typically takes time to recover from disruptions, but if customer relationships are damaged, the impact can be especially long-lasting and difficult to recover from. For example, the network of small-scale shoe factories in Kobe, Japan, responsible for some 34 million pairs of shoes a year, lost 90% of its business in the wake of that city's 1995 earthquake as buyers shifted to other Asian factories, and most buyers never came back.

The Basics of Vulnerability Assessment

Vulnerability assessment involves answering three questions: What can go wrong? What is the likelihood of that happening? What are the consequences if it does happen?

Disruptions can be classified as random events (including natural disasters), accidents or intentional disruptions (such as job actions or acts of terrorism or sabotage). The method of estimating the likelihood of each class differs. The probabilities of random phenomena such as earthquakes, hurricanes, floods or lightning strikes can be estimated from historical data. The likelihood of accidents can also be estimated from industry data, prior events and the enterprise's safety program.³ The probability of intentional disruptions — known as adaptive threats because they are designed by their perpetrators to inflict maximal damage — is more difficult to estimate, in part because of their lack of historical data and in part because the likelihood is a function of the specific company's decisions and actions.

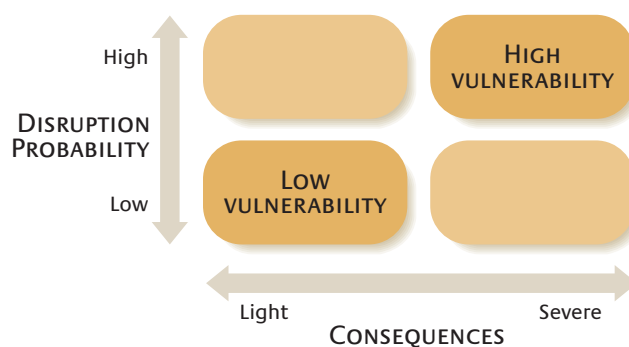
Contributing factors are too varied and too nuanced, and the tools for measuring them are too blunt, to arrive at a single "expected vulnerability" metric. Instead, potential disruptions can be categorized as a function of their probability and consequences. (See "The Vulnerability Framework.")

The vulnerability to a specific risk — say, a terrorist attack on a corporate asset — varies considerably from company to company. For American Airlines Inc., such an attack is both high probability and high impact. For fast-food giant McDonald's Corp., such an event is high probability but relatively low impact, since disabling a single franchise, or even several, is not likely to put pressure on the bottom line of a company with over 30,000 restaurants. On the other hand, while clothing retailer Limited Brands may be an unlikely terrorist target, it would be severely affected should an attack occur since it processes a significant portion of its merchandise through a single distribution center. Lastly, Ace Hardware Corp. is one of many businesses that are unlikely targets of terrorism, and it would be highly resilient in any event. Even though it operates 500 of its stores in more than 70 foreign countries including Kuwait, Saudi Arabia and the United Arab Emirates, Ace Hardware is a dealers' buying cooperative with a low profile. It is not an obvious target and, with thousands of U.S. retail outlets and dozens of distribution centers and cross-dock facilities, it could easily withstand a single-point disruption.

Using Vulnerability Maps Clearly, different companies are vulnerable to different disruptions. For instance, McDonald's is relatively able to withstand a terrorist event such as bombing a facility and is relatively invulnerable to industrial actions (such as strikes and slowdowns), because it uses franchisees rather than employees. However, it would be extremely vulnerable to an outbreak of mad cow disease or to other disruptions (including a terror attack) that would affect consumers' confidence in the meat supply.

The Vulnerability Framework

Vulnerability is highest when both the likelihood and the impact of disruption are high. Rare, low-consequence events represent the lowest levels of vulnerability and require little planning or action. Disruptions that combine high probability and low consequences are part of the scope of daily operations management in the normal flow of business. On the other hand, those characterized by low probability but high impact call for planning and a response that is outside the realm of daily activity.



Individual companies can create an “enterprise vulnerability map” by placing various threats in the appropriate quadrant of the vulnerability framework. (See “A Vulnerability Map for a Single Company.”) Such maps can then direct management attention and prioritize planning. Vulnerability maps must be continuously updated as new threats emerge. In particular, the likelihood of, and resilience to, adaptive threats will change with a company’s actions. For example, human resources policy may affect the likelihood of industrial actions, and the availability of alternate manufacturing resources may affect the severity of a potential supply disruption. Similarly, defensive measures might deflect a terrorist attack or sabotage, while significant redundancy may allow for a fast recovery, thereby reducing the likelihood of an attack even further.

