SUPPLY CHAIN MANAGEMENT

PLAN, MANAGE, RECOVER

In a world of uncertainty, supply chain managers must be able to plan, manage and be prepared to recover when things go awry. This Special Digital Issue offers the best of *Supply Chain Management Review* on getting the most from your supply chain in uncertain times.

PEERLESS CONTENT CREATION

SUPPLY CHAIN MANAGEMENT REVIEW

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welcome

Plan, Manage, Recover

Supply chain managers live in a world of uncertainty. On any given day, customer expectations, government regulations and long-held trading alliances and rules can change. Its more incumbent than ever that supply chain managers do their best job at planning for the known, manage for the unknown and have in place systems to recover when the best laid plans go awry.

Plan, Manage, Recover, a Special Digital Issue, offers the best of *Supply Chain Management Review* on getting the most from your supply chain in uncertain times.

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STRESS-TESTING YOUR SUPPLY CHAIN

Supply chains, like the products that pass through them, are subject to stress. Those internal stress points can be identified, re-evaluated and repaired.

BY STEVEN BOWEN

A standard practice in engineering and product design is stress-testing. Commonly thought of as an engineering process for determining whether a particular product will hold up under extreme usage, it seeks to answer the question, "How harshly can consumers treat this product before it breaks?" But stress testing isn't just for hard goods, the practice is also used to test the limits of processes and procedures and is especially useful in procurement, logistics and operations. Operational processes can break just as easily as a plastic toy on Christmas morning.

Supply chains in particular are vulnerable to stress, sometimes from flaws in internal planning and design, and sometimes from external factors. Internally, supply chains are made up sometimes of hundreds of different parts. Multiple potential bottlenecks must be identified, especially in an environment where investments in equipment and software are moving at an accelerated pace and the supply chain continues to take on a global scope. New innovations like blockchain technology, artificial intelligence, and an exponential increase in the volume of related data trigger more potential chokepoints.

Those internal stress points can be identified, re-evaluated and repaired. Externally, factors like new tax laws and tariffs that may bring significant disruption to the supply chain. While it is not likely a corporation can change tax laws or tariffs, the supply chain processes around those factors can be adapted in response to these external stress points. Regardless of the origin of the stress points, stress

testing the supply chain is an important, but often overlooked, part of supply chain management. The supply chain may look good on paper – but at what point, and under what circumstances, will it break down?

Two of the biggest bottlenecks stress testing may uncover are in the large volumes of data that exist, which, if not understood and organized, can present a significant roadblock to success. Most companies have a wealth of data at hand, but may not be making full use of it, and that can be a source of confusion. With proper data, procurement becomes more transparent, once the company understands areas such as how much they are spending in each category and with each supplier, and what marketplace and engineering specifications are for those items or services. Without that information at hand, increased costs and a bottleneck can result. Stress-testing can identify how to transform big data into an organized and useful format – and which data is most essential to the process. This can then be used to make better procurement and operational decisions and transform the complex logistics of an extended supply chain.

Nearly every supply chain has a weak link, sometimes there are several. Knowing where those weak links are, and at which points they break down, is the first step towards competitive success through Total Value Optimization (TVO), or the ability to successfully leverage stress-testing to anticipate and meet demand by synchronizing the buy-make-move-fulfill supply chain, to deliver the greatest value at the lowest cost to business. Part of that optimization process is understanding the maturity level of each area, and how it compares with other functions at similar companies. In addition, the stress testing process, as carried out through TVO, will help assess where the weaknesses are in the supply chain. Doing so begins with understanding the maturity curve of areas including procurement, logistics, operations, data analytics, and S&OP capabilities.

Identifying the maturity level of the procurement function, and in understanding how well each step in the process is being executed, is a major part of stress testing – and may help identify areas where the execution breaks down. In addition, testing the level of collaboration across all functions, from development and engineering, to sales, to forecasting – including the suppliers and the entire extended supply chain – also presents special challenges because doing so requires dealing with multiple organizations.

Stress-testing requires a sophisticated level of expertise, but done correctly, it helps the organization understand that their investments are going into the right places.

Other areas of stress testing include looking at the steps involved and how they are being executed, and finally, the level of collaboration and integration between all functions, both internally and externally.

A common bottleneck and source of delay in nearly every sales and operations planning (S&OP) process is forecast accuracy. In logistics, warehousing and distribution, forecasting is essential for planning, and with an inaccurate forecast severe bottlenecks may result if capacity has been underestimated or overestimated. For logistics to work correctly, forecast information must be accurate, to determine things like lead time and production time.

Identifying the maturity level of the procurement function, and in understanding how well each step in the process is being executed, is a major part of stress testing – and may help identify areas where the execution breaks down.

Additional bottlenecks coming from external sources may include new tariffs and a trade war, which would likely cause manufacturers to have to re-evaluate supply relationships, negotiate new shipping and transportation deals, and deal with changes in demand. Depending on which side of the tariff the manufacturer finds themselves, they may experience decreased or increased demand, and both can be equally devastating – and the domestic steel industry for example, may face the prospect of increased orders, but may be unprepared to meet the demand.

Stress testing, and understanding the maturity level of each process, has grown increasingly important especially with the acceleration of change in most organizations. With the proper approach to stress-testing, the supply chain becomes more than just an abstract grouping of processes and sources, it becomes a meaningful and strategic competitive weapon. •

Steven Bowen is the chairman and CEO of Maine Pointe, and the author of Total Value Optimization: Transforming Your Global Supply Chain into a Competitive Weapon. *He has 30 years of P&L experience, leading turnarounds, high-growth businesses, and Fortune 1000 companies."*

Supply Chain Planner of the Future

THE SUPPLY CHAIN PLANNER OF THE FUTURE

New technologies could revolutionize planning. Will the supply chain planner become obsolete?

BY KNUT ALICKE, KAI HOBERG AND JÜRGEN RACHOR

Advances in supply chain 4.0 technologies have recently triggered thoughts and visions of managers across the globe towards driving automation to the next level. For example, Richard Liu, founder of Chinese retail giant JD.com, expressed the hope for full automation in his company with "no human beings anymore, 100% operated by AI and robots." This is what we call a true no-touch supply chain. For physical flows, technologies that enable dramatic automation are currently widely piloted: Think lights-out factories, picking robots and AGVs, self-driving trucks or drone delivery. Similarly, ordering processes also advance quickly and move away from fax or phone to internet, EDI, personal assistants and IoT with automation degrees of over 90% possible even in B2B environments. Automation benefits are obvious: 24/7 operations, lead time reduction, higher process consistence, instant optimization and human error reduction.

Accordingly, the outlooks for many simple blue and white collar jobs are rather dull.

When it comes to automation of information flows and decision making, we see many interesting technologies on the rise: cloud platforms, robotic processes automation (RPA), negotiation bots and artificial intelligence. Automation will affect jobs that have so far been deemed relatively safe. Planners (entailing demand planning, inventory planning, supply planning, production planning and order management are typically the most frequent white-collar job groups in many supply chain functions, often making up a third of SCM admin roles. Automation of planning is still in its infancy in many companies that use tools from the 1990s and deal with master data problems from the 2000s. Here, planning is very manual, time-consuming and changes are cumbersome. However, some companies are already far ahead and experience how the role of planners will be affected by new technologies. So, what will change for planners – will they become obsolete? Here are some of the ways the profession may change.

For example, Richard Liu, founder of Chinese retail giant JD.com, expressed the hope for full automation in his company with "no human beings anymore, 100% operated by AI and robots." This is what we call a true no-touch supply chain. For physical flows, technologies that enable dramatic automation are currently widely piloted: Think lights-out factories, picking robots and AGVs, self-driving trucks or drone delivery.

Planning tasks will shift

Planning has always been challenging as planners fill the gaps in broken business processes hindered by legacy IT systems, limited system integration and poor (master) data maintenance. Further, planners have often been overwhelmed by the number of decisions they need to make with the increasing number of products, higher product complexity, frequent changes and lack of sufficient buffers, very often having to go through a long list of products one-by-one to decide on quantities and timing. While many SC planning systems automatically generate demand forecasts and production/purchase order recommendations, these numbers are frequently not trusted and manually checked or even overruled. Planners often rely on gut feeling and the experience gathered over the years.

New technologies and solutions

RPA and predictive analytics promise to avoid the need for much manual routine work, which comes along with a task shift for planners. Instead of manual data inspection and constant fire-fighting to plan and schedule the products manually, planners will rather develop and maintain solutions that automatically check the data, identify issues and ensure a high-quality planning basis. Similarly, AI forecasting approaches are able to more accurately forecast standard demand and allow planners to focus on fewer items that really do require attention. Smart algorithms detect items where human input is required for better decision making, especially if historic demand is not a good indicator of future sales, but rather information on market developments and pending offers need to be integrated manually. The advanced planning systems point the planners towards those exceptions and focus their efforts on where they are really adding value.

New roles will be created

Currently many planning roles are structured along the planning steps of demand planning, supply planning, production planning or scheduling. In the future, planning roles will evolve from a domain-focus to be focused around tasks that require specific capabilities (and can be used across all planning). In particular, planners will specialize in data management, algorithmic optimization, exception management and partnering with the business, creating roles around the following tasks:

Data management

The right data is the basis for any planning automation, and entails both data availability and data quality. This will require dedicated data engineers who need to set up procedures and RPA protocols to automatically check for data gaps and consistency, comparing master data with

actuals to identify and correct for deviations. Another crucial task is to design and align data exchange with supply chain partners. For example, Amazon uses innovative EDI systems and APIs for connecting to vendor systems and educates the vendors on how to best use these interfaces to ensure seamless connectivity and high data quality. To enable drawing the right conclusions from the data, data visualization is another core task within data management, developing customized user experiences.

Algorithmic optimization

As SC planning will be widely automated, the key differentiator will be the optimization quality of the algorithms. To build out this advantage, there is a need to continuously optimize analytics approaches using approaches around advanced modelling, machine learning, and stochastic optimization. Planners will need to combine cutting-edge research with pragmatic incorporation of learnings into the planning algorithms – similar to what leading e-commerce players already do today. For example, Zalando combines algorithms developed and described in academia and adapts these in a pragmatic trial-and-error approach for usage in their warehouses. The quality and performance of the algorithms are then tested in limited pilots within the live system.

Exception management

While algorithms and software robots will take over many routine activities, exceptions will still occur and conflicts need to be resolved. To do so, exceptions managers need to evaluate scenarios and options, and take trade-off decisions together with internal and external partners. These tasks require good communication skills to align the needs of all parties involved. The role of the exception manager is a good example of the "automation paradox" that describes how the automation of simple tasks creates new issues as employees now constantly deal with difficult cases.

SCM business partner management

The shift towards more capabilities-centered roles requires a translator-role within SCM to act as counterpart to the Business and Operations, to translate their requirements and reality into the planning process. This "SCM Business Partner" will play a pivotal role in shaping the design of the SC planning processes and systems. Also, the SCM Business Partner will be driving and optimizing the S&OP/IBP process, to facilitate between the functions and find an overarching business optimum.

New organizational setup will be adopted. The next level of automation and the new roles in SC planning do not aim to reduce the cost for SC planners - but the new setup will cut lead times, minimize errors, optimize margins and provide a real competitive advantage. To make this work, however, it will require a new organizational setup for planning. As a large share of routine planning activities are automated, the physical proximity to operations such as locating production planners in the plants, will be less important while a knowledge exchange and best practice sharing among planners becomes even more crucial. Thus, planners will require a co-location to enable the continuous interaction and improvement.

We might therefore see a resurrection of shared service centers for SC planning – this time, however, to move closer to the right talent and to enable close collaboration, rather than to save personnel cost. While the number of planning FTEs might go down, the total cost will most likely not change dramatically, as the change of roles comes with increasing capability requirements and therefore higher salaries. The need for highly qualified talent is continuously increasing and even today already, there is a tendency to outsource such jobs into "shared service centers" with access to the right talents rather than into low cost countries. The prime decision criteria will be how to best access the top talents in data engineering and algorithmic optimization.

Future planning will not make planners obsolete, but the "Planner 4.0" will not be comparable anymore with many of today's planners. Planners need to become much more analytical and IT-savvy, requiring significantly enhanced capabilities, and will be a core differentiator of supply chain performance.

Already, companies can prepare for future requirements in establishing the data engineering and optimization roles for creating batch jobs doing "automatic" master data checks and creating suggestions for adaptation. While doing so, it is essential that companies codify the extensive experience/knowledge of their planners and ensure that future systems can use it rather than having to re-discover core aspects of the operational reality. On top, skills in SC planning and advanced analytics need to be urgently built to not lose ground in the context of a fast evolving SC planning function. •

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How They Did it: Red Wing Shoes' Journey to S&OP

By Stephanie Grothe

Who owns your Sales and Operations Planning process? Is it the supply chain? Is it sales and marketing? Is it manufacturing? Is it your executive team?

