

BUILDING A RESILIENT SUPPLY
CHAIN CAN HELP A COMPANY
SURVIVE IN THE FACE OF A
CALAMITOUS DISRUPTION

By Yossi Sheffi

Preparing for the Big One

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Fire strikes Toyota's sole supplier of brake pressure valves. An earthquake in Taiwan shuts down chip manufacturers for Dell and Apple. The US Pacific ports are forced to close during the Christmas rush. A hurricane devastates the US Gulf Coast. What happens

when such high impact/low probability (HILP) disruptions strike? How can companies avoid these disruptions? What steps can companies take to come back and even thrive in the face of HILP disruptions? First, it's important to recognise the characteristics that distinguish HILP disruptions from normal disruptions.

In many cases, HILP disruptions involve public fear (recall 9/11, anthrax, foot and mouth disease, etc). The fear may also lead to hoarding of resources, such as fuel during a fuel shortage or antibiotics during an anthrax scare. This fear can also lead to overreaction by governments, further aggravating the disruption because of the need to instil public confidence.

In the fourth quarter of 2001, Ford lost 13% of its planned output not because of the 9/11 attacks, but as a result of the border closing that followed. Similarly, when the United Kingdom closed its countryside to fight foot and mouth disease (FMD) in 2001, it suffered more damage from reduced tourism than from the actual agricultural impact of FMD. Companies should expect these phenomena to be part of any HILP disruption. Furthermore, in this modern connected world, they should expect that many disruptions simply cannot be foreseen.

The range of potential disruptions to the operations of retailers, manufacturers, transportation carriers, and all others involved in the supply chains of goods and services is infinite. They can be classified as follows: random phenomena, such as hurricanes, floods and earthquakes; accidents of all kinds, like Exxon Valdece, Chernobyl, and Bhopal; intentional disruptions, which include not only terrorist attacks but, on a different scale, sabotage and industrial actions.

Each type of disruption should be anticipated and defended against differently. Statistics regarding natural phenomena are available and can be used in deciding on facility location and redundancy measures – insurance rates, which are based on these statistics, can be used as a proxy for the risks. After years of safety research to identify causes and effects, leading companies have reduced dramatically the number of accidents by instituting safety and care processes. Intentional disruptions, however, are adaptive – the threat can change in response to defensive measures. Thus, the probability of a disruption is a function of the security and resilience measures taken.

To reduce the likelihood of successful intentional disruptions, firms have implemented security measures – investing in methods that reduce the vulnerability of an enterprise. Of course, a company is a citizen of its own

“Each type of disruption should be anticipated and defended against differently”

supply chain, and thus it is the chain's vulnerability that should be addressed.

While security principles have been practiced for many years in the national defence and intelligence communities, their application to supply chain requires certain adaptation. Principles such as layered and balanced methods should be combined with various collaborative efforts, including public-private partnerships, industry consortia, and employee-based community watch programmes, to result in a security culture.

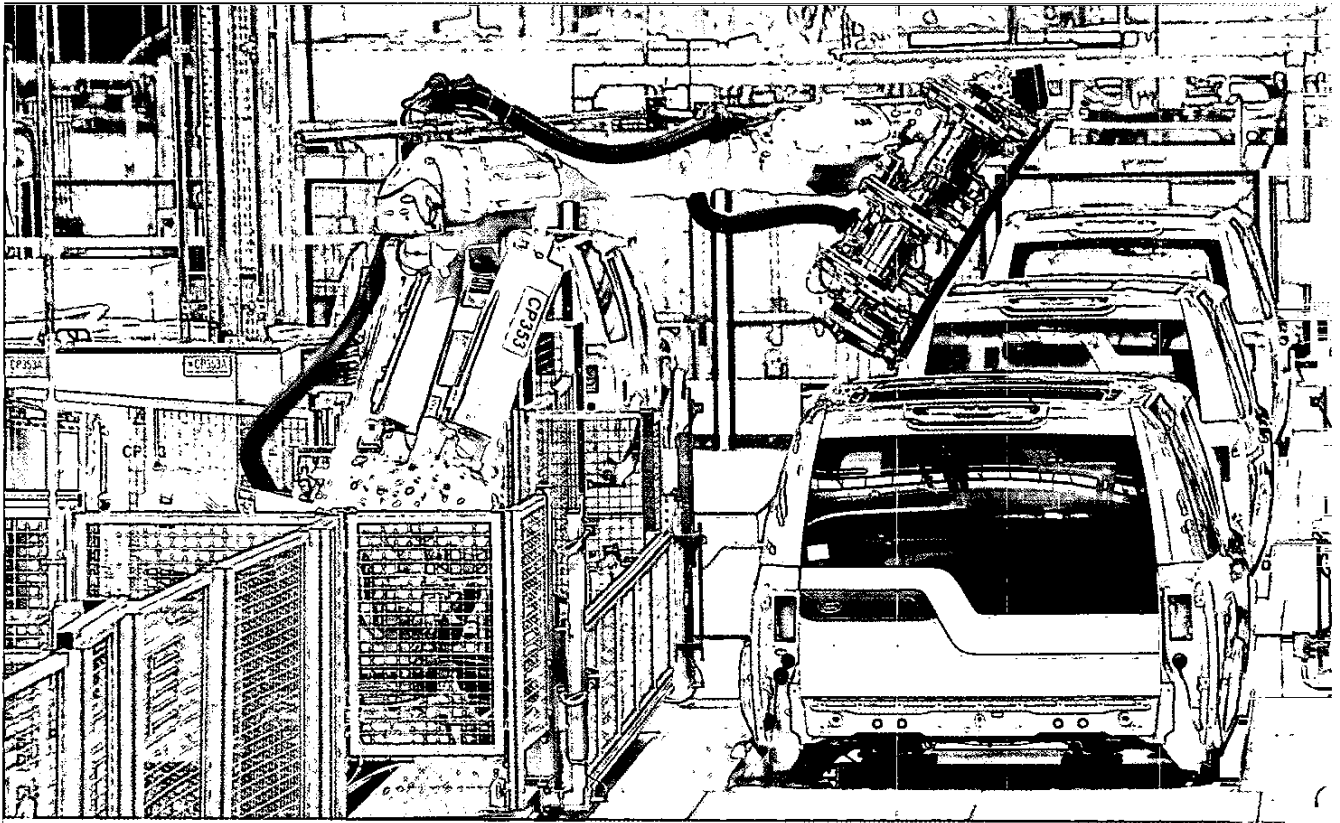
Resilience, a notion borrowed from the materials sciences, represents the ability of a material to recover its original shape following a deformation. For companies, it measures their ability to, and speed at which they can, return to their normal performance level – production, services and fill rate – after an HILP disruption.

