

**NOTE: John Gattorna's work is referenced on page 22.**

## The physical internet

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From The Economist print edition

**Like information on the internet, goods are moving around the world with ever greater efficiency. But Paul Markillie spots dangers lurking in modern supply chains**

Corbis



LOUISVILLE, Kentucky, 2am. Roaring thrust-reversers rapidly slow the giant MD-11 jet as it touches down on the runway before turning to taxi towards a sprawling floodlit building. Seconds after it has pulled up at the ramp, large doors on the fuselage swing open and people scurry around with equipment. But they are not about to unload hundreds of passengers: instead, the aircraft carries stacks of air-freight containers stuffed with parcels and documents. Soon they will be emptied to join the 300,000 packages that are sorted every hour at the UPS Worldport.

Every package is automatically photographed, measured and weighed and has the information on its super-barcode analysed by computers to determine its trajectory along some of the 17,000 conveyor belts. This requires awesome computing power: more data are processed here every 30 minutes than in an entire day of trading on the New York Stock Exchange. Eventually the packages slide down a chute to be placed into a bag or an air-freight container. And before dawn they are off again to complete their journey in another aircraft or in one of a fleet of waiting trucks.

A few hundred miles to the south-west, in Memphis, Tennessee, more landing lights line up across the night sky. This is FedEx's global hub, and for the next few hours an aircraft will land here every 90 seconds. Every one of them has the company logo painted on its tail. Tractors towing containers and cargo pallets dash everywhere. Documents are automatically sorted in a maze of machines. In

one giant building, known as the “matrix”, packages zoom around on 300 miles of conveyor belts. Before dawn, all these packages too will have departed again.

As the night continues to travel west, similar scenes unfold at airports in Manila, Taipei, Hong Kong, Mumbai, Guangzhou, Dubai, Cologne, Paris and Anchorage. The goods moving through these air-cargo hubs range from items bought on eBay to vehicle parts, fresh flowers, books, computers, transplant tissue—just about anything imaginable. Even live whales have been “FedExed”. And when the night reaches America again, the landing lights once more appear in the sky over Louisville and Memphis.

## **21st-century clippers**

Frederick Smith, FedEx's chief executive, compares his company's jets to clippers, the sailing ships that once carried cargoes on the trade winds. Mr Smith pioneered the air-express business in the early 1970s by delivering a few hundred parcels overnight to a handful of American cities using Falcon aircraft the size of an executive jet. At Memphis airport, the parcels were sorted on a table. Many of his contemporaries thought he was mad: who would pay to send packages by air? He almost went bust. But now FedEx has ordered a fleet of double-deck Airbus A380s to help cope with demand. Rival UPS has also placed orders for the huge new Airbus. Neither company wants any seats inside, just space for lots of cargo. If they were passenger airlines, UPS and FedEx would now rank among the world's biggest carriers.

In an effort to rebrand itself, UPS is painting the phrase “Synchronising the World of Commerce” on its 270-plus aircraft and 90,000-plus vehicles, including its distinctive dark brown delivery trucks. It may not exactly trip off the tongue, but it is an apt description of a business that has grown far beyond simply delivering things. Nowadays firms ranging from trucking companies to freight forwarders, shipping lines, air-cargo carriers and post offices are more likely to use the word “logistics” to describe what they do.

Logistics is a military term. As generals know, wars can be won or lost by it even before they are fought. Now companies are having to become more involved in planning their own logistics. Under relentless pressure to reduce costs and increase sales around the world, firms are outsourcing operations to subcontractors who can do them better and more cheaply, and moving more of their production and services to lower-cost countries.

Globalisation requires greatly increased co-ordination of transport by road, rail, sea, air and now also by an entirely new route to market: the internet. This makes logistics vastly more complex. The job of ensuring that all these things work together is known as supply-chain management. Thomas Freese, an American consultant in this business, explains: “Supply-chain management is an evolution of logistics. Logistics tends to be tactical, supply-chain management is strategic.”

Supply chains are becoming not only longer but also more enveloping. Supply-chain management these days can include anything from buying raw materials to managing suppliers, warehousing, operating transport fleets, taking orders, collecting payments, repairing products and even answering the telephone at call-centres. Companies are also outsourcing supply-chain services.

Yet supply-chain management is not just about wringing costs out of a business. It can also be used to increase revenue and boost profits without necessarily lowering costs. Indeed, some companies have re-engineered their supply chains to gain a huge competitive advantage. What has put Wal-Mart ahead of Sears in retailing, Dell in front of Hewlett-Packard in the personal-computer business and Zara ahead of Marks & Spencer in fashion? The market leaders all have supply chains that are more responsive to customer demand, according to Yossi Sheffi, director of the Massachusetts Institute of Technology's Centre for Transportation and Logistics.

Things like transport, purchasing and warehousing used to be considered merely part of the cost of doing business, and were often managed as separate entities. Now they are coming together as a strategic item on the chief executive's agenda. There is a reason for this. "Supply-chain leaders are very aware of how a company runs because they have to deal with all the different components of the operation," says Rick Blasgen, who used to work for a big American food group and now runs the Council of Supply Chain Management Professionals.

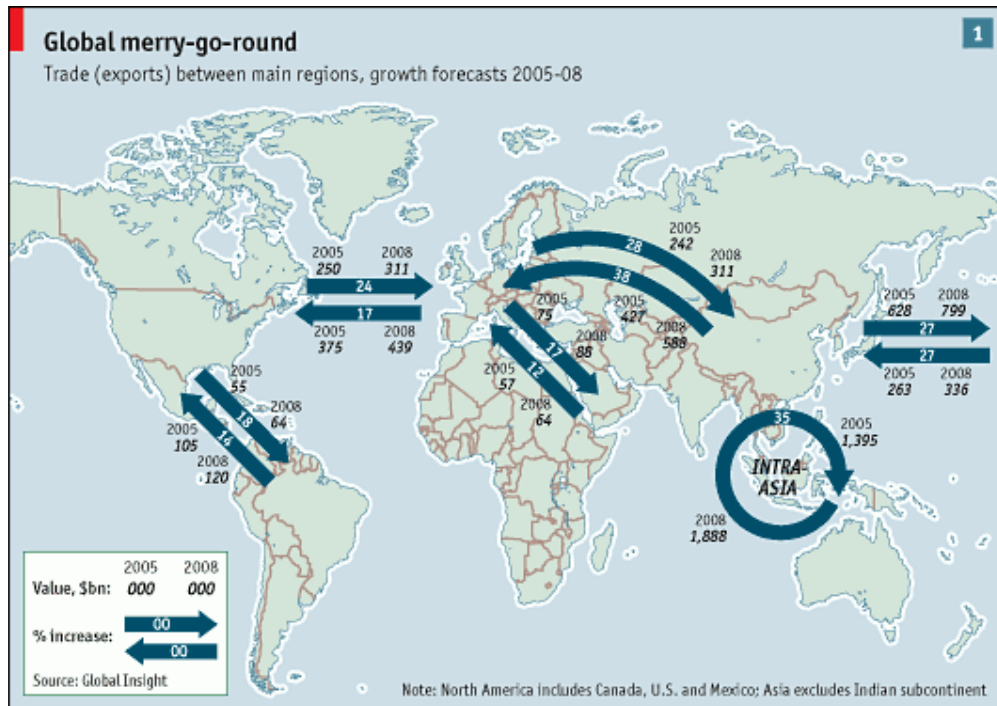
But as this survey will show, supply chains harbour dangers too, and managing risk is becoming a pressing issue. A number of alarm bells have started ringing. Most firms have been organising their logistics to make themselves leaner. Many now carry little or no inventory to save money. Indeed, sometimes their entire inventory consists of what is moving from the factory directly to the consumer in the back of a truck or an aeroplane. If something goes wrong—and it often does—business will quickly grind to a halt.