In 2008, those were questions that we struggled to answer at the Red Wing Shoe Company as we started our journey towards S&OP success. After speaking to consultants and to other companies like ours at conferences, we knew we were certainly not alone. Gartner, for instance, has reported that about 70 percent of global organizations are only in Stage 1 or Stage 2 of the four stage S&OP Maturity Model. Most organizations acknowledge the need for a step-change improvement to their S&OP process.

At the start of our journey, the S&OP process took six weeks to prepare. It was reactive, manual, and primarily a backward looking exercise; much of our planning was based on historical data that we updated by backing out our most recent sales figures from the total projection for the year. The remainder at the bottom of the column became the figure we expected to sell for the rest of the year. There was little collaboration with our suppliers or manufacturing team to understand their capacities and constraints compared to our forecasts. We relied on voluminous and complex spreadsheets and updating them was a manual, labor-intensive process that was prone to error. More importantly, nobody in the organization really owned the process or the results.

Over the next several years, we improved our process through a series of steps. In doing so, we tackled the three primary components of S&OP: people, process, and technology. Along the way, we brought in best practices to reform the way in which we created our forecast and how we finalized our plans. We created new roles for the people involved in

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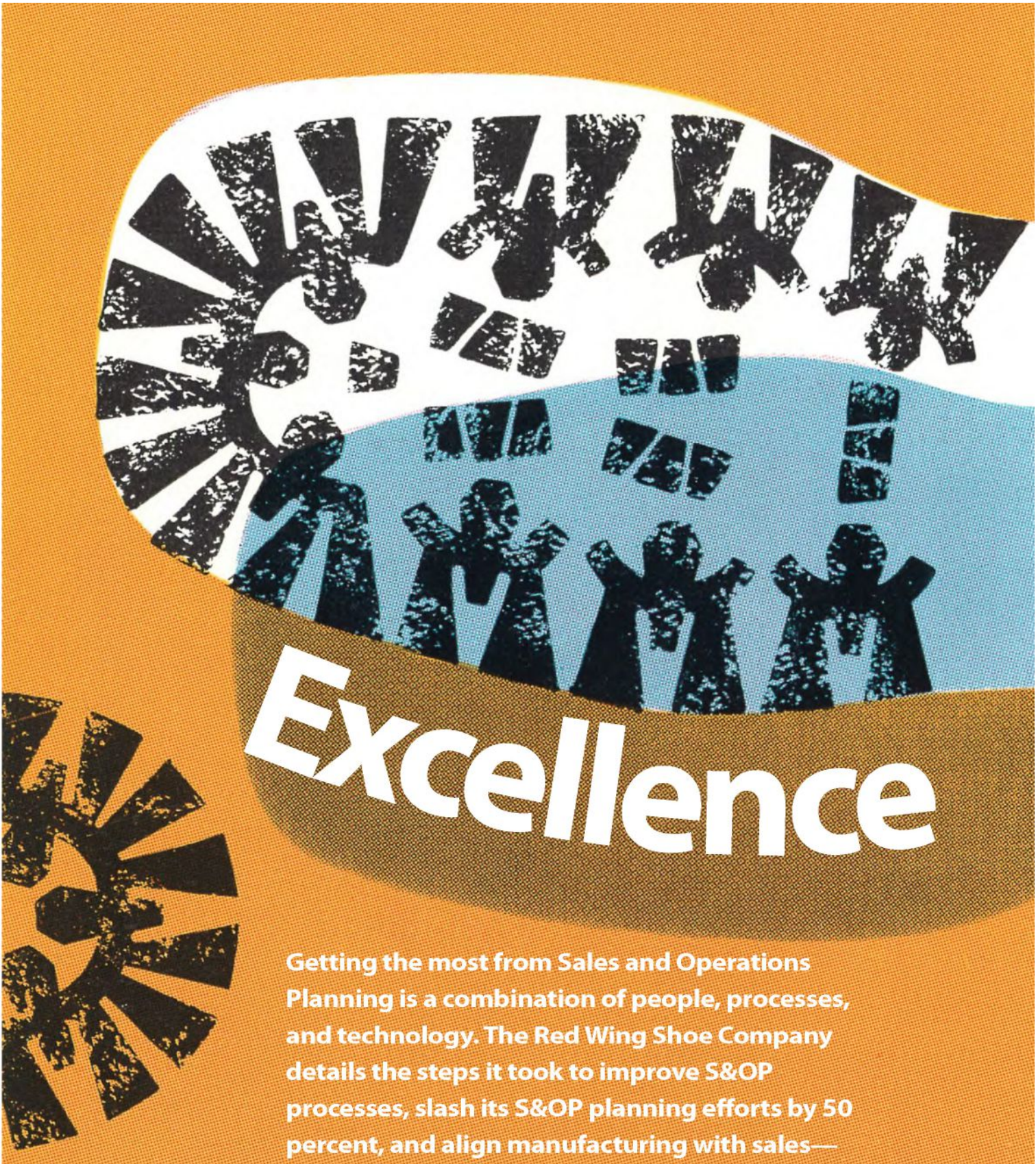

Excellence

Getting the most from Sales and Operations Planning is a combination of people, processes, and technology. The Red Wing Shoe Company details the steps it took to improve S&OP processes, slash its S&OP planning efforts by 50 percent, and align manufacturing with sales—all while growing its business.

demand forecasting and provided training to our team. Finally, we brought in new technology to automate forecasting and reporting, and to enable supplier collaboration.

There were trials and errors, successes and failures. Through it all, however, a process that once took six weeks is now completed in three weeks. Our forecasts and plans are shared collaboratively with our suppliers and manufacturing group. More importantly, each of our functional teams is involved in the creation of the plan, which is approved by our senior management and tweaked with input and adjustments from all of our functional areas. We know who owns the process.

The result is that since full implementation in 2012, we are able to accurately forecast for eight manufacturing plants around the world, and generate a forward-looking, 18-month rolling plan. We have reduced inventory while simultaneously improving customer fill rates, entering new markets, adding retail stores, and expanding our portfolio of products.

This is the story of the steps we took along the way to S&OP success.

Red Wing Shoes at a Glance

Founded: 1905

Sales: Privately held

Products: Footwear, apparel, Personal Protective Equipment (PPE), and accessories for work and outdoor activities

Brands: 6

Manufacturing: 14 locations in the U.S., China, Mexico, Pakistan, Dominican Republic, Vietnam, and Poland

Distribution: Warehouses in Red Wing, Minn., Salt Lake City, Houston, and Dubai, with 3PLs in Japan and the Netherlands

SKUs: 26,000 footwear SKUs and 72,000 garment SKUs

Increasing Complexity

At Red Wing Shoes, we have a saying: "Work is our work." The company was founded in Red Wing, Minn., around the turn of the 19th century by Charles Beckman, a local shoe merchant who saw a need for footwear that works—boots that were comfortable but could stand up to the harsh working conditions of demanding industries such as mining, logging, and farming. In 1905, Beckman and 14 investors opened Red Wing Shoes to manufacture and market his unique designs.

Hard work remains the cornerstone of our business; we produce boots for work in the original factory and use Puritan stitch machines that have been in service for more than 80 years. The styles in our Heritage collection are designed and manufactured just as they were years ago, using premium leather from our own tannery. We also manufactured domestically in Potosi, Mo.

Our markets, however, have expanded far beyond Minnesota. Our products protect workers in more than 150 countries across the world, from the Mideast oil fields to the Midwest cornfields. In countries like Japan, which value the American made label, the old work boot look is considered high fashion. We are expanding our warehouse in Dubai to keep pace with a fast-growing market in the Middle East. All told, we manage six brands, including Red Wing Work, Red Wing Heritage, Vasque hiking shoes, Irish Setter Hunt & Work, and the WORX line of boots and shoes. Currently, we forecast for 26,000 footwear SKUs and 72,000 garment and accessories SKUs.

Our supply chain is global and complex. It begins with hides prepared at our own tannery and extends to our company owned Red Wing Shoe retail stores as well as retail partners around the world. In addition to our domestic footwear operations, we manufacture footwear in China and uppers in the Dominican Republic. Garments and accessories are made in Mexico, Pakistan, Vietnam, China, and Poland. We operate distribution centers in Red Wing, Minn., Salt Lake City, Houston, and Dubai, and partner with 3PLs in the Netherlands and Japan. In addition, we direct ship from all of our factories.

We service a network of between 450 and 500 domestic retail locations, ranging from our own corporate owned stores to big box retailers to mom and pop shops; six Heritage stores in Europe and Asia, with more on the drawing board; 50 industrial trucks that deliver to job sites; and 47 B2B showrooms around the world.

The company continues to look at new markets and new products, such as shoes and apparel to address stricter safety regulations for the gas and oil industries in emerging markets. In 2010, we added fire protection gear to our portfolio. What's more, we are working to position our manufacturing and distribution points closer to the local market to better serve our customers. As we add more customers and products in areas like Africa and the Middle East, we are changing the processes in our warehouses. In some facilities, for instance, customers will pick up full containers of product and transport those to their distribution points. And, as with every other business, all of our customers want it yesterday.

Taken as a whole, we have more items to forecast; more factors that can influence a forecast than in the

past; and S&OP is more important than ever, especially as we try to do an effective job of managing inventory while improving our fill rates. It's still all about having the right product, in the right amount, in the right place, and at the right time.

Spreadsheets, Errors, and Meetings

In 2008 the author of this article was hired to lead a reimplementation of the S&OP process. At the time, there was a planning process in place, but it was less than optimal. A planner and a representative from product development created a yearly forecast broken out by month. The forecast was based on the prior year sales and what we thought might happen in the next year. It was updated once a month in a small meeting.

For example, if we originally forecast to sell 1,000 units of a style and moved 700 units through the first eight months of the year, we updated the plan to reflect projected sales of 300 units over the last four months. Changes to the forecast, or the reasons for changes, weren't tracked. A spike in demand for a certain style, for instance, might lead to a new increased forecast. However, we rarely investigated to determine whether the spike in demand was a sustainable surge in interest or a one-time fluke.

Execution of the plan was driven by our supply chain and not the sales department. If inventory was out of line with what was selling, or where it was selling, we often ended up storing the excess in trailers or containers in the yard until we freed up space in the warehouse. That practice resulted in high demurrage charges. At the end of the day, no one organization owned the process or was responsible for the outcomes.

We took the first steps towards changing that dynamic in 2009. One of those steps was to create a spreadsheet for each of the company's brands. We also created the initial framework for more inclusive S&OP meetings, with representatives from different functional areas within the company, including executives, supply chain, product development, and sales managers from our various brands. The participants included Mallery Dosdall, who was then part of the retail organization and is now the manager of demand planning. The meetings might include more than a dozen individuals and sometimes lasted for three hours.

These were important first steps along our journey. However, there were still a number of drawbacks that limited our effectiveness. For starts, forecasting remained in the hands of product development and planners. And, it was still reactive and manual. Moreover, it was time consuming. Gathering and inputting the data into the spreadsheets took two or more weeks.

The spreadsheets were complex, clunky, and voluminous; we needed over 450 pages to forecast across all brands and styles. If an executive had a question about a brand or style, it could take hours to ferret out the information. Given the number of brands, styles, and warehousing and manufacturing locations, it's no surprise that the process of manually inputting the data was prone to error. As an example, there was an instance where 20 new styles were added to one spreadsheet. Each of the new styles was available in 40 to 50 different sizes. While inputting the data we forgot to add the subtotal to the top of the spreadsheet. The net result was that planned capacity at the production lines based on the forecast was insufficient to meet actual demand.

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In retrospect, the first S&OP meetings were also too large—and too long—to be effective. Like the forecast, the meetings were often a look back at what had just happened since the last meeting rather than a look ahead at what should happen. In all, the process of forecasting and approving a plan took 6 weeks. By the time a forecast was sent to suppliers and to manufacturing, it was already dated.

At the same time, there was little collaboration with suppliers and manufacturing teams. We rarely asked them if they had the capacity to produce what we needed and when we needed it. Nor were they provided with a forecast. We simply issued a PO for what they were expected to produce and the date for when it was due. Unless someone from manufacturing was communicating directly with the sales team, corporate didn't know whether the factories would meet their production requirements or their ship by dates.

The sense from the S&OP team was that there was still room for improvement.

A Step in the Right Direction

In late 2010, we took the next step in the right direction to improve the process. With the help of our IT department, we created a process to automatically pull data from our ERP system and populate a new spreadsheet. That meant that we no longer had to spend two weeks just keying in data. By automating some of the process, we reduced the number of errors—however, we still had to key in changes from the spreadsheet back into the ERP system, which was prone to mistakes.

Although they were still voluminous, the spreadsheets were easier to work with. In addition, the team began meeting with the head of sales and other representatives for each brand to get more accurate data about what was selling and why, including Dosdall who was then still with our work brand. The meetings were still long, but the team now had the ability to see year-over-year demand and had a more complete picture of data. This new approach, combined with more accurate spreadsheets, was a significant improvement.