Resilience can be achieved either through redundancy or through building in flexibility. The standard use of redundancy includes safety stock of material and finished goods. Such inventory can give a company time to plan its recovery after a disruption. Indeed, many companies have increased inventories when preparing for a disruption, such as the extra parts accumulated by NUMMI as the West Coast labour relations deteriorated in spring and summer of 2002, leading to the East Coast ports lockout.

Extra inventory, however, is expensive to hold. Furthermore, as demonstrated by lean and six sigma processes, it can also lead to sloppy operations resulting in increased costs and reduced quality. By contrast, increasing supply chain flexibility can help a company not only withstand HILP disruptions but also better respond to the day-to-day vagaries of the marketplace.

To build in flexibility for resilience, companies must involve many facets of supply chain design by: developing the ability to move production among plants, use interchangeable and generic parts in many products, and cross-train employees; using concurrent processes of product development, ramp up, and production/distribution; designing products and processes for maximum postponement of as many operations and decisions as possible in the supply chain; and aligning their procurement strategy with their supplier relationships.

These principles create not only resilient supply chains that can recover from disruptions but also flexible supply chains that can respond to day-to-day demand changes. One begets the other, because a supply shortage and a demand spike are, at their core, a problem of →



Land Rover suffered disruption from a supplier's bankruptcy

supply/demand mismatch. Companies that have built their supply chains to respond to significant demand fluctuations have also built in the ability to respond to supply shortages.

How exactly do these supply chain principles increase resilience? Postponement – delaying the final configuration of product to as late as possible in the supply chain when more accurate demand information is available – and built-to-order operations allow for diversions of parts and semi-finished material from surplus areas and products to satisfy shortages. Thus, with only a few days of committed orders, Dell fared better than Apple during the 1999 Taiwan earthquake, which disrupted the worldwide supply of memory chips.

The use of a small number of commodity parts not only simplifies operations and concentrates the procurement outlays; it also creates flexibility to move the business among suppliers should one falter. When Intel's Systems Group reduced its mix of 2000 different types of resistors, capacitors, and diodes to only 35 types, it not only simplified procurement and reduced costs but also increased its ability to respond to demand changes and supply disruptions.

Reducing time to market also means that the time to recover from disruptions is likely to be short. To this end, Lucent created a special Supply Chain Network organization in 2001. Cutting across the company's engineering, procurement, manufacturing, distribution, and even sales divisions, the network increased the company's agility.

The use of multiple suppliers with different characteristics allows HP not only to have redundancy but

also builds in flexibility. HP's choice of supply plants for its printers division means that, during ramp-up and end-of-life, they can use their agile, yet more expensive, plant, but during the steady demand period of each printer, they can use the more efficient plant.

Relationships with suppliers represent an important component of resilience. A company can maintain close relationships with a few key suppliers, or shallow relationships with many suppliers. Either way, the company should be knowledgeable about its trading partners so that it is forewarned about potential disruptions.

Inadequate monitoring of its supplier base almost cost Land Rover its business when its sole supplier of chassis frames for the Discovery models, UPF-Thompson, unexpectedly went bankrupt 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. A deeper relationship with UPF would probably have alerted Land Rover to the crisis before it occurred.