Experts worry that some companies do not fully understand the risks of operating very lean international supply chains—or that they choose to ignore them because their rivals are forcing the pace, purchasing critical components from a single supplier to increase their buying power. In fact, some firms do not know who is supplying their suppliers—or even where some of their lower-tier suppliers are based.

# Shining examples

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## How three large and successful companies are using their supply chains to compete



COMPANIES are now tweaking their logistics to give themselves more flexibility should anything go wrong. For instance, instead of relying entirely on manufacturing in low-cost regions, they may put part of their operation—perhaps a rapid-response warehouse or a second factory—closer to, or even inside, the big consumer markets of America and Europe. This will increase costs, but could prove worthwhile by providing greater responsiveness as well as an insurance against risk. Such moves might even put a modest brake on globalisation, although trade flows—especially to, from and within Asia—are likely to continue to grow strongly (see chart 1).

Most experts rate Dell's supply chain as one of the best, even though the computer company faces increasingly tough competition. Instead of building computers according to a sales forecast and letting other companies sell them, Dell sells directly from its own website and call-centres and then builds to order. That way, it not only cuts distributors and retailers out of its supply chain but also gets paid up front. It orders some of its components only when it has received an order itself.

To succeed against its low-cost rivals, Dell must have a supply chain capable of getting computers to its customers within a few days. The company outsources some operations, such as component production and express shipping, but runs its own assembly lines in America, Ireland, Malaysia, China and Brazil. Last year the company opened its third assembly plant in America, in Winston-Salem, North Carolina. This can make a desktop computer every five seconds. Dell decided to expand in America in order to be close to its customers, but it is still growing in Asia too.

In terms of speed to market, Dell has much in common with Zara, a fast-fashion company that is part of Spain's Inditex group. Fashion is highly perishable, quickly influenced by the latest thing seen on the catwalk or on the back of a celebrity. Zara's designers follow such fashion trends closely. But whereas a typical clothing company manufacturing in Asia could take six to nine months to get a new design into the shops, Zara completes the process in around five weeks. It buys some garments and material from Asia, often partly finished or undyed, but around half its clothing is manufactured in-house at its base in La Coruña in north-west Spain, or by a cluster of small contractors in the same area. The clothing is delivered by truck to Europe and by air to the stores Zara is now opening in other parts of the world.

AFP



**From catwalk to checkout in five weeks**

Zara avoids mass production. Although some stock is replenished, its clothing, for both men and women, is deliberately made in small batches. This helps create a scarcity value: better buy now in case it is gone tomorrow. It also keeps shops looking fresh and reduces markdowns. At Zara, the number of items that end up in a sale is about half the industry average.

Behind many successful companies lies a successful supply chain. Indeed, someone who knows about logistics may be running the company. Lee Scott, the chief executive of Wal-Mart, rose through the ranks of the company's transport and logistics divisions. And at Toyota, the pioneer of lean manufacturing, Katsuaki Watanabe, who took over as president of the Japanese car company last year, made his name cutting some \$10 billion of costs out of Toyota's supply chain.

But buying things more cheaply from suppliers is not the only way of achieving cost savings. Another tempting economy is to cut down on stocks. The chief reason for holding stocks is to smooth out bumps in the supply chain. Hau Lee, a professor of operations, information and technology at Stanford University, points to one of the biggest sources of inefficiency in logistics. He calls it the "bull-whip effect", after the way the amplitude of a whiplash increases down the length of the whip when it is cracked.

Procter & Gamble (P&G), a giant consumer-goods company, discovered this effect more than a decade ago. The company noticed an odd thing about Pampers, its well-known brand of disposable nappies: although the number of babies and the demand for nappies remained relatively stable, orders for Pampers fluctuated dramatically. This was because information about consumer demand can become increasingly distorted as it moves along the supply chain. For instance, a retailer may see a slight increase in demand for nappies, so he orders more from a wholesaler. The wholesaler then boosts his own sales forecast, causing the manufacturer to scale up production. But when the increase in demand turns out to have been only a blip, the supply chain is left with too much stock and orders are cut back.

A more reliable flow of information can smooth out these fluctuations. One way of achieving this is to integrate supply chains, as P&G has now done with Wal-Mart and other big retailers. The idea is to organise things so that sales information from a store will automatically prompt the level of deliveries needed to keep the shelves stocked.

For a company such as Wal-Mart, with more than 60,000 suppliers in America alone, keeping everyone informed is critical. The company does this through its Retail Link system, which suppliers can tap into over a secure internet connection. They can check stock levels and sales down to the level of individual stores. Wal-Mart may have a brutal reputation for driving down costs, but its investment in information systems has played a large part in building one of the world's most efficient supply chains, capable of handling more than \$300 billion of annual sales.

There is a direct relationship between inventory and information, says Martin Christopher, director of the Centre for Logistics and Supply Chain Management at Britain's Cranfield School of Management. The more information a company has about its suppliers and its customers, the better it is able to plan. A greater understanding of each link in the supply chain can also improve efficiency and reduce risk. This is leading to a much higher level of co-operation, says Patrick Ducasse, global head of the consumer practice at Boston Consulting Group. According to Mr Christopher, in future it will be supply chains that compete with each other, not individual companies.

Members of supply chains invariably do business with one another over the internet. You may not know how to ship a product from, say, Bangladesh to Barbados, but there will be a freight forwarder or express-delivery firm that does. Increasingly services of this kind are available online. Some companies, such as INTTRA and GT Nexus, two American firms, now provide specialist web-based platforms capable of doing much of the work for logistics managers using ocean freight. The internet is ideal for this purpose, says Greg Johnsen, of GT Nexus: "It is global, it is always on and you can get to it from almost anywhere." His service, which provides on-demand logistics software that links into widely used office applications, now has around 40,000 regular users.

Logistics managers ship their goods through hub-and-spoke systems that resemble those used by the internet, except that they are visible. If you could look inside the big internet exchange points scattered around the world, you would see immense numbers of packets of information, each with an address attached, all being read, redirected and sped on their way, just like their physical equivalents in the cargo hubs at Louisville and Memphis. And just as computer networks are getting faster and more efficient, so too are those for moving goods in the physical world.

## Manufacturing complexity

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### As distinctions between ownership and control become blurred, supply chains are getting more twisted

IT COULD happen anywhere in the world, on any production line, but if one of its products or components fails a test, Cisco Systems knows about it. This is because the world's largest maker of the networking equipment that powers the internet has linked up all the test machinery in the factories that make its products, and results are immediately relayed to Cisco's headquarters in San Jose, California. If the company's engineers do not like what they see, they can remotely shut down a production line or distribution centre until the problem is fixed.

The Guardian



**Our daily bread**

This degree of transparency in a global manufacturing operation is quite remarkable—even more so when you consider that Cisco, which may achieve sales of some \$28 billion this year, does not own the vast majority of factories that make its products. The company believes that outsourcing has allowed it to grow far more rapidly than if it operated its own assembly plants. But it has had a few problems along the way.

In 2000, Cisco briefly became the world's most valuable company as technology firms' share prices soared to astonishing levels. Some customers were ordering



technology products on a hunch that shortages were on the way. But the bubble suddenly burst, and despite its clever manufacturing system Cisco was left heavily overcommitted as some of its customers slashed their spending. In 2001, Cisco reported its first quarterly loss since it went public in 1990 and wrote off \$2.2 billion-worth of unsold networking equipment. That was a powerful incentive to improve its supply chain.