As they chart their vulnerability maps, supply chain managers not only must take into account familiar risk factors such as the financial viability of their vendors, the likelihood of natural disasters, the availability of energy supplies and so on, but they must also worry about terrorism and the vulnerabilities of more complex, sensitive global supply chains. Many companies use comprehensive scenario planning to model the dynamics and consequences of high-impact risks such as terrorism, the 2001 foot and mouth disease outbreak in the United Kingdom or the 2003 SARS outbreak in China. Such comprehensive scenario planning can illuminate the direct effects of large-scale disruptions as well as

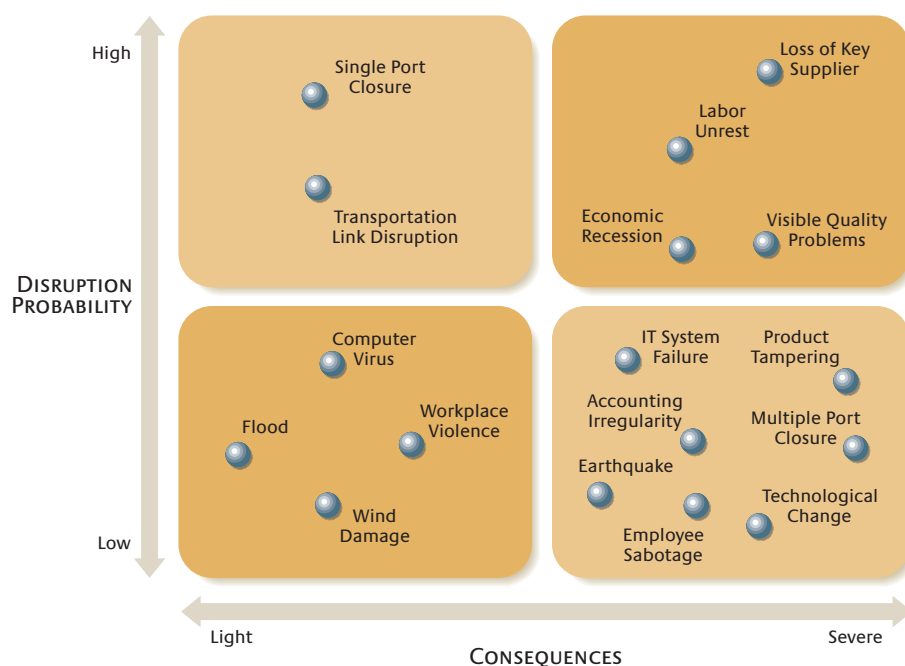
their secondary effects, such as the public fear and resource hoarding that these events can engender. Then, in an attempt to restore public confidence, governments may overreact with draconian regulation that may exacerbate the problem.

Building in Resilience

Each company is a citizen of its supply chain, since it depends on the web of suppliers, logistics companies, brokers, port operators, dealers and many others to get its parts to its plants and distribute its products to customers. Thus, avoiding a customer disruption can be thought of in terms of the level of “shock absorption” between stages in the supply chain. A company’s resilience is a function of its competitive position and the responsiveness of its supply chain. (See “Company Position and Responsiveness.”) In competitive markets, fast-responding companies can gain market share, and slow responders risk losing it. Companies with market power that respond quickly to disruption have the opportunity to solidify their leadership positions. The investment in resilience for such companies is typically justified due to the high margins associated with such strong market position and because market leaders that are slow to respond may invite regulatory intervention. Fundamentally, companies can bolster their resilience by either building in redundancy or building in flexibility.

A Vulnerability Map for a Single Company

An enterprise vulnerability map categorizes the relative likelihood of potential threats to an organization and the company’s relative resilience to such disruptions. Such maps can then direct management attention and prioritize the planning.