Still, our business was growing, further complicating the task of forecasting. By early 2011, it was clear we needed to increase our visibility into our true demand and provide more reliable plans to suppliers and manufacturing if S&OP was going to effectively support the growth plans we had for the business. To learn more about best practices, Dosdall and Grothe attended an S&OP conference sponsored by the Institute of Business Forecasting & Planning (IBF) and led by the consulting firm Oliver Wight. The two attended other S&OP conferences as well, such as the Best of the Best S&OP conference put on by IBF and APICS.

Following these events, they developed ideas on ways to evolve from a backward-looking to a forward-looking organization. For instance, they wanted to create manufacturing capacity graphs and to provide suppliers with better forecasts. The idea was to take actual sales data and use that to forecast at the level of the production line. They would then work with manufacturing to ensure that forecasts aligned with capacity.

Dosdall and Grothe presented a proposal for a new approach to S&OP. To illustrate the challenges of forecasting, they recreated an exercise from one of the conferences. Participants were handed bags of M&Ms and asked to forecast how many M&Ms were in the bag and to predict the distribution by color. No one got it right, not even one clever executive who called the 1-800 number on the back of the pack to speak to the candy manufacturer. The point was made: If you think estimating the number of M&Ms in a pack by color is tough, try forecasting across tens of thousands of SKUs with limited visibility.

Two important changes came out of the proposal. The first was a commitment to redesign S&OP meetings from one large inclusive event into smaller meetings divided by functionality. The idea was to create a forecast based on consultations with each brand and then separately review and refine the plan with functional areas, such as manufacturing, distribution, and transportation. That forecast could then be massaged by the sales department based on the capacity constraints in the supply chain. If everything couldn't be manufactured, what was sales' priority? If there was too much capacity, could sales run a promotion to move more product? Did manufacturing need to add a second shift? Once that plan was

Three weeks from planning to execution

Streamlined processes enabled by technology allowed Red Wing Shoes to reduce its forecasting and planning time from six weeks to three weeks. Meetings are scheduled in advance, using an S&OP Calendar tool. Here are the steps they follow.

Build the forecast: During the first week of a fiscal month, demand planners and sales analysts hold conference calls with each of the regions to get feedback on current trends. The forecast is tuned within the demand planning tool.

General manager approval: On day three of the month, demand planners take their forecasts to the general managers of each brand for approval.

Executive approval: On day three or four of the month, the forecast numbers are reviewed by the President/CEO and CFO. If approved they are published to the organization. This is called S&OP1.

Supply chain handoff: By Friday of the first week, an email notification is sent from the Demand Planners to the Supply Chain Planners for review. Supply chain uses the data to create capacity plans by factory and by production line. Once the data has been analyzed, supply chain develops next steps and plans to bring back to sales. This is known as S&OP2.

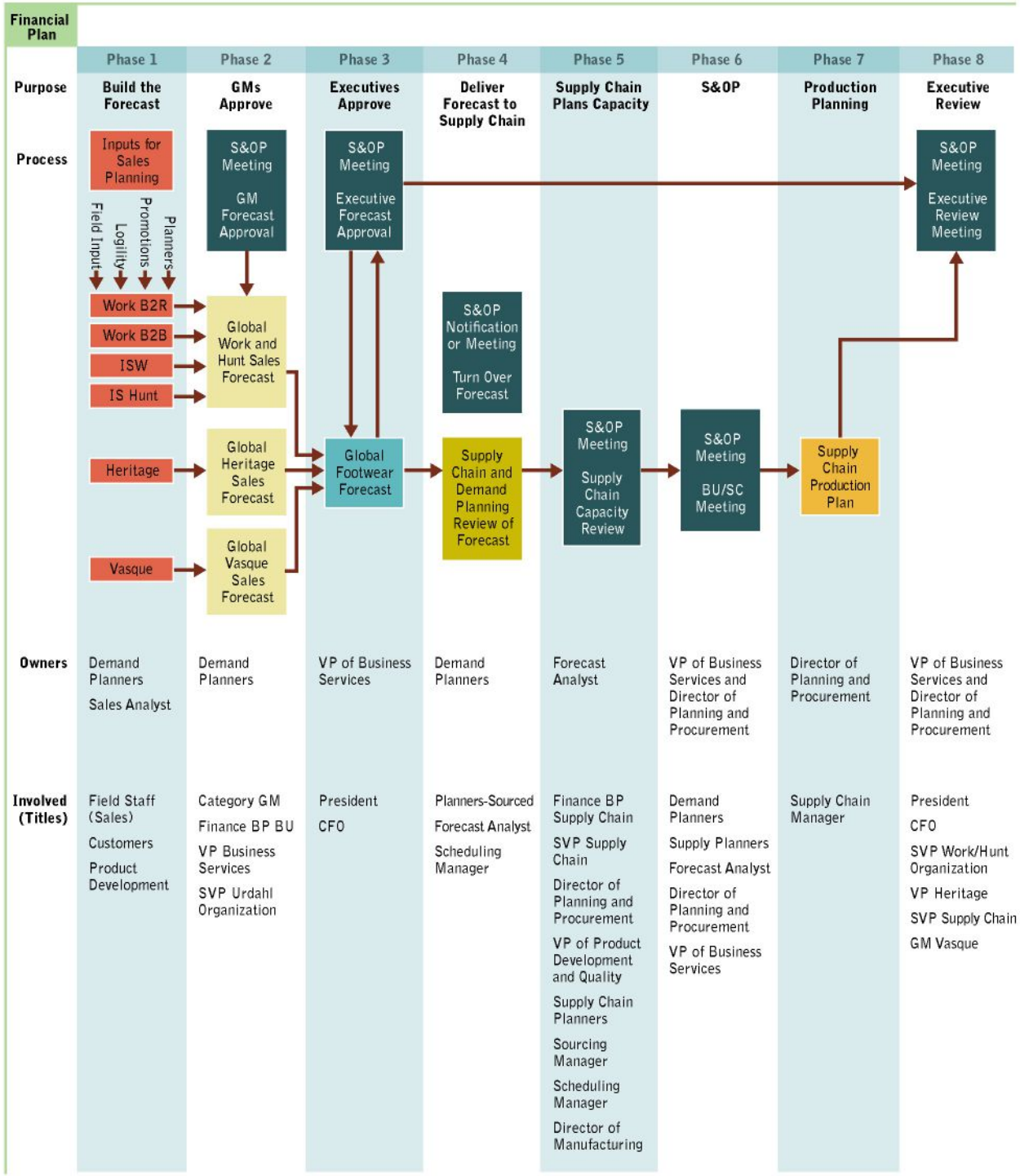
Consensus meeting: On Thursday of the second week, sales and supply chain iron out any issues related to promotions, capacity, or distribution.

Planning and executive review: Planning continues through the process. Another executive review takes place on the first Tuesday of the third week. This meeting is a recap of prior S&OP meetings and is meant to address long term issues that need further discussion. Inventory projections for the next 12 months are also reviewed.

After this final review, the plan is put into action.

EXHIBIT 1

The Red Wing Shoe Company's S&OP Process



Source: Red Wing Shoes

LESSONS LEARNED

Four key takeaways from Red Wing Shoes' S&OP Journey

Revamping an S&OP process doesn't happen overnight. After a several year journey, Stephanie Grothe, Red Wing Shoe Company's process improvement manager, offers the following lessons learned.

1. It starts at the top: "Your management team must be on board," says Grothe, who adds that initially, the process was driven by her boss, who was responsible for planning and procurement, and not the company president. Now, senior management signs off on the plan. "Initiatives like S&OP only work if your top executives want them to work and instill that to everyone."

2. Patience is a virtue: There's an old saying: Just because you throw nine women at the problem doesn't mean you can give birth in a month. "It's important to remember that some things will take time," Grothe advises. "You'll find that some new ideas work but some won't and you'll have to start over."

3. Celebrate successes: Because there will be some trial and error along the way, Grothe believes it's important to celebrate successes as they occur. It will boost morale.

4. Be accountable: It's important that stakeholders take their responsibilities seriously. "We use technologies to plan meetings around everyone's calendars well in advance," Grothe says. "You want to make sure that everyone who needs to be part of the process is at the meetings and accountable for their functional area."

complete, it was reviewed by the executive team. (See *Red Wing Shoes' S&OP Process*.)

A second outcome was to evaluate the people involved in S&OP. For instance, we created a new demand planning position—this was an individual who would work directly with each brand to analyze data, input information from the sales groups, and formulate a better process. That role was initially filled by Dosdall. She began holding conference calls with domestic and international sales regions. During those calls, for instance, she might learn that the Northeast had been really wet and that waterproof products might be in more demand. That information became part of the statistical forecast. Since then, we have added additional members to the team and now have five demand planners, including Dosdall who manages the team.

We had been holding weekly conference calls with suppliers and manufacturers as part of a lean manufacturing and warehousing initiative since 2009. Now, we could provide better sales and forecast data during those conference calls; we also got a better understanding of how each of these areas was producing and their constraints. By collaborating with our partners, they too became part of the S&OP process and shared in the forecast.

Demand Planning Made Easy

At the end of the day, S&OP is a process and not a technology. However, demand planning is made easy by technology. Although we were refining our processes and redefining the roles of our people, we were still working with spreadsheets. To take the initiative to the next step, Grothe attended an APICS conference in Toronto to learn about software forecasting tools designed to streamline the S&OP process.

After a vetting process, Red Wing Shoes settled on a software application from Logility. The implementation process began in late 2011; the demand planning module went live March 2012, and was followed by inventory management and replenishment two months later in May.

As we were preparing to work with the new technology, we realized we were making significant changes to our organization. To prepare our staff, we sent a key group of stakeholders to a course on planning and forecasting tools offered through APICS. This group not only learned how the new software tool was going to work, the members also learned how a change in one of the parameters, such as safety stock or bumping up a forecast, had an effect on manufacturing and distribution. We felt this type of change management and training was essential if our people were going to make the best use of the software and the new process.

During the implementation, we populated the software solution with three years of demand history. Once the tool went live, the old clunky spreadsheets were replaced with streamlined, dynamic views of the business, including global visibility by brand and company. It took about three months for our organization, our suppliers, and our manufacturers to trust the data, but soon they became convinced that the data was solid.

Since then, we have realized a number of benefits:

- The S&OP process itself has been cut in half, from six weeks to three weeks.
- By populating the software solution with three years of demand, planners can take a deeper dive into the history of a style or SKU and apply statistical methods to forecasting.
- When we were using spreadsheets, it could take days to answer a question for senior management, like

the sales demand for waterproof styles from a specific factory. Now, reports are available in minutes.

• The system allows planners to manage by exceptions. While every style is reviewed at least once a quarter, the system is set up with alerts that let a planner know in between reviews if they're missing their forecast or if we are selling more than our forecast.

• And, suppliers and internal stakeholders trust the data. Our suppliers tell us it's the best information they've ever received.

The most important outcome of the new approach to forecasting and planning may be that we were able to finally answer the question of who owns the process: Supply chain owns the tool and prepares the forecasts; the brands own the sales; sales owns the inventory; and so on. It was all geared towards making certain that manufacturing had accurate sales forecasts that were also in line with their capacity and ability to ship the right product to the right stores at the right time.

After working with the system for the last two years, inventory has been reduced by 27 percent while customer fill rates have been improved by 8 percent to 10 percent. Those pesky demurrage charges have been decreased by 50 percent—all while growing the business.