This is becoming more complex as Cisco expands into new areas. The big routers and network-switching equipment that make up its core business are custom-built to order. But that does not apply to the consumer products into which Cisco is now venturing. In 2003 the company bought Linksys, which provides wireless networking equipment, much of it for home use. And last year it splashed out \$6.9 billion on Scientific-Atlanta, which makes television set-top boxes for video, cable and satellite. As technologies merge, Cisco may make the equipment to broadcast television programmes taken from the internet around people's homes.

Building big internet routers involves some forecasting of future demand, pre-manufacturing certain common parts and rapidly customising the equipment when an order comes in. By contrast, making consumer electronics involves manufacturing lots of standard products that will be sold mostly through retailers.

To keep on top of demand, Cisco has had to do the sort of things that P&G does in supplying supermarkets, avoiding shortages on one hand and too much stock on the other. This means that on the consumer side of its business Cisco is in daily contact with retailers. "What happens in Ohio at Best Buy is going to be quite different at Dixons in Manchester," says Angel Mendez, head of Cisco's worldwide manufacturing.

Plenty of consumer-electronics companies outsource their production, but Cisco is now having to re-examine whether that is really the best option for its consumer division, because Scientific-Atlanta has done rather well building its own products in its own factories. Mr Mendez is convinced that outsourcing, albeit with strong centralised controls, has given Cisco a huge competitive advantage in its core business, but he is open-minded about what will work best on the consumer side. "The one-size-fits-all solution may or may not be right," he says. "What does matter is having an agile, adaptable and speedy supply chain." For Cisco, that means it will have to find a system that can cope with a spectrum of products ranging from \$99 consumer items to \$1m-plus purpose-built router systems. The answer may be to set up completely different supply chains with some common features, such as combined component-purchasing.

## **Doing it their way**

It is not unusual to find different outsourcing strategies among successful companies in the same industry. Apple, for instance, designs its hugely popular iPod but outsources the supply of the components and the assembly to other companies, many of them in Taiwan and China. By contrast, South Korea's Samsung Electronics is highly integrated, even making its own chips and liquid-crystal displays.

In the electronics business, there are two sorts of contract manufacturer building products to be sold under the brand name of an "original-equipment manufacturer" (OEM), the industry's odd name for a company that outsources its production. The first kind are "original-design manufacturers", who use their own designs and intellectual property to produce for OEMs. These companies tend to

be specialised and design things from the ground up. Most began by making circuit boards but have progressed to designing and producing complete products, such as laptop computers, digital music players and printers. Many are based in Taiwan.

The second kind are providers of electronic manufacturing services (EMS), which make products to the design and specification of an OEM. Increasingly these companies offer a broader range of services, such as helping with the design so that products are easier to make. Such firms include Flextronics, based in Singapore, Solectron and Sanmina-SCI, both with headquarters in Silicon Valley, and Celestica, based in Canada. They all operate factories around the world. Contract manufacturers do not like to disclose whom they are working for, but their clients include IBM, Microsoft, Dell, Nortel, Xerox, Sony-Ericsson, Cisco, Sun Microsystems and Hewlett-Packard.

"It's much more of a supply-chain play now," says Tom Wright, who is in charge of worldwide logistics for Flextronics. The firm has factories in more than 30 countries around the world, most of them in low-cost regions such as Asia, eastern Europe and Latin America. Companies are constantly asking their suppliers to become "quicker, cheaper and more responsive", says Mr Wright. "Where it gets massively complicated is the physical movement of all these materials." That complexity has increased enormously in the past five years, with so much manufacturing moving to China, India and other Asian countries.

Which companies come out on top will depend crucially on the integration of supply-chain information systems, Mr Wright believes. He, too, doubts that there will be a single solution. Flextronics has organised itself into different divisions to handle its \$15 billion-plus sales of mobile phones, computers, networking equipment, digital cameras, printers, medical devices, car components and many other products.

One of the problems companies face is that different products may need to move along their supply chains at different speeds. A supermarket, for instance, needs regular supplies of perishable products such as bread, eggs and milk, although customers coming in to buy them will also occasionally buy slower-moving items such as shoe polish or light bulbs. A supplier cannot afford to ignore either. If people cannot find what they are looking for, they may go elsewhere. "Being in stock is one of the most important measures supermarkets look at," says Sam Israelit, an expert in retail logistics for Bain & Company, a firm of management consultants.

Companies need to offer different service levels for different products, says Mr Israelit. The idea is never to be out of stock of high-velocity items, which tend to be the most profitable. On lower-velocity items, there is slightly more room for error. But demand will also vary by location and season. One supermarket may sell lots of ethnic food because of local demographics, whereas another may get runs on things like barbecue sauce and charcoal when the sun comes out. According to Mr Israelit, "it adds enormous complexity to the planning process." Few firms will have the clout to build an organisation capable of handling all of these things, so they will outsource their logistics to specialists.

Even P&G, which is one of the world's largest consumer-goods companies, outsources parts of its supply chain, such as trucking operations. The company talks about two "moments of truth" in retailing. First, is your product on the shelf? Second, when you have persuaded a customer to pick your product, does it deliver what it promised? The first requirement can be met through a

collaborative effort between supplier and retailer; the second will depend on a combination of things such as product innovation, marketing, packaging, presentation and pricing.

Collaboration in the supply chain improves visibility, says Chris Poole, P&G's director of outbound logistics in western Europe. He calls it "joint value creation". At a practical level it means that by sharing more sales information, a supermarket planning a special promotion, for instance, can be reasonably sure that a supplier will be able to deliver the necessary goods. At the same time the supplier will be better placed to increase production. With better information, both the retailer and the supplier can afford to carry less stock. "Supply chains are becoming leaner, but paradoxically they can also become more agile," adds Mr Poole.

There are various ways to streamline the process, he says. One way of reducing costly handling is to put items into "shelf-ready packaging" so they do not need to be unpacked from a box and placed on a shelf individually. In Europe, P&G uses a three-tier logistics system to schedule deliveries of fast- and slow-selling goods, bulky and small items in the most efficient way. The idea is that every shop gets what it wants when it needs it and lorries travel as full as possible. When the load is too small to justify a truck, it is sometimes sent by courier. And thanks to satellite-tracking gear on vehicles, supermarkets can be alerted when a truck is about to arrive so they can prepare for unloading.

Individually these are small things, but taken together they can make a huge difference. In Europe, P&G uses some 2,000 trucks a day just for outbound deliveries. Excluding small items like cosmetics and fragrances, those trucks between them carry more than 1,800 different products. Ensuring that the supply chain runs like clockwork—and to do it every day, seven days a week—takes an enormous amount of effort.

## **Jumbo task**

Yet some companies' supply chains have to cope with things that are a magnitude bigger still—such as building a jumbo jet. A Boeing 747 contains some 6m parts, all of which have to be ordered, tracked, assembled and often carefully monitored throughout their service life. That adds up to a huge information load even for a single aircraft—and this year Boeing expects to deliver almost 400 new jets.

AP



**Where the aerospace giants come together**

At Everett, just north of Seattle in Washington state, Boeing manufactures its 767, 777 and giant 747 airliners in the largest factory in the world. The parts that go into each aircraft arrive by road, rail and air from all over the globe. Now Boeing is gearing up to produce a new airliner on the site, and at the same time fundamentally reform its own supply chain.

The company has been steeped in the traditions of engineering, yet members of the team developing the new 787 Dreamliner, due to make its first flight next year, now talk like people working on new consumer products. That is largely because the design of the 787 is heavily influenced by Boeing's customers.

These are a varied bunch. For airlines struggling with high fuel prices, the 787 will offer around 300 seats, but with its sleek, lightweight construction it will give a 20% fuel saving over other aircraft of a similar size. To please passengers, the fuselage is designed to give them more room, the windows will dim electronically, and a new pressurisation system will provide them with healthier cabin air. The owners of the aircraft (who nowadays are mostly groups of investors who lease them to carriers) will want the 787 to have a long and flexible service life. It needs to be easily reconfigured to suit different airlines, thus improving their return on investment.