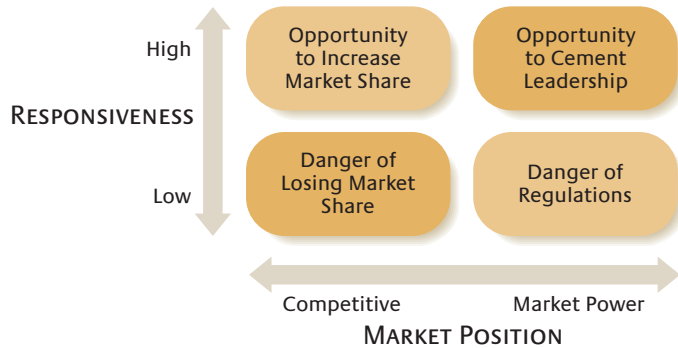


The Cost of Redundancy Redundancy is the familiar concept of keeping some resources in reserve to be used in case of a disruption. The most common forms of redundancy are safety stock, the deliberate use of multiple suppliers even when the secondary suppliers have higher costs, and deliberately low capacity utilization rates. The incremental cost of safety stock, additional suppliers or backup sites is effectively an insurance premium. (Information technology resources are in something of a separate category in that IT backup is relatively inexpensive and failing to do backups has such severe consequences that they are standard practice.)

Note that, especially with safety stock, companies have to be careful not to digress from “just-in-time” to “just-in-case” inventory management. While the latter does offer redundancy and, with it, limited immediate response capacity, extra inventory has proven to be detrimental to product quality and to lean operation in general. Consequently,

Company Position and Responsiveness

Two important variables determine a company's resilience: the competitive position of the enterprise and the responsiveness of the supply chain. In competitive situations with low switching costs, a company must be able to respond quickly or else risk loss of market share. Conversely, companies that are very responsive will have an opportunity to gain market share in competitive environments or solidify their leadership position in areas they already dominate.



some have advocated the use of strategic inventory (for example, the “sell one, stock one” inventory policy⁴), which is based on keeping extra inventory that can be released only with special authority. This is similar to how the U.S. strategic oil reserves are managed.

The Five Facets of Flexibility There is significantly more leverage in making supply chains flexible than there is in adding redundancy. Flexibility amounts to building organic capabilities that can sense threats and respond to them quickly. Not only does this bolster the resilience of an organization, but it also creates a competitive advantage in the marketplace. To see how flexibility can be achieved, consider the essential elements of any supply chain: Material flows from *supplier* through a *conversion process*, then through *distribution channels*. It is controlled by various *systems*, all working in the context of the *corporate culture*. Each of these five elements offers a dimension of potential flexibility. (See “Supply Chain Elements,” p. 46)

Supply and procurement. In December 2001, UPF-Thompson, the sole supplier of chassis frames for Land Rover’s popular Discovery vehicles, suddenly stopped shipping product. UPF was bankrupt. Land Rover learned of this “one Friday morning [when] no chassis frames were delivered,” according to a Land Rover representative. When Land Rover contacted UPF to determine the cause of the shipping delay, UPF’s receiver, KPMG LLP, told Land Rover it was not prepared to deliver any more frames unless Land Rover was willing to make a multimillion-pound “goodwill” payment. If Land Rover lost the UPF supply of frames, it would have had to suspend Discovery production for up to nine months while new tooling was

developed. Nearly 1,500 jobs at Land Rover and 10,000 jobs among Land Rover’s other suppliers would have been severely threatened.

Although Land Rover and KPMG eventually came to a settlement, it is clear that relying on a single supplier can be dangerous. If such a supplier is crippled, a manufacturer can be left without critical parts. Consequently, some companies surveyed by our project team indicated that they are changing their procurement practices to ensure at least two and, in some cases, more suppliers for each critical part. Other companies, in contrast, have cut the number of suppliers and deepened their relationships with a single supplier for each critical part, citing the benefits of core supplier programs, especially for outsourcing of highly engineered parts.

Both approaches are “right.” The issue is not whether to use a single supplier or multiple ones; the issue is the correct alignment of the corporate-supplier relationship with the procurement strategy. If a company chooses to work with a single supplier, it must develop deep relationships and work very closely with it. Doing otherwise would put the company at great risk. Developing such relationships is expensive and requires constant vigilance; some companies instead may choose to have less deep relationships with multiple suppliers so they can spread the risk of losing critical capacity.

After a fire at Aisin Seiki Co., a supplier to Toyota, halted production in all of Toyota’s Japanese plants in February 1997, the company used the help of its *keiretsu* to replace the lost capacity and was back to full production within nine days.⁵ After analyzing the situation, Toyota decided to stay with a single supplier since the cost of having multiple suppliers for the part in question was deemed too high and, as a Toyota official commented, “We relearned that our system works.”