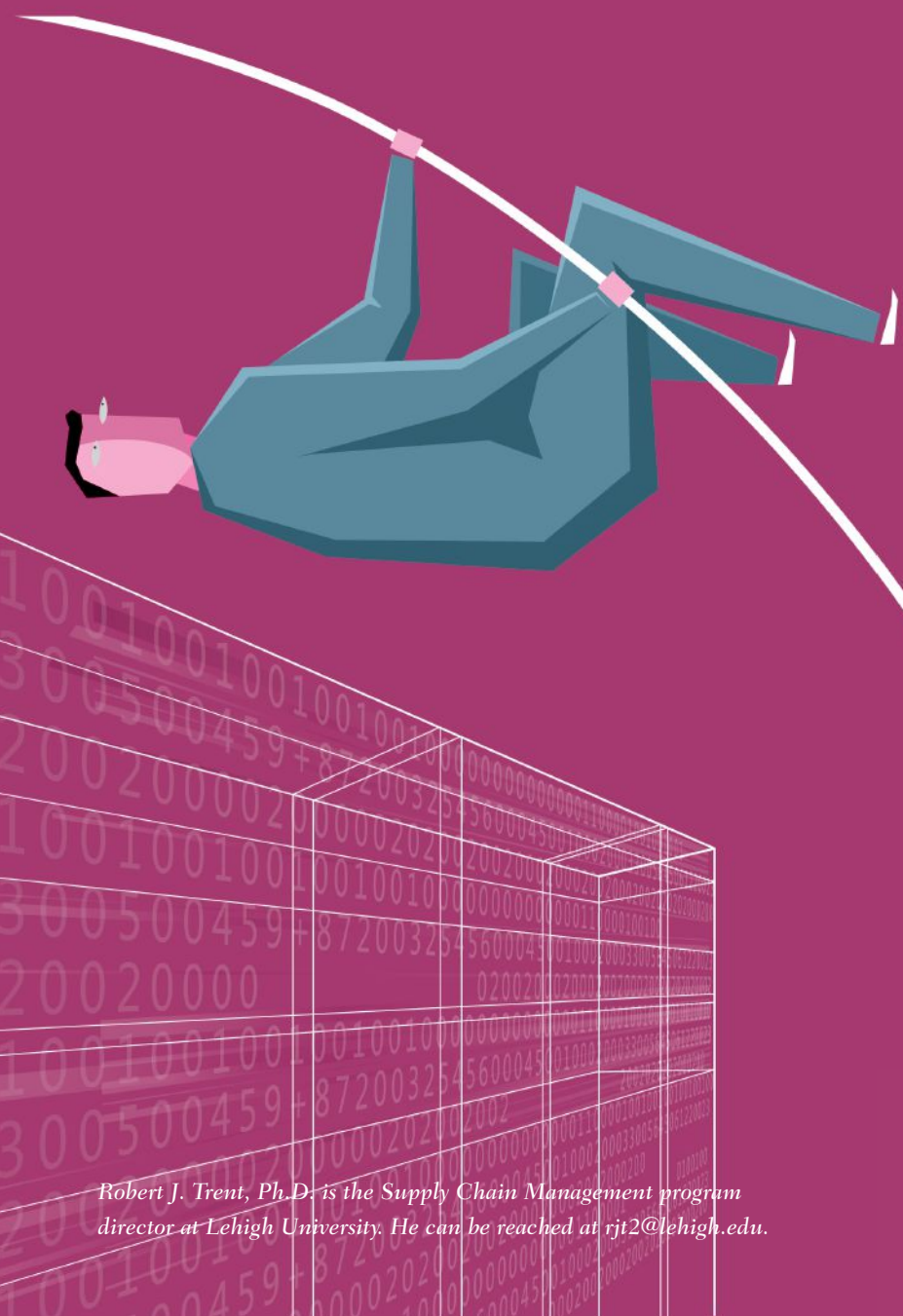
The impact on the company was summed up by one senior executive shortly before the system went live: "This will be a game changer for us." Indeed, we could not have added the number of new products or entered the number of new markets we have taken on with our old spreadsheets and old S&OP process. •

The most important outcome of the new approach to forecasting and planning may be that we were able to finally answer the question of who owns the process: Supply chain owns the tool and prepares the forecasts; the brands own the sales; sales owns the inventory; and so on.

REEL IN RISK WITH A BROADER VIEW OF SUPPLY CHAIN FLEXIBILITY

In an era when supply chain risks are soaring, senior managers are putting more of a premium on supply chain flexibility. But they now need to view the concept as more than just adjusting manufacturing supply to demand—a narrow perspective that can lead to problems. Here's how managers can take a much broader view of supply chain flexibility, with risk reduction foremost in mind.

BY ROBERT J. TRENT



It has become a classic example of the effects of supply chain disruption: the time when fire destroyed the premises of a supplier that provided Nokia and Eriksson with critical components for mobile phones.

The two companies had entirely different responses to the event, resulting in a dramatic industry shift. Nokia was able to secure components quickly from other sources. By contrast, Eriksson struggled to respond. The disruption not only cost the company several hundred million dollars in lost sales; it essentially ended its position as a player in the growing wireless phone business. Poor business continuity planning by Eriksson, combined with a lack of supply chain flexibility, turned a hazard risk into a strategic risk.

As the search continues for new and improved ways to manage supply chain risk, senior managers will put more and more of a premium on operations that are as flexible as possible. The concept of flexibility is receiving increased attention in the popular press as well as from supply chain professionals. A global supply chain survey conducted by PwC and reported in *Industry Week* concluded that almost 65 percent of respondents plan to implement greater flexibility to better respond to supply chain challenges, making flexibility a top supply chain priority.

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Rethinking Traditional Definitions of Flexibility

If those challenges are to be fully met, however, broader interpretations of supply chain flexibility are required. It is neither a static nor a monolithic concept. Yet many managers view it in terms of adjusting volumes in a manufacturing environment. Consider this definition from one business dictionary: "Flexibility is the ability of a system, such as a manufacturing process, to cost effectively vary its output within a certain range and given time frame."

In fact, supply chain flexibility involves much more than that, and managers need to view it broadly rather than narrowly. They have to think in terms of an organization's ability to be agile, adaptable, and responsive to change—particularly changes brought about by risk events. Flexibility should be an important supply chain objective—a characteristic that enables companies to enhance the resilience of their supply chains. Resilient supply chains can adapt quickly to changes or risk events, according to authors Mark Stevenson and Martin Spring in the *International Journal of Operations Management*, including supply disruptions or changes in demand, while maintaining appropriate customer service levels.

Experience, literature searches, and research with hundreds of companies enable us to identify more than a dozen dimensions of supply chain flexibility, along with possible ways to achieve that flexibility.

The point here is that effective risk management requires the ability to respond quickly to a risk event with alternatives, sometimes within minutes. Nokia's supply chain had that kind of in built flexibility; Eriksson's didn't.

To help foster a broader view of supply chain flexibility, this article presents a variety of interpretations of the concept. Experience, literature searches, and research with hundreds of companies enable us to identify more than a dozen dimensions of supply chain flexibility, along with possible ways to achieve that flexibility (See Exhibit 1). For practical purposes, though, this article focuses on three aspects where attention from senior management will pay the greatest dividends. We will also look closely at three approaches that facilitate the transition from a conceptual understanding of supply chain flexibility to embedding it in the organization's thinking and culture.

Supply Chain Design Flexibility. Supply chains are rarely as neat and tidy as those presented in academic models. In fact, they often feature a multitude of forms as companies pursue a variety of customer segments and work through different sourcing and distribution channels. Supply chain design flexibility means that an organization has designed or can adjust its supply chain to satisfy specific requirements.

Dell Computer, a company that faces strategic risk as customers shift from personal computers and laptops to tablets and other devices, realized that the supply chain it had established to support make-to-order online sales would not readily support its expansion into retail sales and other market segments. Dell has since developed four supply chains, as described by David Simich-Lefi in the *Sloan Management Review*. Each is dedicated to a different customer segment that provides much more flexibility to respond to a broader array of market opportunities. The build-to order supply chain supports Dell's online customer segment; the build-to-plan supply chain supports the retail segment; the build-to-stock supports the company's online/popular configurations segment; and the build-to-spec supply chain supports its corporate segment.

Logistics Flexibility. Logistics flexibility means being able to adjust the route or mode of transportation taken to move goods, funds, and even information. This kind of flexibility allows shipments to be rerouted when natural hazards occur, roads are closed due to accidents, a strike occurs at a port or a carrier, or a mode of transportation becomes less viable.

The benefit of logistics flexibility is increasingly evident in the U.S. oil industry. A proposed $2 billion pipeline (a fixed, inflexible mode of transportation) designed to take plentiful crude oil from West Texas to California has failed to generate interest among large California refiners because of the flexibility offered by rail cars. Relying on rail shipments to transport oil allows refiners to source from different locations around the U.S. and route the oil to their California refineries, something that is not feasible with a fixed pipeline. A growing supply of North American crude oil is coming from locations where prices fluctuate, allowing refiners to use different routes and modes of transportation (such as rail cars) to make opportunistic purchases for their crude supply.

EXHIBIT 1

Different Types of Supply Chain Flexibility

Type of Flexibility	The Ability to...	Supply Chain Tactics
Volume Flexibility	Adjust order volumes internally and with suppliers in response to changes	• Overtime and weekend production • Access to temporary labor • Contract manufacturers and secondary suppliers • Safety inventory
Order Lead Time Flexibility	Have variable rather than fixed lead times with suppliers as required by customer demands	• Ask for shorter lead times from suppliers • Negotiate variable lead time requirements with suppliers • Select suppliers that have lead-time flexibility capabilities
Scheduling Flexibility	Adjust production and delivery dates internally and with suppliers as conditions change	• Real-time data visibility and dynamic scheduling • Work to secure preferential scheduling treatment from suppliers
Product Configuration and Variety Flexibility	Modify the design of a base product, including adding new varieties or features	• Develop platform products that allow re-configurability and modification • Practice mass customization
Physical Flexibility	Change the structure or layout of physical processes or sites	• Use modular facilities that can be modified for new uses • Build in future expansion and re-configurability capabilities during facility design
Capacity Flexibility	Modify the internal and external capacity levels of supply chain members	• Reconfigure work cells to shift according to product mix requirements • Use overtime and weekend production • Approve secondary supply sources and contract manufacturers • Reserved capacity slots with suppliers
Design Flexibility	Modify product designs quickly	• Computer aided product designs • Virtual simulation and testing • Use standard components wherever possible
Internal Routing Flexibility	Alter how a product flows through a facility	• General rather than specialized workers and equipment • Preapproved alternate routing
Logistics Flexibility	Reroute or adjust movement through logistical networks; shift modes of transportation or carriers	• Pre-approved secondary carriers • Have multiple port options • Have pre-approved multiple modal choices • Control title to goods to enable rerouting

Material Flexibility. Material flexibility—allowing producers to shift from one material to another with relative ease—is valuable to industries that rely extensively on raw materials. It is especially useful when commodity prices are volatile, as they are today. The size of fluctuations in commodity prices has more than tripled since 2005 compared to 1980-2005, based on International Monetary Fund data.

Some users of nickel have already come to appreciate this facet of flexibility. In the not too distant past, the price of nickel soared, making it prohibitively expensive for companies that rely on stainless steel 318, an industry standard material that contains nickel. Companies that manufacture vehicles to carry food products were hit especially hard. Fortunately, material engineers at some of those tank trailer manufacturers were able to shift quickly to lean duplex, a type of stainless steel that offers material properties that are 30 percent to 200 percent better than traditional alloys with only a fraction of the nickel contained in other stainless steels. Lean duplex also offers higher yield strength, making it less susceptible to cracking and corrosion, Denise Rondini writes in *Transport Topics*.

Embedding Flexibility in the Supply Chain

Our discussion so far has opened up the view of what supply chain flexibility can mean. (Exhibit 1 provides other views that we don't have time or space to explore in this article.) However, it's one thing to develop a clearer conceptual understanding of the concept and another thing to make it an embedded part of the organization's thinking and culture. Where should supply chain managers start?

There are many ways to answer that question, but in our experience, the three most important areas where flexibility should be embedded are: during the development of business continuity plans; during the development of new products and services; and during the development of commodity strategies. Let's examine each in turn.

Incorporate Flexibility into Business Continuity Plans. The objective of a business continuity plan is to assure the availability, reliability, and recoverability of business processes that service a company's customers, partners, and stakeholders. Business continuity formalizes a company's overall approach to effective risk management, and should be aligned closely to its procedures for incident management, emergency response management, and information technology disaster recovery. Investor Warren Buffett once observed that risk comes from not knowing what you are doing. Business continuity planning helps ensure that we know what we are doing when bad things happen.

A Basic Plan for Assessing Commodity Risk

Here is a simplified five-part framework for a risk assessment plan that should become part of any commodity sourcing strategy.

Section 1. This section includes an external intelligence report that describes in detail the supply market for the commodity/material. Who are the major suppliers and where are they located? Who are the major customers? What are the supply trends? Are there specific supply and demand price drivers? What is the overall competitive environment of the market for this commodity?

Section 2. This section identifies and categorizes risk(s), including a detailed description of each risk (i.e., not a generalization such as "potential supply disruption" or "bad weather").

Section 3. This section requires the development of a risk scenario map with each risk plotted on the map. The dimensions of the map can include the probability of a risk occurring and its expected impact if it were to occur.

Section 4. This section contains a comprehensive risk management plan that identifies risk management actions that describe how to manage the risks identified in Section 2. This section should also include a timeline that shows how and when to carry out risk management actions.

Section 5. This section includes a listing of objective references and information sources about the demand and supply market for that item and supplier(s). It should identify why each information source is valuable. Particular emphasis should be given to information sources that are updated on a regular basis.

A key part of a business continuity plan involves the recovery strategies put in place to mitigate specific risks identified during a risk assessment. This is where various kinds of flexibility will come into play. Data gathered from business impact analysis and risk assessment (two important parts of continuity planning) will lay the groundwork for recovery strategies that mitigate potential risks. Recovery strategies and the associated estimated costs for implementation are then developed and presented for review to a business continuity governance board (such as the executive management board). Increasingly, different kinds of flexibility should be considered when developing risk strategies.

Integrate Product Development and Risk Management. In typical new product development projects, particularly at technology companies, engineering teams work as fast as possible to develop new products or technologies. Then, at some later point, supply chain professionals become involved and suppliers are selected to support the design. This sequential approach limits a company's ability to anticipate and perhaps even prevent supply chain risks. Unfortunately, this model is the norm; there are few companies that address product development and supply chain risk simultaneously. Although integrated product and process development is well understood, the integration of supply chain risk and new product development is not.