Boeing began development of the 787 by seeking its suppliers' advice, which is also done by other manufacturers, such as Toyota. "We asked them, how would you do it?" says Steven Schaffer, vice-president of Boeing's "global partners"—a title that reflects the new, more collaborative approach. Boeing has already begun to build aircraft more like cars, with a moving assembly line and a larger proportion of parts being completed as sub-assemblies before final fitting. As a result, the number of individual items that have to come together for final assembly has shrunk to a fifth of what it was a decade ago.

The 787 takes that process further. As much as half of its primary structure, including the fuselage and wings, will be made out of light but enormously strong carbon-fibre composite materials. Much of this will be prefabricated, rather than being riveted together from thousands of aluminium sheets and ribs. Two specially converted 747s with huge bulbous fuselages will be used to fly the composite structures directly to Everett.

Suppliers at more than 130 sites around the world are linked together with Boeing's development teams through regular face-to-face meetings, known as "partner councils". Urgent items are dealt with by video conferencing. These video links, often over secure internet connections, are becoming a common feature in the offices of suppliers and the companies they work for. They are the modern-day version of engineers gathering around a drawing board to scratch their heads and work out how to make something.

Mr Schaffer says that more sharing of information between Boeing and its suppliers allows everyone in the supply chain to take a longer-term view of how the market for the new aircraft will develop. This should allow suppliers to prepare more effectively for future demand, and Boeing to be ready for possible problems. The aim is to smooth out any potential lumps in the supply chain before they materialise. With a price tag of around \$130m for each 787, both Boeing and its partners are understandably keen to get the logistics right.

## Cargo cults

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### **With more and more stuff being moved around the globe, efficiency is at a premium**

THERE are few customers more demanding than Toyota. The challenge that Transport Corporation of India (TCI) has been set is to deliver the parts the Japanese company needs to build cars at a factory near Bangalore. TCI operates some 6,000 trucks, which is a good start. But the obstacles are formidable.

Getty Images



**A well-contained revolution**

For a start, Toyota wants just-in-time delivery. In the car business that usually involves suppliers delivering to a staging area near the factory, often run by a logistics partner, from where components are taken directly to the production line where they are needed, when they are needed. In Bangalore, Toyota wants those deliveries to take place every two hours—and with a level of reliability in excess of 99%.

But how do you do that when roads are often in poor condition and sometimes choked with traffic, and when crossing from one state to another can involve hours of border queues and miles of red tape? Trucks are lucky to manage an average speed of 30-40km (19-25 miles) an hour. With the most distant supplier more than 2,000km away, some components could take a week to reach the factory, always assuming the drivers and the lorries prove reliable and there are no accidents.

“Toyota taught us how to do it,” says Vineet Agarwal, executive director of TCI. His company set up a joint venture with Mitsui, a Japanese trading group, which acts as Toyota's logistics partner in India. They began with training to ensure that drivers would take care of their loads, moderate their aggressive driving habits and wear seat belts. Sometimes trucks are followed to make sure standards are maintained. This has helped to build a reliable service that meets Toyota's service levels, says Mr Agarwal. It has also cut stocks, saving \$100m a year in financing costs.

With more overseas companies investing in India, companies like TCI can expect to be kept busy. It is not just India's business-processing sector that is attracting foreign investment. The country is also enjoying a—less noticed—manufacturing boom, and merchandise exports are growing at a rate of about 25% a year.

TCI reckons that India's third-party logistics market will be worth more than \$16 billion this year, and that it will grow at a compound annual rate of 6.5%. As India develops, inevitably its low-cost advantage will diminish. On the other hand, the demands of foreign companies will make local supply chains more efficient, in India as well as in other developing countries such as China. And there is still a lot of scope for increased efficiency.

Mr Agarwal says the cost of logistics in India represents some 13% of GDP. For China, the Council of Supply Chain Management Professionals puts the figure at around 21% of GDP—a big improvement on 1991, when it was around a quarter. America shows just how much cost can be wrung out of the system: back in 1982, logistics represented 14.5% of America's GDP, but now the share is down to just over 8%. Between then and now, estimates the CSCMP, inventory costs in America have fallen by 60%. Europe is lagging behind America, with logistics costs of 11% of GDP or more.

Supply-chain efficiencies can be improved in various ways. One of the most dramatic was discovered 50 years ago when Malcom McLean, a American trucking magnate, reinforced the decks of the *Ideal-X*, an oil tanker left over from the second world war, and loaded it with 58 large metal boxes containing goods that would normally have travelled as loose cargo. It was this event, says Marc Levinson (a former finance editor of *The Economist*) in his recent book "The Box", which marked the birth of the shipping container.

## **Boxing clever**

The *Ideal-X* sailed from Newark, New Jersey, to Houston, where after a five-day trip the boxes were unloaded directly onto trucks and hauled to their final destinations. In 1956 the back-breaking business of loading cargo onto a ship cost \$5.83 per ton, says Mr Levinson. McLean calculated that loading the *Ideal-X* cost less than 16 cents a ton. Containerisation dramatically reduced the cost of shipping products from one place to another.

Today most goods and raw materials spend some time in a container as they move around. The container-shipping industry is booming (see chart 2), especially with exports from Asia. Giant container ports such as Hong Kong, Singapore and Los Angeles have flourished thanks to rapid-loading equipment. And container ships are getting bigger. Some now carry around 9,000 containers, and there are plans for giant vessels with double that number, which would require a line of lorries more than 50 miles long to haul away all the containers they could carry.

So why is Kuehne+Nagel (K+N), the world's leader in arranging seaborne cargo, so keen to expand its ground-transport side? The Swiss company developed as a freight forwarder, which means it arranges for other companies' goods to be carried by other companies' ships. It has already become a big air-freight forwarder and also operates road and rail services. Last year it paid €440m (\$532m) for Paris-based ACR Logistics in order to increase its presence in contract logistics.

Klaus Herms, K+N's chief executive, says he believes the time is right to develop his company's overland business. That does not mean he wants to own trucks, but rather to buy European companies that do on land what his company already does at sea and in the air. In the next three to five years, Mr Herms hopes to have the whole of Europe covered with a network of trucks working for him.

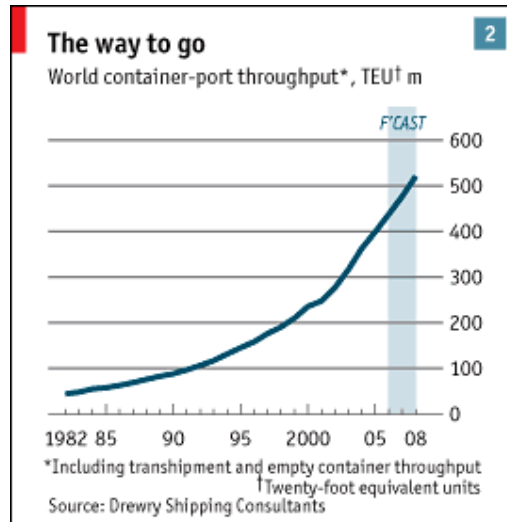
Trucking has been a highly fragmented and cut-throat business, says Mr Herms. But now the industry is consolidating, thanks to globalisation and the demand for more integrated and specialised services. Increasingly, customers need to use several different modes of transport, which are often handled by the same IT systems. As a freight forwarder, K+N sees its future as offering a broad range of supply-chain services.

Others have the same ambition, including many of the express operators. That does not seem to bother Mr Herms. "They can't jump out of the box," he says. "The box is their prime business." He points out that vast amounts of cargo are not actually carried in an individual box that can be picked up, sorted and hand-delivered. Many goods are carried as bulk loads and on pallets, which can be transported in different ways for maximum efficiency.