Conversion. Conversion flexibility measures a company’s ability to respond to a disruption in one of its own manufacturing facilities. Rapid response involves using standard processes and having multiple locations with built-in interoperability.

For example, on January 16, 1994, the bustling Louisville, Kentucky, air hub for United Parcel Service of America Inc. was shut down by an unexpectedly severe blizzard. The city closed all roads and instituted a travel ban for a week. After diverting more than 100 airplanes to an alternate airport, UPS still had the challenge of getting the packages from its Louisville hub delivered across the country. Due to the local travel ban, employees could not make it to the airport, even though the airport itself was soon reopened. Instead of using its local work force, UPS flew in employees from around the country to help process the stranded packages and load the outbound planes. That tactic was possible because of UPS’s uniform practices — sorting machines were interchangeable, the processes were interchangeable and the people who were

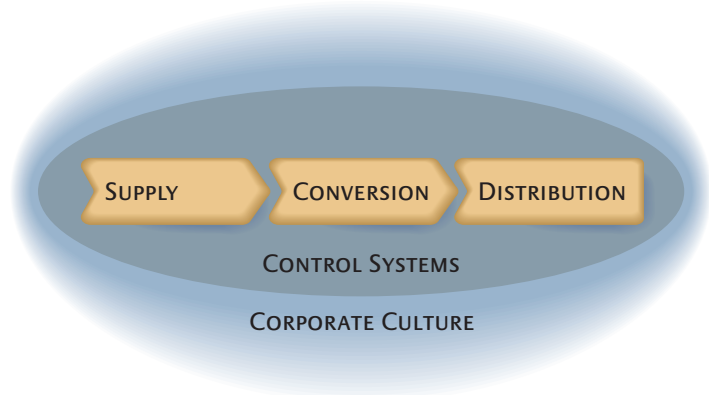
familiar with operations at one location could operate at any of them. (In order to avoid future disruptions of this kind, UPS has developed its own weather service, which sometimes even beats the National Weather Service in forecast accuracy.)

The use of standard processes allows a firm to operate in another facility when one is disrupted or to replace sick or otherwise unavailable operators. Clearly, a company with five warehouses running five different warehouse management systems is less flexible than a company running the same system in all its warehouses.

While having redundant production lines is expensive, having multiple capabilities at each plant location adds flexibility to the supply chain. For example, at the same time as Toyota is building plants around the world to produce cars to local preferences, it is ensuring that these plants can manufacture cars for other regions as well.⁶ Interestingly, it has been shown that a company may not need to have the ability to manufacture all products in all plants in order to increase its flexibility substantially.⁷

Supply Chain Elements

In any company's supply chain, material flows from supplier through a conversion process through distribution channels and is controlled by various systems, all working in the context of the corporate culture. Each of those five elements represents an opportunity to introduce flexibility and, by doing so, create organizational resilience.



Distribution and customer-facing activities. In the immediate aftermath of a disruption, managers face a triage-like choice about which customers to serve first. Such decisions can be based on customer vulnerability or on more internally focused criteria, such as how profitable the customer is, how costly it would be to serve it, or how important the customer is in the long term. Which criterion is used may be less important than having a coherent process for setting priorities during the time-sensitive postdisruption period. The company has to be seen as using a fair allocation process so long-term relationships are damaged as little as possible. For example,

following 9/11, Continental Teves, a unit of Continental AG that supplies automotive, industrial and agricultural products, had to make tough decisions regarding which of its customers would get parts that were in short supply. It looked at how many parts it had in stock for each customer and divided that by the customer's known production rate to determine how many days of production the customer would have before it ran out. Continental Teves then equalized the "days of production" metric across all its customers. NUMMI, on the other hand, decided during the 2002 West Coast lockout to serve its automobile customers first, since it was cheaper to fly in car parts than truck parts from Japan.

A company's customer-facing activities are part of its resilience. After an earthquake rocked Chi-Chi, Taiwan, on September 21, 1999, disrupting the flow of semiconductors to many personal computer and laptop manufacturers for several weeks, two leading computer makers, Apple Computer Inc. and Dell, were equally affected yet reacted quite differently to the supply crunch.