So what are the characteristics of a process that brings together product developers and supply chain risk managers? First, supplier selection must happen early in the design process, so that those responsible for supplier risk management have time to identify and address any supply concerns. Next, each cross-functional team involved in product development, with the help of supply chain managers, will have responsibility for identifying a set of supply chain risks, including logistical risks that may affect their part of the project. Those risks are then collected and categorized for easy access. Development team members will meet regularly to review product development progress and also the actions taken to address potential risks. Increasingly, these actions will focus on supply chain flexibility.

Taking this a step further, a team will estimate the probability of each risk occurring and the impact on product launch if the risk occurs. Priority is then given to evaluating the higher risks to determine what action can be taken to reduce their probability and impact, including the development of approaches that support supply chain flexibility.

Make Risk Plans Part of Commodity Strategies. One indicator of an organization's maturity is the presence of well thought-out strategies, which in supply chain management includes commodity or category strategies. A purchase commodity or category is simply a grouping of like items or services. Something that should increasingly be required is for commodity or sourcing teams to include risk assessment plans as part of their formal commodity strategies. That will encourage commodity teams to assume the responsibility for risk management rather than shifting it to another party. It will also help embed risk management thinking into the corporate culture. A risk assessment plan is an extension of a risk analysis. The plan documents known risks and includes descriptions, causes, likelihood of risk occurrences, costs, and proposed risk management responses. It can easily be included as part of a formal commodity strategy. Again, many of the risk management responses proposed in the plan may relate directly to actions that enhance supply chain flexibility.

The sidebar, A Basic Plan for Assessing Commodity Risk, provides a template for developing a risk assessment plan. Section 4 of the template will include the flexible capabilities that help manage the risks identified in Section 2. Executive management should not accept a proposed commodity strategy unless it includes a fully developed risk assessment plan.

A Culture Attuned to Risk

Companies that are effective at managing supply chain risk will have created a corporate culture that constantly considers risk implications. A culture that emphasizes risk will benefit from a set of action plans, capabilities, tools and techniques, skilled personnel, and the ability to quantify the value of risk management efforts. When these capabilities are present, a company can engage in thoughtful risk taking that is supported by supply chain flexibility rather than being paralyzed by an irrational fear of risk. Within the domain of risk management, supply chain flexibility might just be your next source of competitive advantage. •

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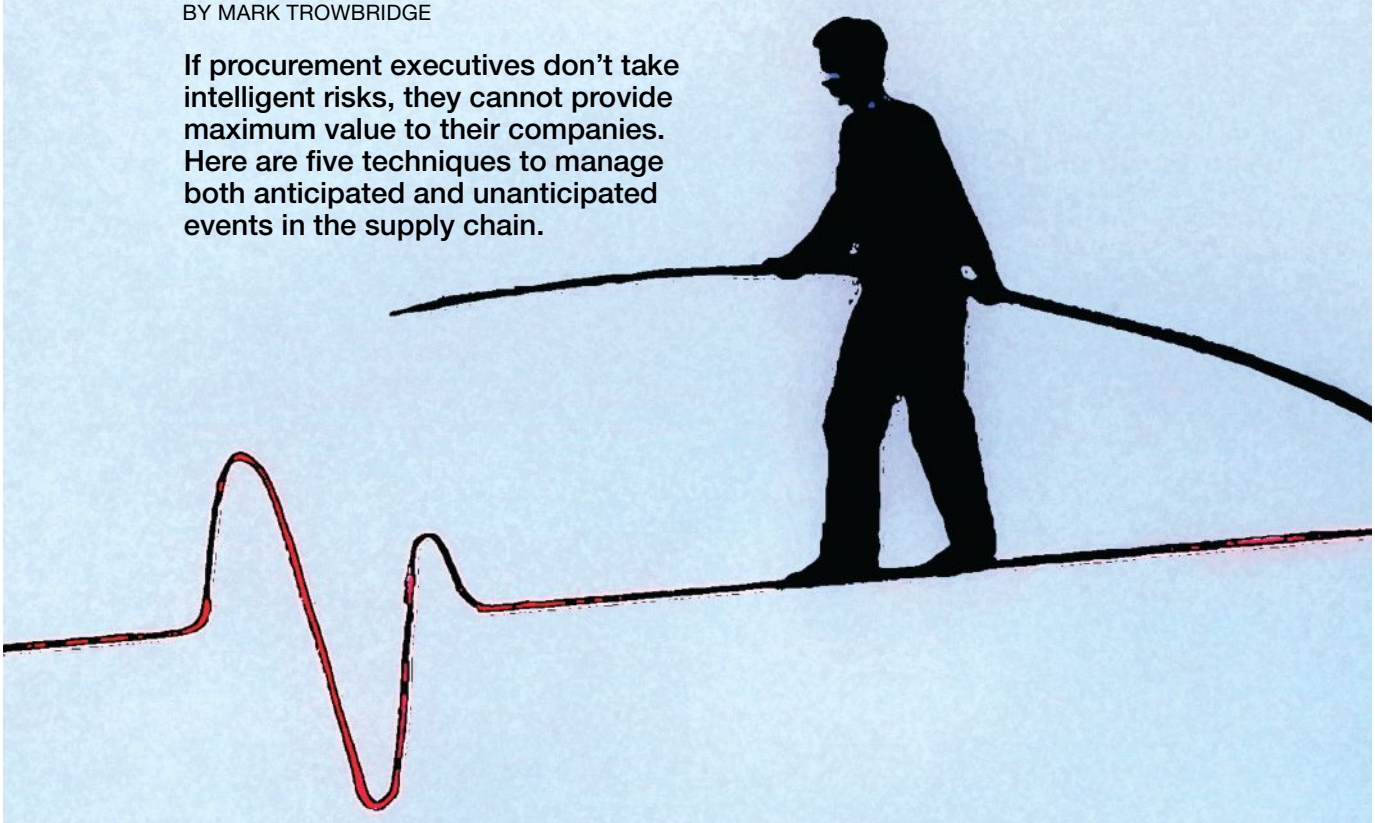
Five Techniques to Manage Supply Chain Risk

BY MARK TROWBRIDGE

If procurement executives don't take intelligent risks, they cannot provide maximum value to their companies. Here are five techniques to manage both anticipated and unanticipated events in the supply chain.



RISK has always been part of the supply chain. It's a reality inside and outside the four walls of any organization. It's no surprise then that as Enterprise Risk Management (ERM) programs proliferate, they have naturally begun to address anticipated and unanticipated events occurring both upstream and downstream in the supply chain.

Upstream of an organization are the suppliers who create goods and services used in a company's own operations. These include raw components or materials that flow into direct manufacturing as raw materials. There are also indirect products and services that facilitate the company's actual operations.

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The downstream supply chain efficiently distributes a company's products or services to its customers. All contracted suppliers, both upstream and downstream, must be proactively managed to minimize financial, confidentiality, operational, reputational and legal risks.

You don't have to look any further than recent headlines to see potential fallout here. Did Equifax have proper data liability insurance coverage in place before 143 million accounts were hacked? And even if they did have coverage, how much was their reputation and customer account credibility damaged? This is still playing out, so not even Equifax management yet knows the impact of the risks taken.

Unfortunately, ERM is too often used as a weapon against procurement executives. They can be beaten down by their firm's own siloed ERM or legal groups and forced to develop and use cumbersome processes.

Ideally, if risk is properly managed, nothing occurs that has a negative impact on operations or profitability such as what happened to Equifax, Samsung, Chipotle or any of the other companies that have seen their share price fall and their value erode following an untoward event. But, after all, shouldn't the point of an ERM program be to eliminate all supply chain and legal risk for our employers? The answer is an emphatic "no." The only way to truly eliminate risk would be to never conduct any procurement or contractual activities using third-party suppliers. What private or public sector organization could operate that way? Not a one.

Instead, a rational objective for procurement and supply chain leaders should be to create a secure but high-performing supply chain. This is one in which risk can be minimized while value-added business relationships can flourish. Think of it as "intelligent risk management."

I learned this lesson in one of my early corporate positions directing sourcing and contracting management activities for one of the world's largest companies. My boss included an interesting objective in my job description. He insisted that I develop a willingness/ability to take "intelligent risks" and then included it in my annual evaluation. You see, he realized that an overly aggressive approach to contracting management for our enterprise with 195,000 employees and 110 subsidiary companies worldwide could shut down our ability to be fast and nimble.

Along with his mentoring, I learned ways to execute well-researched business plans while properly managing risk, which made a huge difference in my career. My success was measured by balancing well-researched supply management saving initiatives with carefully thought out fallback plans. I knew my performance evaluations would suffer if I did not consistently push the limit of what could succeed in the supply chain arena—if I didn't take intelligent risks.

My boss often reminded me of something that professional hockey star Wayne Gretzky once said: "You'll always miss 100% of the shots you don't take." During my last two years in that corporate role, my team was very successful in deploying this balanced approach, saving shareholders a quarter of a billion dollars and reducing external legal support expenses by nearly a million dollars annually, while not experiencing a single supplier lawsuit with a portfolio of several thousand sourced supplier relationships.

Now, on the surface, this all sounds good. Unfortunately, ERM is too often used as a weapon against procurement executives. They can be beaten down by their firm's own siloed ERM or legal groups and forced to develop and use cumbersome processes. Such precautions may give the appearance of diligence but in reality they actually reduce the company's ability to truly manage supply chain performance in a risk-averse manner.

Worse yet, this can create a culture with an outsized fear of failure. As a result, people:

- delay or avoid making difficult decisions;
- push responsibility onto others;
- fail to acknowledge/confront problems; or
- try and eliminate every conceivable chance of failure.

From a procurement and supplier relationship management perspective, examples of overly risk-averse procurement behaviors include:

- cumbersome or overly-restrictive approval processes;
- unwillingness to identify or "try" new suppliers, no matter how well-qualified;
- unwillingness to source from low cost country sources;
- an inclination to select established and bloated supplier organizations rather than investigating and qualifying best practice supplier firms that lead their sectors (ignoring

billionaire Warren Buffet's comment about industry evolution that, "first come the innovators, then come the imitators, and then come the idiots.");
- failure to empower user departments with user-friendly methods of ordering products and services;
- insistence upon excessive procurement involvement in low-value transactions;
- acceptance of excessive inventory levels for safety reasons; and
- failure to secure best pricing due to unwillingness to make long-term volume commitments.

It is now many years later and I'm privileged to work in the consulting realm with many world-class procurement organizations. The senior supply chain leaders I find most impressive are those who demonstrate a willingness to move forward with key supply chain improvement opportunities. These are people who are willing to take intelligent risks in order to generate profits for the bottom line.

So, what are key ways that procurement professionals can contribute to their organization's overall enterprise risk management strategy? I suggest five supplier risk management techniques that make a significant contribution to ERM security. These are:
- innovation and efficiency in contracting management;
- strategic requirements for supplier insurance, indemnification and limitations of liability;
- provider optimization and redundancy;
- supplier financial stability visibility; and
- proper diligence in operational supplier assessment reviews.

All five are of equal importance to making intelligent risk work. They are even effective at dealing with so-called "black swan" events that cannot be predicted using normal methods of statistical analysis.

For instance, did Apple know that an earthquake and tsunami would shut down critical component supplier manufacturing facilities in Japan during 2011? Probably not. But accounts of their prescient negotiation of protective Force Majeure language in key supplier contracts apparently guaranteed Apple first right of resumption, mitigating the effects of that black swan event.

Make these five techniques part of your process and your company can be in a similar risk management position across the supply chain.

Technique 1: Innovation and efficiency in contracting management

How a procurement group approaches contracting management sets the stage for managing risk intelligently.

As an example, the firm I work for often assists leading companies in revising or creating strategic portfolios of pro-forma contract templates. Contract streamlining is an emerging trend and is the outcome of better understanding the significant cost of creating and negotiating

The senior supply chain leaders I find most impressive are those who demonstrate a willingness to move forward with key supply chain improvement opportunities.

old-style "legalese" contracts. Many of these are unnecessarily onerous—written in legal prose, lengthy, difficult to understand, one-sided protections and the like. But newer styles of contract design and wording enable procurement teams to have a dramatically-higher success rate of executing well-drafted agreements. Procurement contract portfolios are a great example of how legal risk can outweigh business balance, extending the contracting cycle time and procurement efficiency. Instead, many legal and procurement groups find that it is better to rely on concise and well-balanced contract documents that result in easier acceptance by suppliers.

Optimized processes and technology tools used in Contracting Lifecycle Management (CLM) also fit here. My team frequently performs reviews of how large enterprises manage their contracting processes and portfolios. They also sometimes find stunning gaps in the approaches that have evolved over time within company cultures.

One corporate example involved master agreements put in place by one company group. Then, another company group executed separate Statements of Work (SOW). But as our research showed, many of the SOWs expanded the list of services beyond those ever addressed by the master agreement, and thus lacked proper protection from the governing terms.

In one of these findings, the original master agreement only covered traditional delivery by ground trucking

services. But a new SOW called for the use of a helicopter for the delivery and installation of capital equipment. The lack of aircraft liability insurance in the master agreement exposed the company to very significant risk.