Box-bound or not, the three biggest express operators are broadening the range of services they offer. FedEx began in the air-freight business and grew into ground transport. UPS, which started in 1907 as a messenger and delivery service in Seattle, has expanded into aviation. In May, UPS announced a \$1 billion expansion at its Louisville Worldport to boost its sorting capacity by 60%. The company is also investing in lots of warehousing.

DHL, which takes its name from the initials of its three founders' surnames, began delivering documents by air from San Francisco in 1969. It expanded westwards and eventually reached Europe, where it was bought by Germany's Deutsche Post. In December 2005 Deutsche Post bought British-based Exel, a leading logistics-management company, for £3.8 billion (\$6.7 billion) and is now integrating Exel with DHL.

FedEx is also offering more services, but is being more selective than its rivals about the areas it wants to expand into, and less convinced about some of the synergies to be reaped. The company is structured so that each of its operating units is free to compete in its own way, even if sometimes they seem to be competing against each other.





In 2000, FedEx started a specialised home-delivery service to meet the growing demand from e-commerce and online sales. The company thinks that residential deliveries are a different sort of business from those made to commercial premises, which are generally manned during office hours. Many people are not at home during the day, so deliveries may need to be made later and alternative collection arrangements offered. Consumers will also expect overnight packages shipped on a Friday to be delivered on a Saturday. For less time-sensitive packages, FedEx also operates a consolidation service that passes packages to America's postal service for final delivery.

That might seem like giving work to a competitor, but FedEx sees it as just another line of business. Even its trucks are starting to compete with its aircraft. Traditionally trucks set off as full as possible to maximise efficiency. But by running trucks to a schedule, which can mean they leave only partly loaded, transport companies can offer guaranteed delivery times. In a lean-manufacturing world such a service could justify higher charges. Like other fast-delivery services, the shipments can be tracked over the internet. The industry calls these operations "less-than-truckload" services. FedEx says its LTL services now span the whole of America. It even offers a money-back guarantee if its trucks fail to turn up at the promised time. For regional deliveries, LTL services can provide a cheaper alternative to sending packages by air.

Having introduced guaranteed on-time delivery services to trucking, could the company expand the idea to ships? Dan Sullivan, a senior executive at FedEx, says the company is currently talking to some operators of fast ships. The ships could, for instance, carry packages already labelled which could bypass some distribution points. "It's all about fast-cycle logistics and taking time out of transit at a reasonable cost and with a high level of service," Mr Sullivan adds.

FedEx's purchase in 2003 of Kinkos, whose main business was a chain of photocopying centres, has given the company some 1,300 high-street locations, mostly in America. FedEx is now using these to offer additional services. Despite the internet and e-mail, the demand for paper-based communications shows no sign of diminishing. But instead of shipping printed documents by air, FedEx now provides its clients with a remote-printing service. So instead of sending, say, lots of bulky brochures for a sales conference by air, a client could send them electronically to a Kinkos near the venue and pick them up in printed form from there.

FedEx is also using Kinkos as an emergency back-up for companies that supply hospitals with medical devices, such as stents and heart valves. These can be extremely expensive and are sometimes required without notice for unscheduled operations. Such a service could replace what Tom Schmitt, chief executive of FedEx Global Supply Chain Services, calls "million-dollar cars". Some of the companies that make these devices, he says, keep their back-up supplies in the boots of their salesmen's cars. Now, if a hospital is in desperate need of a particular device, it may be able to find one at its local Kinkos.

The range of logistics businesses the express operators are moving into is huge. One service offered by UPS's local branches is a drop-off facility for broken Toshiba laptops. Most owners think that when they have told Toshiba about their problem and put their laptop into a UPS box, it is sent to the Japanese company to be repaired and then returned by UPS. But what really happens is that when the laptop arrives at UPS's Louisville hub, it is taken to a vast estate of warehouses near the airport and mended in a repair shop owned and run not by Toshiba but by UPS. The UPS technicians are trained by Toshiba and the

warehouse holds Toshiba spare parts. Even the people in the Toshiba call-centre that deal with inquiries work for UPS. The delivery company has been contracted to provide a complete repair and customer-service operation. And having done this for one company, UPS could capitalise on its investment by providing a similar service for others.

One of the big investments UPS is making at Louisville is the development of a huge logistics centre for health-care companies. Vast racks containing boxes of over-the-counter medicines, medical devices, testing kits, surgical supplies and other goods are held in its buildings, some of which are temperature-controlled. "It's a patient, not a package," states a large banner in one of the buildings where teams of workers sort through the orders that come in from pharmacies, hospitals and doctors. The required items are retrieved and dispatched from Louisville overnight.

## **Changing the landscape**

Historically, transport technology has always made a physical impact on centres of commerce. In the days when cargo was loaded onto ships mainly by hand, factories would often cluster nearby because transport costs were high and delivery slow. With the arrival of the shipping container, factories were able to move to cheaper locations and away from crowded city ports such as New York City and the London Docks. Container terminals did not have to be so close to large population centres, provided they had plenty of space, railways, good roads and workers prepared to handle containers, which many stevedores in older ports were not.

Something similar is now happening around logistics centres, especially at airports. Companies are moving some or all of their operations to be near such centres because this allows them to process orders late into the day and put their goods on the last flight out, for delivery the following morning. As a result, some surprising businesses are setting up shop near logistics hubs. For instance, even though Louisville is a long way from the sea it is now home to the world's biggest distributor of fresh lobsters (see [article](#)).

The idea that if you build a logistics centre companies will come is being taken to extremes in the United Arab Emirates. Dubai is investing heavily in infrastructure and businesses for when its oil starts to run out about a decade from now. When its state-owned port operator, DP World, took over Britain's P&O for \$6.8 billion earlier this year, America's Congress was up in arms because the purchase came with the commercial operations of six American ports. DP World decided to sell them. Even so, it still ended up as one of the world's largest port operators, alongside Hutchison of Hong Kong and PSA, Singapore's state-backed port authority.

Now Dubai is building what it describes as the world's first "logistics city". It will be next door to the new Jebel Ali Airport, which will eventually have six runways with a capacity for 120m passengers a year. One runway will be dedicated to cargo aircraft. The new airport is also adjacent to DP World's giant Jebel Ali Port, now one of the region's busiest container terminals. Will the gamble pay off? Dubai is well placed midway between Europe and the booming markets of Asia. But as the region's own businessmen know to their cost, consolidation in the logistics business is creating formidable competition.

## Chain reactions

Jun 15th 2006

From The Economist print edition

### Delivery companies are consolidating

"WE ARE competing with giants," says Fadi Ghandour. The Jordanian businessman has first-hand experience of consolidation in the logistics business. He is chief executive of ARAMEX International, which began life as the Middle East partner of a number of American delivery companies. Partnerships and alliances allow operators to link with others to provide services in places where they have no operations of their own. All went well until 2003, when DHL bought Airborne Express, ARAMEX's chief partner in America. The deal gave DHL a way to compete in the backyard of UPS and FedEx. But for ARAMEX it meant its link to the crucial American market was cut.

Bloomberg News



Chasing the competition

To restore it, Mr Ghandour set out his own strategy of alliances and acquisitions, replicating what his big rivals were doing. ARAMEX now offers a delivery service to more than 190 countries. Last year it was listed on the Dubai stock exchange. The company is continuing to buy local operators, and recent acquisitions include logistics firms in Ireland, Britain and Egypt. "There are always entrepreneurs out there," says Mr Ghandour. "We are never going to be left without a real partner."