Apple suffered an immediate shortage of semiconductors and other critical components for both its iBook laptop and G4 desktop product lines. The company, which had announced the launch of its new machines and had taken thousands of orders, was not able to modify the configurations already contracted for by retailers and ordered and paid for by consumers. Its attempt to ship a slower version of the G4 generated an avalanche of customer complaints, and it relented, offering to refund consumers' payments. Most consumers responded by either ordering different machines (which happened to carry lower margins) or canceling their Apple orders altogether. Retailers simply had to wait until Apple was able to build the agreed-upon configuration. Apple sales declined in that quarter.

Dell, on the other hand, weathered the storm. Its famous build-to-order operating strategy meant that it held only five days of inventory, with no backlog of specific orders. The "sell-what-you-have" model allowed Dell, using attractive pricing and service representatives' advice, to steer customers to products that they could build with available components. This was nothing new for the company; one of the main reasons for developing the direct sales model was its ability to steer customers to where Dell wants them, either for "up-selling" or for selling available configurations. Instead of losing customer sales and disappointing customers, Dell actually thrived, increasing third-quarter earnings 41% over the same period of the previous year.

Like Dell, some companies are well-placed to influence demand for their products, thereby mitigating the effect of a disruption.⁸ Postponement strategies such as Dell's generally utilize product designs and supply chain processes that are based on delaying commitment and customization until demand is known. Before customization, products are kept in a semifin-

Gauging the magnitude of a large disruption early requires a mindset that continuously questions prevailing wisdom and a culture that allows “maverick” information to be heard, understood and acted upon.

ished state that can be converted to whatever finished product is selling well, wherever that happens to take place, thus increasing the company’s flexibility to respond to demand disruptions.

Generally speaking, companies can treat disruption as an opportunity to deepen relationships with customers. If a company cannot fill its customer’s orders, it should help find new sources of supply, help validate the quality of those supplies and qualify new suppliers even if they are competitors. Such actions will garner good will and make it less likely that competitors will keep the new business after the disruption has normalized. Also, to make sure that the market keeps its faith in the company, the company should communicate frequently and actively after a disruption. As a supplier to the fast-paced electronics industry, Taiwan Semiconductor Manufacturing Co. Ltd. set up a 24-hour hotline for customer inquiries just seven hours after the Taiwan earthquake struck. A steady stream of press releases and executive missives followed, successfully quelling concerns and keeping the market informed of TSMC’s actions and plans for recovery.

Control Systems It is difficult to pinpoint exactly when an organization realizes that a disruption has occurred. Information accumulates until it coalesces and reaches the point at which enough is known to take action. The two principal functions of control systems are to detect a disruption quickly and to foster speedy corrective actions.

In order to detect supply chain disruptions quickly, many enterprises are using shipment visibility systems. Such systems became widespread in the 1990s and are now familiar to consumers who use FedEx or UPS. Such tracking and tracing capabilities can help customers anticipate late shipments and sometimes detect abnormal patterns that can warn of larger problems.

The coming deployment of radio frequency identification technologies may increase the ability to identify disruptions quickly by providing managers with an accurate and detailed picture of all inbound material and outbound goods at any given point in time. In case of a disruption, flows could be rerouted immediately and used where they are needed most.

Sensitive control systems often can identify a disruption before its cause is apparent. In August 2001, healthcare company Baxter International Inc. was mystified by higher than normal death rates among European patients using its kidney dialysis blood filters. Although extensive tests by an independent labora-

tory revealed no anomalies, Baxter’s statistical process control determined that there was a disruption that could not be explained by random phenomena. The company pursued the problem and eventually determined that perfluorocarbon liquid left inside the filters could create small gas bubbles in the patients’ blood that could precipitate their deaths.

The Right Culture In their early stages, disruptions may seem innocent enough, as suppliers and even governments release reassuring information. But gauging the magnitude of a large disruption early requires a mindset that continuously questions prevailing wisdom and — at least as important — requires a culture that allows “maverick” information to be heard, understood and acted upon. From Pearl Harbor to 9/11, there are abundant examples of foreknowledge and analysis that contributed little to the understanding of a developing threat, largely because governments were prisoners of certain dogmas regarding the intentions and capabilities of their adversaries. Similarly, the business literature is full of examples of companies that failed because they could not comprehend and respond quickly enough to the implications of the changes around them.