During another engagement with one of the globe's ten largest privately owned enterprises, with more than 50 subsidiary companies, our team found sizeable gaps in process that frequently exposed the firm to legal risk. Simple to fix, but only when the firm's management understood the gaps and methods of fixing.

Failure to proactively ensure that each policy is renewed and continues in effect through contract expiration means that buffer of protection can disappear without the procurement organization's knowledge.

Technique 2: Strategic requirements for supplier insurance and limitations of liability

Use of any external supplier of products or services, either upstream or downstream, requires an evaluation of potential liability exposure. Every contract must address the three-legged stool of protections: limitation of liability, indemnification and supplier insurance. The last requires special administrative attention, but is frequently under-managed.

Suppliers should carry insurance for two reasons. First, it protects them from legal and financial exposure that could limit their ability to support contractual commitments. Second, it provides a buffer of protection to the procurement organization against direct or indirect claims from suppliers or other third parties that may be affected by contracted suppliers' actions or inactions. If a contracted supplier is allowed to utilize key subcontractors in the performance of services, those firms must also be required to provide insurance coverage compliance.

All too frequently, procurement groups fail to demand a properly executed and endorsed certificate of insurance (COI) from each contracted supplier before contracted actions occur. I'll admit, it's a pain to collect and properly review COIs from every contracted supplier. But studies performed by leaders in risk management groups indicate that 80% or more of initial COI submissions do not conform to the language in the customer's contract.

An even more frequent failure point is one of timing. Quite simply, a supplier's multiple policies of insurance will never expire on the same date as the contract itself. Failure to proactively ensure that each policy is renewed and continues in effect through contract expiration means that buffer of protection can disappear without the procurement organization's knowledge. Special risk occurs if the supplier switches policy types or insurance carriers when a policy expires, and the properly-worded endorsement of an organization as an "additional insured" fails to be implemented in the new policy.

Any procurement team that is proactively managing the three-legged stool of risk protection must have resources in place to proactively collect and knowledgeably review COIs. Fortunately, there is at least one new no-cost supplier risk mitigation resource that can do this at your supplier's expense. This model effectively outsources these reviews to a highly skilled team of professionals without any budgetary impact. The use of that type of outsourced service is dramatically better than trusting internal staff groups to perform this type of task, and provides superior visibility to this important area of supply chain risk.

Technique 3: Provider optimization and redundancy

As part of initial strategic sourcing and supplier selection, ERM principles should be employed to ensure that excessive consolidation of the supplier community does not occur. Too often, aggressive sourcing groups will push to award a contract to a single-source award contractor. That works fine until a disaster occurs, such as financial failure of the supplier or a plant shutdown.

Proper strategic sourcing works much better with a balanced supplier portfolio with either of two requirements. One is multiple plant or data center redundancy by the provider. This enables the provider to manufacture or perform services in multiple locations. The other approach is to segment the provider relationship across multiple suppliers in a primary and secondary contractual manner. This ensures sustainable supply chain operations even in the event of a failure in one production location.

Technique 4: Supplier financial stability visibility

In 2016, Han Jin Shipping, one of the seven largest maritime shipping companies in the world, announced bankruptcy and stopped operations that same day. Thousands of containers were literally locked aboard ships anchored

in harbors or tied up at docks around the world. The impact was substantial. Han Jin processed nearly 10% of Asia-American container shipments. Furthermore, countless other shipments with other trade locations between other national trade partners were affected. The mess took months to sort out.

Most companies fail to have adequate visibility into the financial stability of their entire supplier community much less their key suppliers. Some companies do acquire financial reports from a leading provider on a case-by-case basis. However, the largest provider of these reports relies on data voluntarily submitted by the supplier company themselves, calling into question the accuracy of the data. They also charge a fee for their services, which is often beyond the budgets of most procurement teams.

The good news is that a new model for managing supplier financial stability has now emerged. It relies on predictive financial stability reporting that is provided by a major credit rating agency on thousands of potential suppliers. Much like the insurance COI collection services mentioned earlier, the availability of predictive financial stability data for a firm's entire supplier community can be outsourced without cost. The information is available in a Cloud information tool that warns procurement leadership of potential supply chain failure, providing highly positive ERM visibility to a firm's management team for free.

Technique 5: Proper diligence in operational supplier assessment reviews

When you were in school, you received report cards. There were three reasons for them.

First, report cards provided students with feedback on their educational accomplishment. Second, they provided parents with visibility into their child's performance. And third, report cards provided a useful reference tool for conversations between the teacher, parents and student about areas of potential improvement. And it worked. I'll be the first to say I would not personally have tried nearly as hard in school (all the way through college) if those report cards didn't keep showing up.

Far too many companies fail to provide their suppliers with any report card feedback on how they are performing. For most companies, the exceptional few suppliers that do receive any scorecard are a small fraction of those that don't. That is a problem. Any supplier that does not receive frequent feedback will probably assume that their performance is just fine even if it's not. And why shouldn't they?

Top companies are now separating their supplier portfolio companies into categories based on financial spend or assigned risk using techniques like the Pareto Principle. It breaks out like this:

- Class A suppliers, the 15% of suppliers representing 75% of total spend;
- Class B suppliers, the 25% of suppliers representing 15% of total spend; and
- Class C suppliers, the 60% of suppliers representing 5% of total spend.

Using this type of categorization, a strategy of scoring and providing feedback can be developed.

At a high level, one very useful strategy is to automate score-carding and reporting to Class B and C suppliers using systematized data capture and reporting. Class A suppliers can be given report cards that contain more subjective scoring feedback data.

Often Class A and some Class B providers meet with the procurement organization much like the old parent/teacher/student model. The objective, of course, is to identify improvement opportunities and corrective actions for deficient performance. Typically, Class C suppliers are rated and moved up or out based on their ability to meet objective performance objectives.

It's worth noting that performance reports are only noted for the company under evaluation. However, an overall scoring matrix for a segment of suppliers can be shared with all to provide a benchmark for expected performance among suppliers.

Using these five Supplier Risk Management Techniques is a solid starting point for building a supplier supply chain that can greatly contribute to your organization's overall ERM strategy. Obviously, this is only the tip of the entire supplier relationship management iceberg; however, it is a huge improvement over the typical methodologies used by far too many companies to manage supply chain exposure.

Taking intelligent risks doesn't mean we can fail to carefully research and structure our supply chain decisions. Writer John A. Shedd said: "A ship in harbor is safe—but that is not what ships are for." The same is true in supply chain management. If we don't take some intelligent risks, we're not going to provide maximum value to our employers. •

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BOOK EXCERPT:

The Power Of Resilience

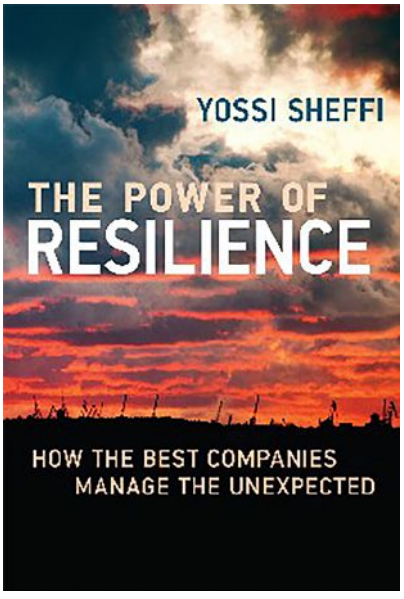
In a global economy, the beat of a butterfly's wings in one part of the world can truly lead to a supply chain disruption on the other side of the globe. In his new book, Yossi Sheffi describes how the best companies prepare for modern vulnerabilities and develop corporate resilience.

BY YOSSI SHEFFI

Surely you've heard of the butterfly effect: The energy produced by a butterfly beating its wings near the sea on one side of the world generates a tidal wave thousands of miles away. In an interconnected, global economy, the disruption of supply chains by those tidal waves, tsunamis, banking crisis, and volcanoes are all too real.

Since disruption is a given, the real measure of an organization isn't how it plans to manage risk, but how the resilient company bounces back when something happens.

In *The Power Of Resilience: How The Best Companies Manage The Unexpected*, Yossi Shefi shows that supply chain risk management "is a balancing act between taking on the risks involved in new products, new markets, and new processes - all crucial for growth - and the resilience created by advanced risk management."



Chapter 1. **A Quake Breaks A Supply Chain** is printed below. You can read a Q&A with Sheffi about the new book on *Supply Chain 24/7* (courtesy of *Supply Chain Management Review*).

Afternoon, March 11, 2011, Japan

Jackie Sturm and Jeff Selvala sat with a dozen other Intel colleagues in the Narita Airport outside Tokyo, Japan. They were waiting for the long flight home after a conference with their Japanese suppliers. At the conference, they had discussed routine operations, quality improvements, forthcoming production plans, and technology roadmaps to ensure a continuing smooth supply of the hundreds of arcane materials that feed Intel's $36.5 billion in fabrication facilities (fabs). Staying ahead of the world's ravenous demand for chips required choreographing a global supply chain, which meant traveling to Japan to visit the many silicon wafer and specialty chemical suppliers who produce the ultrapure materials needed for Intel's chips.

Change of Plans

Unbeknownst to the Intel employees - and the world - a horrendous accumulation of geophysical energy had reached a breaking point. At 2:46 pm local time, some 72 kilometers off the coast of Japan, the Pacific plate broke its locked fault line and began to shear downward and westward while the Okhotsk plate beneath northern Japan thrust upward and eastward. More than 1,000 years of accumulated strain broke free, sending a seismic shockwave racing at over 7,000 kilometers per hour through the solid rock of the floor of the Pacific. The shock caused more of the surrounding fault lines to rip like a broken zipper. A 500-kilometer-wide sheet of the earth's plate east of

Japan slid under the islands, the coastline sank about one-half meter, the adjacent sea- bed rose up to three meters, and that part of Japan lurched over two meters toward North America. As the sheet shifted, a prolonged and growing shockwave radiated in all directions. In less than a minute, the first earthly shudders reached Japan.

A few minutes later, the shockwave reached the Narita airport. Those who live in Japan or spend any amount of time there know about the ordinary tremors that remind the Japanese of where they live. But this was no ordinary tremor. In Narita, the quake began with a long low rumble that turned into a rolling motion that steadily gathered strength. This was a big one and everyone knew it. As the quake built, people who were standing sat down. As the strength increased, many sat on the floor. And there they remained for four to five minutes as the quake rumbled on.

The Japanese know they live on a treacherous island prone to quakes, tsunamis, and even the occasional volcano. Born of bitter experience and untold hundreds of thousands of deaths throughout their history, today's Japanese erect heavily reinforced structures and heady seawalls to survive most of the worst that the earth can throw at them. But history does not always repeat itself, and the disaster that followed was worse than anything the Japanese planners had anticipated.

The Living Assess the Situation

When the shaking stopped at Narita, everyone looked around and breathed a sigh of relief. They were alive and unhurt. The airport's well-designed buildings had withstood the shaking. Then came the fears: worries about the safety of family, friends, and coworkers in Japan. Intel has some 600 employees in Japan at two facilities, plus innumerable friends and acquaintances at the company's long-term suppliers. The travelers also worried about what their families would think when they heard of the devastating quake. Immediately, people started calling, texting, and emailing to determine if everyone was safe and to tell everyone that they were safe.

The Intel employees and others found communications to be difficult in the immediate aftermath. The barrage of anxious callers overwhelmed local cell towers. Internet access was sporadic. Long lines of people clustered around working landline phones. Moreover, no calls were reaching the most damaged areas. The disaster had knocked out power plants, downed power lines, and severed telecommunications cables. Three prefectures had no power, and two additional ones had partial blackouts.

The Japanese know this, too, and they have elaborate processes for detecting quakes, estimating the potential magnitude of any tsunami spawned by a quake, and alerting seaside authorities of potential wave heights.

The Quake Was the Least of the Worries

Although the worst of the shaking had stopped and inspectors were rushing around Narita to confirm the lack of damage, the disaster was only just beginning. Earthquakes on the Pacific's ring of fire have the ironic tendency to produce walls of water. When that Pacific plate of rock dropped, the Japanese land mass lifted, as did the thousands of meters of water above the seabed. Drop a stone in a bathtub and the ripples expand to slosh against the sides. Move thousands of square kilometers of rock in an underwater quake, and the sloshing is immense. The Japanese know this, too, and they have elaborate processes for detecting quakes, estimating the potential magnitude of any tsunami spawned by a quake, and alerting seaside authorities of potential wave heights.

As Japan's network of 3,700 seismic sensors relayed data on the quake, the seismologists of the Japan Meteorological Agency (JMA) quickly estimated the size of the quake and tsunami and sounded the alarm in the first three minutes of the event. Unfortunately, the system was actually too quick - it used only the first minute of quake data, not the full duration of the shaking, in initially estimating a 7.9 magnitude value to the quake. In reality, the quake was a magnitude 9, making it the largest earthquake ever to hit Japan in the country's 1,500 years of recorded history. Solid engineering, reinforced concrete, and lofty seawalls can handle a lot, but a magnitude 9 quake is more than a lot. An earthquake of mag-

nitude 9 on the moment magnitude scale releases over 31.6 times more destructive energy than a magnitude 8 and 44.7 times more energy than the initially estimated 7.9.