ARAMEX illustrates how local markets present their own, often unique opportunities for logistics companies. ARAMEX's services range from the secure delivery of credit cards and legal documents to delivering goods and accepting payments for users of [souq.com](http://souq.com), an Arab version of eBay. The company also offers a "shop and ship" service for people buying things in America, especially online. Although international deliveries have become easy, some American companies and traders on eBay will not ship goods overseas. ARAMEX helps out Middle East shopaholics by providing them with addresses in America to which goods can be shipped. It then couriers the items to the buyers.

Consolidation in the logistics industry also extends to postal services, which face a decline in standard mail as more people pay their bills online and send e-mails instead of letters. Coupled with deregulation and privatisation, this has led some mail firms to move into other areas.

Deutsche Post, which became a listed company in 2000, has been the most active with its purchases of DHL and Exel. Britain's Royal Mail has also done well with its express-package business, Parcelforce International, which has grown outside the regulated postal market. But this year there has been more deregulation in Britain and now the Royal Mail, which is still state-owned, faces new competitors. One of them is TNT, a big Dutch post and delivery service. In May it bought a courier company to allow it to deliver to about 80% of all addresses in Britain. TNT also recently formed a partnership with Japan Post, the world's second-largest postal operator after America's. Japan Post, too, is being privatised.

The internet has already had a profound effect on the delivery business, not least because it enables customers to track their goods. When parcels are being shipped by an express service they are given a tracking number, and every time the parcel's barcode is scanned at a hub or dispatch point its whereabouts are automatically recorded. Customers can follow the progress of their packages by entering their tracking number. Some systems also allow shippers to see online who has signed for an item, thanks to the digital devices now carried by delivery drivers. A London courier company even offers a service that lets people watch their packages move in real time on a web browser (see box on the next page).

Soon the labels on packages will carry a lot more information. Talk to logistics experts about the future, and they are bound to mention RFID. The acronym stands for radio frequency identification, a technology going back to the second world war. Devices using it were fitted in aircraft to bounce back radio signals, distinguishing friend from foe. Today RFID technology is already commonly used in things like motorway-toll tags and keyless-entry devices. Shrinking these devices down to the size of a barcode has now made it possible to attach them directly to products, carrying a wealth of information about them. Some are already printed as part of a product's label, using electrically conductive ink.

## **The next big thing**

Products fitted with RFID tags could work all kinds of magic. In a supermarket, for instance, they could eliminate the need to unload the trolley and scan its content item by item. Simply pushing the trolley up to a checkout would relay all the product and price information, so supermarkets could automate most of their tills. In a warehouse, an RFID reader would record every item loaded into a truck, and a similar device at the truck's destination would record everything being unloaded.

With the addition of suitable sensors, it would become possible to tell whether a product had been dropped or kept at the wrong temperature. Finding a single product in a mountain of containers would become a simple matter of getting an RFID reader to analyse the contents—without even opening the doors. And combining RFID technology with GPS tracking would mean that nothing need ever get lost in the supply chain again.

But such magic is not yet imminent. Some companies that have carried out trials of RFID tags say that the technology is promising, but it still needs to become cheaper and more reliable in the rough-and-tumble of a commercial environment.

Christian Kern, chief technology officer of InfoMedis, a Swiss company, has overseen the successful introduction of RFID tags in libraries, where they keep track of books, and medical clinics, where they identify patients to make sure they are given the right treatments. For many applications, however, he thinks the humble barcode is sufficient. "There will be applications I am not even dreaming of; that is quite possible," says Mr Kern. "But I don't expect miracles."

One of the biggest boosts to the adoption of RFID tags has come from Wal-Mart, which in 2004 began testing them in 150 stores around Dallas, Texas. By the end of 2006, the tests will be expanded to some 1,000 stores in America. Wal-Mart has already seen some benefits, including a 16% reduction in out-of-stock items in stores using RFID. Moreover, items with RFID tags were replenished three times faster than non-tagged items.

The technology promises other benefits, too. One is a reduction in inventory "shrinkage"—the industry's polite term for pilfering. There have been some concerns that RFID tags might breach personal privacy, but these are mostly overblown. When a customer buys an item the tag can be removed, just like the anti-theft devices attached to existing products.

If Wal-Mart and other retailers greatly expand their use of RFID tags, the price of each tag will keep falling and mass adoption will move closer. Within 15 years most items in shops will carry RFID tags, predicts Sebastian Taylor, an RFID expert working for IBM. Many high-value goods already carry them. Mr Taylor says the average cost of an RFID tag at present is around 20 cents. Next year he expects it to fall to around ten cents. That may seem a small price to pay to put such a clever device on, say, a television set. But attach them to millions of cans of baked beans, and the cost starts to mount up.

Even with existing technology, the amount of information that a supply chain can provide changes the way in which companies deal with both shipments and inventory. "It has allowed our customers to treat our trucks and planes as a warehouse," says David Abney, president of UPS International. "They know exactly when they are going to receive their goods and they can make decisions based on this information."

Managing operations such as replenishing stock or delivering spare parts can be outsourced too. This is an area many logistics firms are keen to expand into. "We want to manage our customers' supply chains," says Mr Abney. In the past it was only multinational companies that could afford to compete with global supply chains, not just because of the cost and complexity of operating trucks, aircraft and warehouses on different continents but also because of the difficulty of managing all these diverse elements. Yet according to Mr Abney, all that has changed. Even small companies can now afford to operate internationally by contracting out the management of the process.

The logistics business used to be all about the management of transport costs, says John Allan, "but it is now more about the ability to transform the capital nature of the business." Mr Allan ran Exel, one of the leading logistics companies before it was taken over by Deutsche Post. He has now joined the board of the German company and is chief executive of DHL Logistics. More companies, he reckons, are starting to realise that if they can move goods through a supply chain faster and more efficiently, the effect on their performance can be profound, going well beyond being able to keep stocks low.

But as supply chains become longer and more complex, they are becoming harder to look after. "This reinforces the need to have them professionally managed," says Mr Allan. He would say that, because that is what he does for a living, but he has a point. The ability to design, engineer and put in place a supply chain is no mean feat, even for a big company. Yet the employees who carry out the operations that make up much of a supply chain's individual components, such as driving trucks, overseeing warehouses or operating fork-lifts, are not always treated as though their jobs are important. Specialist logistics operations are in a better position to look after them by offering more training and better career prospects, and will be able to spread their investment in these things across several clients.

The most critical factor in logistics is people. Companies may deploy lots of powerful technology, but a close examination of successful supply chains shows they also pay a lot of attention to their employees, says John Gattorna of the Centre for Supply Chain Research at Australia's University of Wollongong. In a new book, "Living Supply Chains", he argues that this interest in people is not confined to what happens in the individual firm, but extends to customers as well. "Most successful companies also understand, almost intuitively, what is happening in their marketplace," he says.

Supply chains come in a number of different forms, and some companies use more than one for different parts of their business. One chain may run lean to keep inventory costs low, whereas another may be more flexible to enable it to respond to new opportunities as they arise. The important thing, says Mr Gattorna, is that different supply chains within an organisation must work together. These days companies cannot afford to make mistakes with their logistics. When supply chains break, the consequences can quickly become disastrous.

## Just-in-time lobsters

Jun 15th 2006

From The Economist print edition

### Winging it to the pot

Alamy



World travellers

FOR someone who enjoys maintaining a saltwater aquarium, Mike Middleton has an interesting job. The former marine looks after two 25,000-gallon saltwater pools for Clearwater, one of the world's biggest seafood companies. But he does it in an unexpected place: not at the company's base on the Atlantic coast in Nova Scotia, Canada, but in a small warehouse far from the sea in Louisville, Kentucky.

Mr Middleton is the operations manager for a distribution centre that every week ships some 30,000 pounds of live lobsters to restaurants and adventurous cooks, not only in America but all over the world. He is based in Louisville because UPS has its giant Worldport hub nearby and can pick up his orders in the evening for delivery the next day.