It is important not to underestimate the contribution of culture to an organization’s flexibility and resilience. There are many cases in which responses to disruptions cannot be prescribed in a well-defined process, where there is a need for situational awareness and initiative at levels closest to the event and furthest from the headquarters-based strategic planners. One of the important tenets of resilience is empowering front-line employees to take initiative and actions quickly on the basis of the facts on the ground.

In March 2000, for example, a fire at a Philips Electronics plant in Albuquerque, New Mexico, disrupted the flow of chips to cell-phone makers Nokia Corp. and Ericsson. Both competitors depended solely on Philips for these particular chips and were equally affected by the fire, but their reactions were very different. Nokia invoked a special process developed for just such situations, putting Philips and the chip on a special “watch list.” Nokia engineers then called Philips daily to inquire about the situation. It became clear very quickly that the fire was a major disruption and the plant would be out for months. Nokia responded aggressively, sending 30 employees to work with Philips and other suppliers to restore supply. It also used different manufacturers, designed its handsets to use different chips where possible and secured Philips’

entire worldwide capacity for manufacturing the chips it needed. Nokia's CEO communicated directly with Philips' CEO about the problem on a regular basis.

Ericsson, by contrast, was not proactive and did not realize the seriousness of the disruption until weeks later. By the time it mounted a recovery effort, the worldwide supply of the chips in question — from Philips and other suppliers — was committed to Nokia. Nokia achieved its sales plans; Ericsson missed a critical new product introduction that resulted in an estimated \$400 million revenue loss. Not long after, Ericsson ceased making cellular phones under its individual brand.

Observers have attributed Nokia's resilience in large part to the company's culture of *sisu*, which is Finnish for "courage under pressure," or simply "guts."⁹ That ethos, along with Nokia's deep relationships with its suppliers, enabled the company to recognize the severity of the situation quickly, disseminate the news and take immediate action at various levels of the organization, from the CEO on down.

Organizations that distribute decision-making power and are successful in getting their employees to be passionate about the company's mission are fundamentally resilient. During the 2003 SARS epidemic, for example, most international conferences and business travel were curtailed. In fact, many airlines cut their flights to and from Southeast Asia. Local employees of global shipping company DHL International Ltd., however, obtained protective gear and continued serving their clients. Furthermore, they visited many conference organizers and convinced them to send materials around the world in lieu of the canceled meetings. The result was several months of record business for DHL in and out of Southeast Asia.

The awareness of front-line employees can be nurtured using many of the same processes used to shape a culture of quality in corporate America in the 1980s and 1990s,¹⁰ including learning from errors and fixing the root causes. Drawing on the processes used by the safety movement, companies can minimize the risk of large disruptions by paying attention to small disruptions as indications of developing problems, using "near miss" methodologies.

The Business Case for Investing in Flexibility

Companies are increasingly vulnerable to high-impact/low-probability events. The risks grow daily as global supply lines stretch, competition stiffens around the globe, customers demand faster responses and more choice at lower cost, and political instability takes its toll worldwide. Many companies have increased their security efforts and updated their business continuity plans. Some go as far as regularly conducting extensive "red team" exercises, in which a disruption is simulated and employee reactions are monitored and used in training; others use formal processes to gather risk metrics for presentations to their boards of directors. Many business continuity plans are based on increasing redundancy in several facets of the companies' operations. Such investments,

however, can go only a limited way toward reducing vulnerability. Furthermore, they present a cost to the company with a return that can be realized only in case of a major disruption.

The most important step companies can take to increase their resilience fundamentally and efficiently is to increase their flexibility. Flexibility not only increases resilience in times of disruption but also garners benefits and operational efficiencies in the normal course of business. As companies move to build flexibility in order to respond to demand and supply volatility, they are also building in resilience and vice versa. For example, a low-cost offshore supplier may be supplemented with a local supplier that has reactive capacity and can respond quickly to market changes. Such capacity can supplement the first supplier not only when that supplier is disrupted but also during volatile periods such as when introducing new products and phasing out old ones. Therefore, although the results of increased flexibility are difficult to measure with traditional accounting and risk management tools, investment in flexibility can be justified in terms of the increased sales, reduced costs and increased competitive advantage that companies can enjoy by developing flexible operations.

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