About half an hour after the shaking ended, a tsunami two to three times higher than projected overwhelmed coastal defenses and inundated the shores nearest to the quake's epicenter. In some areas, a fateful conspiracy of the direction of the tsunami and the shapes of land, harbors, and sea bottom acted to concentrate the tsunami into a 20-meter-high wall of water. Large container ships were lifted over piers and wharves and were shoved inland as the water invaded the land. Along the Sendai coast, seawater flowed more than four kilometers inland across the broad coastal plain. As the waters retreated, houses, buildings, cars, and thousands of people were dragged out to sea. In some areas, rubble created by the quake was simply wiped from the land.

Over 19,000 people lost their lives, some 50,000 were injured, and 400,000 became homeless. Of those who died, nearly 3,000 were never found - sucked into briny depths.

The violent ground motion, waves, and fires started by the quake damaged or destroyed some 1.2 million buildings across a large swath of northern Japan. Far worse was the human toll. Over 19,000 people lost their lives, some 50,000 were injured, and 400,000 became homeless. Of those who died, nearly 3,000 were never found - sucked into briny depths. The tsunami was responsible for 80 percent of the destroyed buildings and over 94 percent of the deaths.

Too Hot to Handle

Even as the Japanese quickly started their rescue and inspection efforts, more phases of the disaster began unfolding. Some 180 kilometers away from the quake's epicenter lay the nuclear power complex of Fukushima Daiichi, with six nuclear reactors. The reactor complex was part of Japan's strategy of avoiding the risks of reliance on foreign supplies of fossil fuels. On March 11, three reactors were live and three were shut down for routine maintenance. When the quake struck, the three operating reactors immediately performed an emergency shutdown, dropping control rods into the reactor to suspend power production.

The Japanese thought they understood the seismic risks of Fukushima. A long historical record of earthquakes and careful modeling of the faults near Fukushima suggested that the region had manageable seismic and tsunami risks. "With firm geological foundations and major earthquakes rare, Fukushima is a safe and secure place to do business," said the government website for Fukushima prefecture.

But the seismic modeling failed to include the potential for co- seismic coupling - a knock-on effect in which the rupture in one fault induces larger ruptures in the many other faults around the Japanese islands. The violence of the quake exceeded the design specifications of three of the reactors; eyewitness accounts and postquake activities suggest significant quake-related damage to the reactor cooling systems.

The cold seawater that was the reason for the plant's seaside location became the facility's ultimate nemesis. About 50 minutes after the quake, the tsunami arrived. The sea rose to the 10-meter-high level of the plant, began flooding it, and kept rising. High waters soaked various parts of the plant for between 30 minutes to one hour. Seawater flooded the backup diesel generators, thoroughly soaked critical controls with corrosive seawater, and shorted key electrical systems.

Even when powered down, the nuclear byproducts inside the reactor core's fuel rods generated tremendous heat. Without a continuous supply of cooling water, the remaining water sitting in the reactor chamber began to boil and raise the pressure of the chamber. To prevent catastrophic failure, emergency valves vented radioactive steam. Worse, as the water boiled and exposed the core, high-temperature chemical reactions produced explosive hydrogen gas.

If too much of the core is exposed, temperatures can rise to 2,800°C, melt the core assembly, and potentially allow uncontrolled fission to create vastly larger amounts of heat and radioactive debris. The ultra-hot molten mass of reacting fuel could literally melt down through the bottom of the reactor, through any other containment walls, and begin melting into the concrete foundation of the reactor.

Nor were the reactors the only concern. The Fukushima operators faced a similar threat with the spent fuel rods sitting in the adjacent cooling pools. Without recirculating water, these pools began to heat toward the boiling point. If the pools boiled and evaporated, the rods would be exposed, become extremely hot, and release radioactive materials directly into the air.

The quake and tsunami led to a desperate battle to cool the reactors and fuel pools. At every turn, the workers faced horrible choices with significant risks of radiation leakage, explosions, and irreversible damage to the reactors' systems. The plant's lack of power and damaged sensor infrastructure meant the operators had limited visibility into conditions inside the reactor building and had limited control.

The workers at the Fukushima tried valiantly to cool the reactor cores and the fuel pools. They brought in fire trucks and helicopters to dump water into the stricken reactor buildings. They sent rotating crews of workers and firemen to limit each worker's exposure to radiation. Rather than risk an immediate explosion because of lack of water, they used seawater in an attempt to cool the reactor, knowing that the salt could utterly ruin the reactor and potentially clog the pipes.

Yet without power, without large supplies of fresh water, without full sensor data on what was happening, and without the ability to enter the extremely radioactive reactor buildings, the workers had little hope of preventing a catastrophe. Only 24 hours after the tsunami, a hydrogen explosion shattered the reactor unit #1 building, followed by similar explosions in unit #3 (March 14), unit #2 (March 15), and unit #4 (March 15). Each explosion brought renewed fears of major radiation releases and created unknown amounts of damage to internal systems. Post-analysis of the disaster showed that unit #1 suffered a complete meltdown, and units #2 and #3 suffered partial meltdowns.

From Reactors to Reactions

The third phase of the disaster arose from the horrible realities and uncertainties about radiation spewing from the stricken reactors. On many days, the radiation drifted out to sea to rain down into the Pacific. But on other days, radiation moved inland, motivating evacuations of the area around the reactors and causing concerns for the water supplies of Japanese cities. (Detectable amounts of radioactive materials even crossed the Pacific to appear in US air and rain samples.) The invisible nature of radiation and the potential that it might coat objects or be absorbed into plants and animals created frightening uncertainties about the short-term and long-term safety of residents, businesses, farmers, and fishermen in the affected area. It also created worries for Japanese companies with parts and goods in the area. No one knew how far the radiation might spread and whether it could contaminate shipments sent to customers around the world.

TV images showed the grim aftermath of the explosions and fires - shattered buildings and a miasma of radioactive smoke rising unabated from the remains. News stories buzzed with data on rising heat levels, falling coolant levels, new attempts to stabilize the situation, and new fears of worsening conditions. As the threat of radiation grew, Japanese authorities created progressively larger and larger evacuation zones at 2, 10, 20, and 30 kilometers and asked citizens over a larger area to remain indoors. But were the evacuation zones large enough? Revelations showed that the plant's operator (TEPCO) and the Japanese government had repeatedly downplayed the extent of the crisis.

Companies with business in Japan, who bought Japanese products, or who simply moved goods through Japanese waters began to wonder: were their goods radioactive? Fear of radioactive foods, materials, and dust created questions about the safety of Japanese exports.

Uncertainties about the amount of radiation spewing from the smoldering plant and the potential shifting direction of the winds added to the anxiety. Intel considered evacuating all of its Japanese personnel, but the personnel themselves vetoed the idea.

Companies with business in Japan, who bought Japanese products, or who simply moved goods through Japanese waters began to wonder: were their goods

radioactive? Fear of radioactive foods, materials, and dust created questions about the safety of Japanese exports. Intel and others worried about freight transiting Japanese ports - radioactive dust might settle on or get into shipping containers passing through the area. This potentially affected 7,000 of Intel's shipping lanes, because it affected lanes with Japanese origins or destinations as well as all Asia-Pacific lanes that might sail near Japanese waters.

Another company, chemical giant BASF, worried about radioactive ingredients getting into consumer products. For example, BASF supplies the ingredients that go into lipstick manufactured and sold by Procter & Gamble. To assure itself and its customers of the safety of the ingredients originating from Japan, BASF installed Geiger counters on both the Japanese and German sides of its supply chain.

Intel had an added worry. Even if the chips themselves were clean of any radioactive contamination, exposure to radiation during manufacturing or transportation could affect their functioning. Irradiating the chips wouldn't make them radioactive but could reduce their long-term reliability.

The company had specs for the issue but had heretofore not needed to enforce these specs. In this case, however, Intel had to work with key suppliers to ensure that silicon and chips weren't exposed to radiation at any stage. In addition to attempting to cope with the existing crisis, Intel planned for an expansion of its crisis response if the evacuation zone grew and encompassed more suppliers.

A Nuclear Powerless Country

At the time of the quake, Fukushima Daiichi was supplying less than 1 percent of Japan's electricity needs. Other reactors in the quake zone - totaling 4 percent of Japan's power needs - were shut down for inspection. Yet quake- and tsunami-related damage to nonnuclear power plants and to Japan's electric grid, coming on top of Japan's unique split grid system, created power shortages in the eastern half of the country. Power outages and rolling blackouts became a problem for almost a month.

The government began an intensive media campaign called set-suden (Japanese for "power saving"). It encouraged citizens and companies to conserve as much power as possible by turning off lights, adjusting thermostats, and wearing clothing appropriate for the temperature. Retailers turned off neon lights, office buildings went dark, escalators stopped, trains slowed, and some manufacturers adopted staggered weekly schedules to reduce the weekday peak in demand. Rather than promoting consumption, the glowing giant neon signs of the retailers in Tokyo's Ginza district went dark to promote conservation.

As the Fukushima crisis worsened, public opinion turned against Japan's energy strategy, and the risks from dependence on foreign fossil fuels seemed the lesser of two evils. The extreme loss of confidence in nuclear power caused the government to progressively shut down all the country's reactors. By August 2011, three-quarters of Japan's nuclear reactors were shut down. By August 2012, only two of Japan's 54 reactors remained online. This created a more sizable disruption to the country's power supplies, reducing capacity by over 30 percent. More than three years after the disaster, power shortages still threatened Japan, especially during the hot summer months when electrical demand spikes.

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When the Chips Are down

When the quake occurred, Intel's well-honed and extensively practiced crisis management processes sprang into action. Business unit crisis management teams had kickoff meetings on the day of the quake. On Saturday, March 12, Intel activated its Corporate Emergency Operation Center (CEOC) to help coordinate the response at the highest level. Intel split its response to the Japan disaster into two parallel streams of activities, which is Intel's standard approach for such incidents.

Emergency Management: Stabilizing the Local Situation

First, Intel's Emergency Management team ensured the safety of Intel's people and facilities in the disaster zone. Intel deployed pre-designated local Emergency Response

Teams, who are the first responders in a disaster, and local Emergency Operations Center (EOC) personnel to stabilize the situation and prevent further casualties. At the time of the quake, 300 Intel employees worked in downtown Tokyo and a similar number in Tsukuba, about 100 kilometers northeast of Tokyo.

Intel's office in downtown Tokyo survived intact, but the Tsukuba facility was another matter. Intel had no fabs in Japan, but its Tsukuba facility housed 300 personnel who worked on materials operations, quality assurance, information technology, e-business, and related functions. Although the building wasn't structurally damaged, the quake broke fire sprinkler pipes in the ceiling. Ten inches of water flooded the offices and shorted the building's electrical systems. The Tsukuba office was uninhabitable.

Finding a temporary location for the 300 Tsukuba workers would not be easy given the 1.2 million buildings that had been damaged in the quake. Many companies had been forced out of their offices by the quake, tsunami, and Fukushima evacuations. "We have an organization at Intel called CRESD (Corporate Real Estate and Site Development), and so they worked night and day to try to find alternative work space," said Jim Holko, program manager of Intel's corporate emergency management. Even with its corporate resources, Intel couldn't find a site large enough for all 300 people, so CRESD had to split the workforce across two locations. As a result, Intel also had to set up Internet and collaboration tools across the two sites.

Meanwhile, the company used its large global construction arm - which builds Intel's fabs - to accelerate the repair of the Tsukuba facility. Intel flew structural engineers, electricians, plumbers, and other technicians to Japan to inspect the building, define the requirements for the repair job, and find local contractors to do the repairs.

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Business Continuity: Ensuring Global Operations

The second stream of Intel's crisis response, Business Continuity (BC), focused on Intel's products and processes. BC had to make sure that all the raw materials flows, chip making, and customer-related activities didn't stop - or that they restarted as soon as possible. Whereas the Intel's Emergency Management team took care of the safety issues within a couple of weeks of the quake, the BC side took six months.

Intel's first step in BC was to determine the impact of the disaster on the business operations of the company and its suppliers. Because Intel had no factories in Japan, supplier issues were its main BC focus. Intel assessed the status of 365 materials. By March 15, four days after the disaster, Intel knew it had no major problems with its direct (or "Tier 1") suppliers. At worst, a few Tier 1 suppliers had a few days of downtime, but nothing that was a threat to Intel's production schedules.