Lobsters are best cooked just before they are eaten to ensure freshness, taste and texture, so they need to be kept alive—and, as Mr Middleton explains, they can get very stressed if not treated well. Once they have been caught by the fishermen in Nova Scotia that supply Clearwater, they are taken to Louisville by truck, a journey that can last more than 30 hours. There they recover in tanks filled with saltwater made from mixing the necessary ingredients with fresh water. The water is kept clean by being passed through giant versions of the sort of

filters and skimmers that keep saltwater aquariums in good shape. When an order comes in, the lobsters are packed in special containers for UPS to deliver.

It is not just the proximity of Worldport that makes the Clearwater operation attractive. When the company used to ship live lobsters from Canada to America in small consignments, it faced a pile of paperwork at the border for each shipment. Bringing in a whole truckload at once saves on red tape. Orders can be met more reliably, so gourmets have a better chance of being able to crack open their favourite delicacy.



## Delivering the goods

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### A courier company goes online

MANY successful businesses have been started by someone exasperated by being given poor service. Tom Allason was convinced he could do better when a courier company failed to deliver tickets for an important tennis match in time for the recipients to attend it. He got together with Jay Bregman, an America friend he met at college in the United States, and in the autumn of 2004 the pair launched eCourier in London.



Check out my algorithm

When they took a closer look at the courier industry, they found it had low barriers to entry and was very fragmented. Most companies were small and competed solely on price, which resulted in low levels of service and discouraged investment in new ideas. The way most of these businesses operated was to take an order over the telephone and pass it on to a dispatcher, who then sent a radio message to find a free courier. If a delivery was late, more phone calls and radio messages would be needed to find out where it had got to—and every time that happened, costs would go up.

The idea behind eCourier is to put the whole system online. Bookings are made mostly on the company's website. The customer enters the collection and delivery addresses and the order is automatically relayed to the courier best placed to do the job. Customers can then watch the delivery vehicle's progress on their computer screen as it collects and delivers the goods. Collections and deliveries are confirmed by e-mail. The company's couriers use global-positioning-satellite (GPS) devices and hand-held computers to keep eCourier's computer system updated.

The key to the service is picking the right courier, says Mr Allason. The one whom the GPS system shows to be nearest to the job may not necessarily be the most appropriate. For instance, a courier in London may be only a few hundred yards away from a collection address, but if he is on the other side of the Thames it could take him 15 minutes just to cross the river. Other information, such as

traffic problems and the performance of individual couriers, also needs to be taken into account.

This is a mathematical problem, and eCourier spent some time hunting around for someone able to solve it. Eventually it found a team led by Cynthia Barnhard, a logistics expert at America's Massachusetts Institute of Technology, which devised an elaborate algorithm that is now at the heart of eCourier's business, in much the same way that a mathematical formula drives Google's search engine. What Mr Allason particularly likes about his internet-based courier system is that it is easily "scaleable": more couriers and markets can be added without having to hire many more dispatchers or people to run a call-centre.

"There is no longer any need to pick up a telephone to find out where your package is," says Mr Allason. "Now you can see where it is." Some 85% of the company's bookings are made over the internet. Business is growing quickly: whereas in its first month in September 2004 eCourier delivered only 25 items with four couriers, it is now delivering around 15,000 items a month with 90 couriers. Needless to say, Mr Allason now gets all his tickets delivered on time

## When the chain breaks

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### Being too lean and mean is a dangerous thing

IT BEGAN on a stormy evening in New Mexico in March 2000 when a bolt of lightning hit a power line. The temporary loss of electricity knocked out the cooling fans in a furnace at a Philips semiconductor plant in Albuquerque. A fire started, but was put out by staff within minutes. By the time the fire brigade arrived, there was nothing for them to do but inspect the building and fill out a report. The damage seemed to be minor: eight trays of wafers containing the miniature circuitry to make several thousand chips for mobile phones had been destroyed. After a good clean-up, the company expected to resume production within a week.

PA



**Buncefild burned, firms faltered**

That is what the plant told its two biggest customers, Sweden's Ericsson and Finland's Nokia, who were vying for leadership in the booming mobile-handset market. Nokia's supply-chain managers had realised within two days that there was a problem when their computer systems showed some shipments were being held up. Delays of a few days are not uncommon in manufacturing and a limited number of back-up components are usually held to cope with such eventualities. But whereas Ericsson was content to let the delay take its course, Nokia immediately put the Philips plant on a watchlist to be closely monitored in case things got worse.

They did. Semiconductor fabrication plants have to be kept spotlessly clean, but on the night of the fire, when staff were rushing around and firemen were tramping in and out, smoke and soot had contaminated a much larger area of the plant than had first been thought. Production could be halted for months. By the time the full extent of the disruption became clear, Nokia had already started locking up all the alternative sources for the chips.

That left Ericsson with a serious parts shortage. The company, having decided some time earlier to simplify its supply chain by single-sourcing some of its

components, including the Philips chips, had no plan B. This severely limited its ability to launch a new generation of handsets, which in turn contributed to huge losses in the Swedish company's mobile-phone division. In 2001 Ericsson decided to quit making handsets on its own. Instead, it put that part of its business into a joint venture with Sony.

This has become a classic case study for supply-chain experts and risk consultants. The version above is taken from "The Resilient Enterprise" by MIT's Mr Sheffi and "Logistics and Supply Chain Management" by Cranfield's Mr Christopher. It illustrates the value of speed and flexibility in a supply chain. As Mr Sheffi puts it: "Nokia's heightened awareness allowed it to identify the severity of the disruption faster, leading it to take timely actions and lock up the resources for recovery."

There are two types of risk in a supply chain, external and internal. As in the Ericsson case, they can conspire together to cause a calamity. This seems to be happening more and more often. It is not just that inventory levels are getting leaner, but the range of items that companies are carrying is also growing rapidly, points out Ted Scherck, president of Colography, an Atlanta-based logistics consultancy. Just look around a typical supermarket. Where it once stocked mainly groceries, it now also sells clothing, consumer electronics, home furnishings and many other items.

## **The many faces of risk**

This compounds supply-chain problems. "In many cases shippers have gone too far in implementing the lean supply chain and have found themselves virtually out of business because of a by now annual catastrophic event," says Mr Scherck. As examples, he cites a dock strike in California, a typhoon in Taiwan, a tsunami in Asia and a hurricane in New Orleans. More recently a huge explosion at the Buncefield oil storage terminal in Britain's Hertfordshire caused widespread problems for businesses not just locally but across a large part of England.

In 2003 a number of companies suffered serious disruption because of severe acute respiratory syndrome (SARS). Even though SARS turned out to be not as virulent as influenza, and only 8,000 people got infected, with one in ten dying, it still cost an estimated \$60 billion in lost output in South and East Asia. The latest worry is the spread of avian flu. If the virus concerned were to mutate and become infectious for humans, the consequences could be far more devastating.

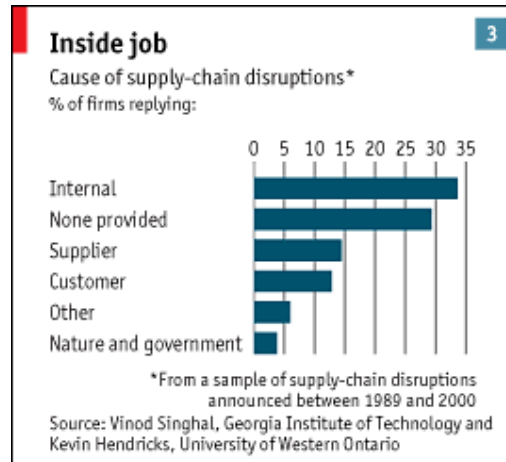
Sometimes even a political wrangle in Brussels will bring a supply chain to a shuddering halt. Last autumn some 80m items of clothing were impounded at European ports and borders because they exceeded the annual import limits that the European Union and China had agreed on only months earlier. Retailers had ordered their autumn stock well before that agreement was signed, and many were left scrambling to find alternative suppliers. A compromise was reached eventually.