Collaborative relationships with trading partners can help companies go to the market faster. Such relationships also 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.

Making components or even manufacturing facilities interchangeable is another way to spread the risk when an unexpected disruption hits a company's operations. For example, Intel, the chipmaker, makes sure that the layout of each of its plants is identical. That way it can easily shift production from one facility to another if it

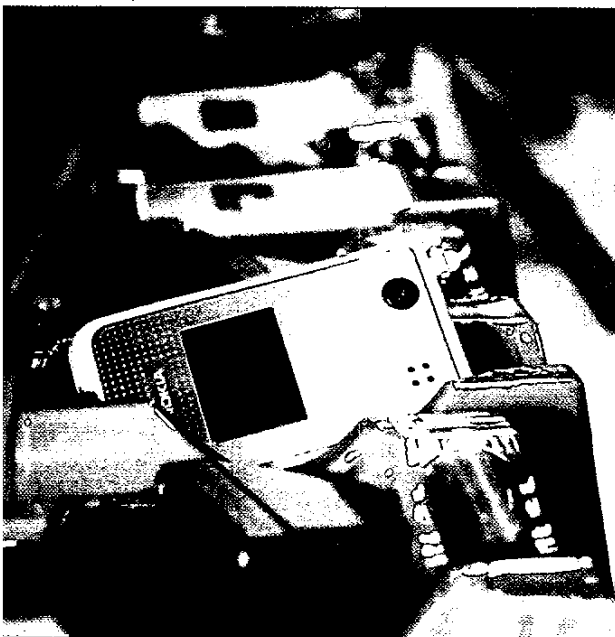
needs to. This can be enormously powerful in an emergency situation. The company can avoid losing production by shifting the load to another plant. Such a design philosophy is also useful in responding to changing global demand patterns.

However, the most important factor, and one which clearly distinguishes between companies that bounce back from a disruption and those who do not, is the corporate culture. Organisations like Nokia, Toyota, UPS, Schneider National, FedEx, Dell, and the US Navy can be studied to understand the principles that make them flexible and resilient. While on the surface, organisations such as Dell and the US Navy may not seem to have much in common, a closer look shows these resilient companies share several common traits, especially within their corporate culture.

For example, these organisations empower people to act when they detect a problem. In the US Navy, for instance, the lowest ranking sailor on the deck can halt the flight operations on an aircraft carrier. If a sailor sees a problem during flight operations, he is empowered to call an immediate halt to the operations of a multi-billion dollar floating air base run by over six thousand well-trained military personnel. Quick action like this ensures that the organisation takes corrective action as early as possible, increasing the chances of successfully dealing with the emergency.

Another common characteristic of a resilient organisation is its ability to circulate bad news and deal with the root causes quickly. An example is that of mobile phone manufacturers Nokia and Eriksson. A fire at a major supplier cut off the supply of a type of chip that was crucial to their manufacturing operations. Nokia's open culture circulated the news, and the company recovered very quickly by finding other sources.

Nokia's open culture



Eriksson, on the other hand, was more closed, and sat on the news. The result: by the time Eriksson realised it was in deep trouble, Nokia has bought up most of the alternative sources of chips. Eriksson later exited the business.

Unfortunately, culture is difficult to define and even more difficult to change; but it's not an impossible task. The successes of the quality movement in the Eighties and the safety campaign in the early part of the last century serve as strong examples of how corporate culture can change dramatically. Several corporate turn-around cases, like that of Continental Airlines under Gordon Bethune, also show the importance and the plausibility of changing corporate culture. Even the culture of populations can change as demonstrated by the anti-smoking and anti-drinking and driving campaigns in the US. These successful cases should serve as blueprints for other companies striving towards resiliency, because the right culture means that the entire organisation is deputised to serve as the eyes and ears of the corporate security efforts and can take the necessary actions to recover from any disruptions, when the normal hierarchy is not operational.

Of course the cost of investments in resiliency has to be justified, and companies need to be wary of some common misconceptions when making such an evaluation. It is often assumed that the cost of building resilient enterprises can be justified by estimating the cost of a disruption and making the case that this expense can be avoided if the organisation is prepared for the crisis. This is not a convincing approach since the costs invested in resilience are real while costs avoided do not show up on the income statement or the balance sheet. However, most investments in resilience carry collateral benefits or benefits that are a by-product of resiliency. The main one is making the enterprise more responsive to markets that are changing faster and faster, thus obviating the need to justify such investments based on cost avoidance alone.

Assessing the level of investment needed is easier when a company has a sense of how vulnerable it is to disruptions. The two most important questions when dealing with a possible disruption are over how likely such an incident is and how bad it can be if it does occur. Placing different disruptions on a graphical representation with two axes – one that measures the event likelihood and the other its expected severity – can help companies prioritise potential disruptions and response preparations. ■

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 three years of MIT research and offers not only recommendations but also the business case for investments in security and resilience.