## **The cost of failure**

However, most supply-chain disruptions have internal causes, says Vinod Singhal, a professor of operations management at the Georgia Institute of Technology (see chart 3). His research on the effects of supply-chain failures shows that they

can be immensely damaging. This emerged from an investigation into what happens to shareholder value when companies announce supply-chain problems, based on a sample of 800 such announcements big enough to generate news in the financial press. The disruptions ranged from a delay in 2000 of shipments of workstations and servers by Sun Microsystems to a parts shortage at Boeing in 1997 that the company said would delay some deliveries.

Typically a company's share price dropped by around 8% in the first day or two after such an announcement. This is worse than the average stockmarket reaction to other corporate bad news, such as a delay in the launch of a new product (which triggers an average fall of 5%), untoward financial events (an average drop of 3-5%) or IT problems (2%). And the effects can be long-lasting: operating income, return on sales and return on assets are all significantly down in the first and second year after a disruption.



"It's like having a heart attack," says Mr Singhal. "It takes a long time to recover." And have the dangers increased in recent years? Like other experts, he believes that some companies may be running their supply chains a little too lean: "It's great when it's working, but too much leanness and meanness can actually hurt you."

The financial information analysed for this study came out before the terrorists attacks on America on September 11th 2001 and the subsequent massive tightening of security around the world, so global supply chains today are subject to many more potential hold-ups. Still, it is impossible for customs officials to search every container, box or package entering every country, so the responsibility for security and import declarations rests with the shipper and the company carrying the goods. In effect, the system works by a process of pre-clearance. The details of everything contained in a shipment now have to be sent ahead electronically, and customs and security officials at ports and cargo hubs divert anything they want to take a closer look at.

Companies that put a lot of effort into ensuring the safety of the goods they are sending, or carrying on behalf of others, are likely to be rewarded by seeing them pass swiftly across borders. Customs clearance is itself a huge business. "Information and technology is the only way to accomplish this," says Ed Clark, chief executive of FedEx Trade Networks. These systems also need to be able to cope with unplanned events. For instance, if a cargo aircraft has to divert to another airport because of bad weather, centrally held electronic versions of the necessary "paperwork" can be transmitted to a new port of entry.

Sometimes even computer systems will not alert a company to a problem. For instance, Toyota is upgrading its business-interruption planning to a higher level in response to the filing for Chapter 11 bankruptcy protection last year by Collins & Aikman, a big American-based supplier of trim items for cars. The parts company had been supplying Toyota in Europe, which had an inkling that

something might be wrong and started to arrange alternative supplies to be on the safe side.

“We realised that through good communication and contacts we had managed to identify a risk in good time and take action,” says Mark Adams, Toyota's European purchasing manager. It was a lesson the company wanted to apply more widely, so it launched a weekly get-together for managers, sometimes by videoconference, to discuss any new rumours and potential risks—and work out a recovery plan just in case.

Toyota builds more than 600,000 cars a year in Europe, where it has some 200 first-tier suppliers operating more than 400 factories. They work with second, third and fourth-tier suppliers, so the overall number grows exponentially the further you go down the chain, where problems can be harder to spot. This means the suppliers themselves have to be involved in the risk-management process.

Mr Adams says a supplier may find it difficult to tell the company that it has a problem. But Toyota emphasises that given the co-operative nature of a supply chain, with early knowledge there is more chance of putting things right. Mr Adams explains that as a first step the company would seek to help its suppliers solve their own problems. “We are hugely more competent at this than we were a year ago,” he adds. And so far, Toyota has been able to act swiftly enough to prevent any supply problems holding up production.

Is a lean, flexible and highly outsourced supply chain like Toyota's any safer than the vertically integrated production methods of old, as practised at Henry Ford's giant River Rouge manufacturing complex near Detroit? At its zenith in the 1920s, ships carrying raw materials such as iron ore and coal—often from Ford-owned operations—would unload directly into the plant. Steel was produced on site, then cast, pressed and machined into all the components needed to assemble a car. The process was inflexible—which is why Ford's cars could be any colour as long as it was black—as well as rather inefficient. Toyota has turned that process on its head, making its manufacturing system far more capable of responding to change. That is one of the best insurance policies a company can have.

Corbis



**Ford's way with supply chains**

"You are always looking for flexibility, particularly as you manage risk," says Cisco's Mr Mendez. Again, transparency is important. "Once you understand where you are, you can begin to design and budget for contingencies," he adds. The risk-management budget should perhaps be seen as separate from the operating and capital budgets, he suggests, to allow risks and their potential costs to be dealt with more directly.

## **The limits to leanness**

Are competitive pressures pushing companies towards running their logistics operations ever leaner? "They are galloping there," replies Michael Cherkasky, the boss of the company that owns Marsh, the world's largest insurance and risk specialist. "I don't think many understand the risks that are involved." He is concerned that companies are outsourcing not only peripheral activities but many core functions too. That makes it difficult to pick up the pieces when things have gone wrong.

Britain's Cranfield University is running a research programme into the fragility of supply chains, prompted by the British government after protests over high fuel costs in 2000. Lorry drivers blockaded fuel-delivery depots, bringing many businesses to a standstill. "I reckon this was the first time the government realised there were such things as supply chains, and just how fragile they had become," Mr Christopher told a recent conference.

Some people even suggest that supply chains should be regulated, a bit like public utilities, because countries have become so highly dependent on private-sector production infrastructure. Barry Lynn, author of a book on this subject, "End of the Line", thinks that perhaps companies should be required to limit their outsourcing and use more than one supplier of essential items. In his book, he argues that globalisation and outsourcing provide only a temporary benefit to consumers because the companies that form part of supply chains will buy each other up in pursuit of ever greater efficiency, and thus lose most of their flexibility.

There are signs that some companies are already alert to these concerns and may be planning to reorganise their supply chains to make them safer. That process could speed up if disruptions become more common. Mr Sheffi is in no doubt that the best way to achieve a resilient supply chain is to create flexibility—and that flexible companies are best placed to compete in the marketplace.

"Customers are rethinking their global supply chains for a lot of their products," says Mr Scherck. For bigger firms, that could mean adopting what he calls the "continental strategy": having a spread of suppliers in different continents for added flexibility, as Dell and Cisco do. Smaller firms may not be able to achieve a geographical spread. But in any case, companies do not want to go back to carrying lots of inventory in different locations. "So you need to do something in-between," concludes Mr Scherck. "You will have to carry a little more cost than an absolutely lean model, but you get protection."

"There are very legitimate, very good business reasons not necessarily to complete and ship from Asia," says Flextronics's Mr Wright. Companies may consider other options in other parts of the world even though these may look more expensive. "Sometimes you might have to go to a higher cost structure to make your supply chain more robust and reliable," observes Mr Singhal.

So the limits of globalisation may end up being defined by the management of supply-chain risk. And unfortunately the world is unlikely to become any safer. There will always be natural disasters, as well as corporate mistakes. In order to insulate themselves from the consequences, companies will have to spread their risks more widely. That does not necessarily mean fewer aircraft will be queuing up to land at Louisville and Memphis, or that fewer container ships will set sail from Asia's bustling ports. But it does mean that in future companies may spend rather more to maintain a number of different supply chains, and some of those may be closer to home.



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From The Economist print edition

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Click to buy from Amazon.com: “Living Supply Chains”, by John Gattorna ([Amazon.co.uk](http://Amazon.co.uk)).

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