Tracing the status of deeper tier suppliers - suppliers to Intel's Tier 1 suppliers - took longer. By March 20, Intel knew that Tier 2 also had only minor problems, but Tier 3, Tier 4, and deeper tiers had more substantive problems. Intel identified 60 suppliers who had issues. Many of them were single-source specialty chemical manufacturers with unique capabilities. Making chips with layers only a few atoms thick depends on highly-specialized, exotic chemicals. In many cases, only one supplier (and sometimes even only one plant) in the world knew how to make the molecules "dance in just the right way," as Intel's Jackie Sturm, vice president, technology and manufacturing and general manager of global sourcing and procurement, put it.

Even as Intel resolved many uncertainties about the quake's im- pact on suppliers, the company could not be certain that it had identified all the impacts. "Everything that was a risk for us in that earthquake, [it turned out] we knew about in the first 10 days, but we didn't know that fact on the 11th day," said Jeff Selvala, Intel's director, assembly test global materials.

Intel continued to probe suppliers, looking for any additional problems. News of issues at other chip makers would make Intel ask more questions, continuously digging for additional hidden disruptions and risks.

Although no new problems appeared after day 10, Selvala said that Intel continued to search for more problems for at least a month.

More than 50 percent of Intel's assembly and test materials suppliers had manufacturing locations in Japan. The number was even higher for the deeper tiers, due to the high concentration of specialty chemicals makers in Japan. In all, Intel realized that 75 percent of assembly/test materials were at risk. One of the more significant challenges was getting enough silicon, which was the base material used for almost all of Intel's chips at every plant around the world. Five minutes after the shaking had stopped, Sturm was on the phone from the Narita tarmac, calling Intel's fab materials people to check the status of the company's silicon suppliers.

By April 11, SEH was in the process of recovering inventory from Shirakawa to increase wafer shipments. Not until April 28 could SEH restart partial production. The Shirakawa plant was the last SEH facility to return to full production on July 1, more than three and half months after the quake.

Quakes and Crystals

In 2011, the Shin-Etsu Handotai (SEH) plant in Shirakawa Japan was producing 20 percent of the world's supply of 300-millimeter silicon - the large platter-like wafers used to make chips. The factory's delicate crystal pullers slowly grew boules of silicon - heavy crystal ingots 300 millimeters in diameter - that were sliced into 600,000 to 700,000 wafers per month.

To give the 250 kilograms of molten silicon time to coalesce into a perfect crystal, the equipment slowly lifts the nascent boules out of the yellow-hot pool of molten silicon over a period of more than a day. The quake's shaking jostled these quiet pools, disordered the crystal growth, and ruined the crystals. When the power died, the gestating boules, representing tens of millions of dollars of chips, froze into stillborn cold gray lumps.

SEH's first order of business was to ensure the safety of its employees, three of whom had been injured in the quake. Next, SEH needed to inspect its facilities for damage to ensure it could restart production as quickly as possible. But even as the company worked to inspect and begin repairs at the affected site, the area came under threat from the nuclear reactor crisis and radiation leakage from Fukushima Daiichi, only 80 kilometers away. Moreover, the Shirakawa plants got their power from the Fukushima nuclear plant. Although the area around the Shirakawa was never under government evacuation orders, some concerned area residents did leave on their own. Local fears were so strong that TEPCO was forced to agree to pay all children and pregnant women living in the area at the time of the crisis 200,000 yen (about $2,600 at the time) each, as compensation for their fears and added costs.

SEH also initiated a series of communications to the business world about the status of damage to the company's facilities and its efforts to recover. The day after the quake, SEH reported three facilities damaged by the quake, including the Shirakawa semiconductor plant. By March 15, SEH announced it had found damage to the production equipment at Shirakawa but did not know how long it might take to repair the facility. By March 17, SEH decided to shift as much wafer production as possible to other SEH facilities. Inspections and assessment took almost a month. By April 11, SEH was in the process of recovering inventory from Shirakawa to increase wafer shipments. Not until April 28 could SEH restart partial production. The Shirakawa plant was the last SEH facility to return to full production on July 1, more than three and half months after the quake.

The larger obstacles to SEH's recovery came from the aftereffects of the quake. Between the quake damage and Japan's decision to take its nuclear plants off line, the country faced severe power shortages and rolling blackouts. Whereas individuals and many businesses experienced power outages as an inconvenience and a loss of productivity, other businesses - especially those like SEH who were running delicate industrial processes - faced potential safety concerns and equipment damage if the power went out. "We are requesting the electric power companies to provide a stable supply of electric power because we have facilities and equipment that need to be operated continuously due to the safety reasons," pleaded SEH in its March 22 report on the company's post-quake efforts.

Acquire, Search, and Prolong Existing Supplies

Where possible, Intel sought to maintain business continuity using existing suppliers and prequalified materials. Its efforts were focused on three work streams. The first was to quickly acquire materials from its normal portfolio of prequalified suppliers. For example, Intel knew it had to acquire more silicon to fill the gap created by the downed factories. The company's first step was to approach its major suppliers, asking them to increase Intel's allocation. Despite suppliers' best efforts, the global wafer industry did not have the spare production capacity to replace what was lost in the quake.

Intel's second tactic was to search and secure the supply chain's inventories of critical materials. All supply chains have inventories at every level, some of it by design and some resulting from inefficiencies. Companies maintain inventories as a hedge against demand fluctuations and to take advantage of economies of scale in manufacturing and shipping. Inventory levels depend on lead times, manufacturing technologies, demand, and process uncertainty (see the section titled "Views on the Risks" in this chapter). At the same time, lack of intra-company communications, incorrect incentive systems and other factors can mean that companies often have more inventories than optimal. "You do have some amount of time, because you have inventory, your supplier has inventory, their supplier has inventory, and so on. And so there's a natural buffer there that you have a period of time to resolve issues," Selvala said.

Third, Intel also worked to prolong the life of constrained sup- plies by minimizing the quantity consumed by each step of the chip-making process. For example, in one case, Intel diluted a key chemical, qualified it for use, and used the alternative formulation for eight weeks. Another engineering group found a way to clean off and reuse test wafers that would have gone to the scrap pile. Moreover, the company pushed the tactic up the supply chain - working with Tier 3 suppliers to minimize consumption of c ritical Tier 4 supplies. By boosting supplies from second-source suppliers, finding as much material as possible and prolonging its use, Intel hoped to fill the gap until the affected suppliers could resume normal production.

The Backup Response: Replace Disrupted Supplies

In some cases, Intel couldn't find enough prequalified suppliers with inventory or capacity to meet Intel's demands while its Japanese suppliers recovered. This unfortunate fact was especially true for sole-source suppliers. The lack of prequalified suppliers had the potential to create a lag during which time Intel could face production interruptions. Needless to say, the entire reason for the business continuity effort was to avoid such disruptions.

The threat of a production disruption led Intel to look for alternative suppliers and alternative products. Under normal circumstances, Intel's fab managers would resist quick qualification of alternative chemicals and materials. But these were not ordinary times. Intel would need to buy previously unqualified materials and quickly qualify them to ensure they met Intel's high quality standards.

Engineers sought alternatives to constrained materials and used fast-track qualification processes - jumping the normal queue of engineering work - to get the replacement materials into use. Intel also gave purchasing managers wide freedom to buy large quantities of materials "just in case" and accelerate the usual materials and spending approvals processes. "We were out there using letters of intent, if that was sufficient, or placing purchase orders if that was necessary, or non-cancelable

The threat of a production disruption led Intel to look for alternative suppliers and alternative products. Under normal circumstances, Intel's fab managers would resist quick qualification of alternative chemicals and materials.

purchase orders. Whatever was necessary to secure supplies. And we were doing that in real time," Selvala said.

In seeking alternatives to disrupted supplies, Intel made sure that the lead-time of the alternative was less than the recovery time of the original supplier. Intel's supplier contracts often include "have made" rights, whereby Intel can

have a proprietary material made by another supplier if the original supplier cannot meet the contract terms. Often, however, the lead-time on getting a material made elsewhere was longer than the anticipated recovery time of the original qualified sole-source supplier.

Collaboration for Better Crisis Response

Intel wasn't the only chip maker affected by the quake. The loss of the SEH plant created a global shortage of silicon. Other chip makers started calling Intel for help in locating silicon. Because the silicon shortage created imbalances in the PC supply chain, Intel assisted some of them in locating additional supplies. "If we were aware of capacity, we certainly tried to assist because the whole industry was down," Intel's Jackie Sturm said. Even if Intel could make its chips, PC makers would not buy them unless they could get all the other chips and components from other suppliers so that they have everything needed to build complete PCs.

Intel also tried to help in other ways. It joined a group of Japanese companies in asking METI - Japan's Ministry of Economy, Trade, and Industry - to expedite the repair of the electrical grid around key suppliers and to exempt certain key facilities from the mandatory daily blackouts. Although it took some convincing, METI did help. Key suppliers were able to get continuous supplies of power even as blackouts affected other parts of Japan.

"We'll work with governments. We will work with competitors if that's what it takes. We'll work with our local authorities and try to engage wherever we think there's opportunity to help fix the situation," Sturm said. Nor was Intel unique in this respect. In the other disruptions described later in this book, companies often collaborated with government, suppliers, and competitors.

Returning to Normal Operations: Winding Down Response

Some aspects of Intel's response were settled relatively soon after the quake. As the BC effort progressed, the frequency of meetings declined. During the first two weeks of the crisis, the crisis management teams of the Worldwide Materials Group had daily meetings over the status of issues such as silicon, chemicals, and back-end supplies. Then, they reduced the frequency to three times a week during April and May. In June, they further reduced the frequency to just once a week. At no time were factories down for lack of silicon, noted Sturm.

Once the recovery effort was under control, the CEOC closed on April 6. Similarly, the logistics crisis management team wound down on April 7, after figuring out the shipping lane issues and how to divert products to avoid radiation. Other business unit crisis management teams kept working until June 30. Overall, the business continuity effort took six months. Some follow-on actions continued thereafter, but operations were mostly back to normal. Complete rehabilitation of the Tsukuba office took 10 months. Throughout the entire crisis, Intel never had to halt production at any of its fabs.

The Globalization of Supply Chains

To understand why the Japanese quake and tsunami had global effects and how other kinds of distant disruptions can affect companies and economies, it helps to understand something about supply chains. From the point of view of a single company, a supply chain - which is actually a network of suppliers, sub-suppliers, and service providers - can be thought of as having five different aspects:

1.) The parts that go into the company's products,
2.) The identities of the network of suppliers who make those parts,
3.) The locations where parts and products are made, assembled, and distributed,
4.) The flows of parts and products (including the transportation links that move materials along the chain), as well as the flow of information and cash, and
5.) The inventories of materials, parts, and finished goods stored or being handled in various stages of the chain.

Each of these five aspects provides different insights into the risks to which supply chain operations are exposed.

Exploding the BOM: The "What" of Supply Chains

The first aspect of a supply chain for a given product, such as an automobile, encompasses all the materials and parts that go into that product - the "what." To manage the myriad subassemblies, parts, and raw materials required to build a particular unit (a car, for instance, may have 50,000 parts), companies create a bill of materials (BOM) that lists the quantities of subassemblies, parts, and raw materials required to make one unit of a product. For example, the BOM for an automobile

would include: one body, one engine, one transmission, four door assemblies, two axles, four brake assemblies, five wheel assemblies, one navigation system, and so forth. Each of these parts, in turn, includes other parts and subassemblies, and so on.

The assembled engine might include one engine block, six pistons, six fuel injectors, six spark plugs, twelve valves, etc. Each piston might include: one connecting rod, three piston rings, and so on. The BOM is a hierarchy that, if drawn, looks like a tree in which a set of leaves makes a twig, a set of twigs makes a branch, and the entire collection of branches makes the finished product.

Companies with multiple products will have a different BOM for each product, and each product will differ in the types and quantities of parts that go into that product. To make some planned number of products on an assembly line, companies use material requirements planning (MRP) software to ensure that they make or purchase the right quantities of every part on the BOM with sufficient lead time.

Given a production schedule, the planned number of units of each product during each time period multiplied by the number of parts per product to be manufactured during this time tells the company the number of parts to make or buy (e.g., one car with six pistons and three piston rings per piston needs 18 piston rings) for the manufacturing plan during that time unit. MRP takes a production schedule and generates a purchasing schedule, given the lead time for each part. Each supplier, in turn, uses its own MRP process to ensure that it, too, buys or makes the required raw materials and parts in time to deliver the requested parts to the product manufacturer by the scheduled delivery date.

Organizations in the Supply Chain: The "Who" of Supply Chains

The second aspect of the supply chain is of a network of facilities and companies that manufacture the parts of the BOM, assemble parts into finished goods, and then distribute and sell the products - the "who." This aspect encompasses a spectrum of manufacturing strategies. At one extreme, a supply chain might be vertically integrated. In this case, a single company owns almost all the stages of production, in one or more facilities. For example, Ford's famous River Rouge plant was renowned for taking raw iron ore, glass, and rubber in on one side and rolling vehicles out of the other side of the massive, sprawling facility. A more modern example is Samsung, which makes many of the parts - such as processors, memory chips, and displays - for its own televisions, smartphones, and computer products.

At the other extreme is an outsourced supply chain in which a company buys complex, preassembled parts from a wide, tiered network of independent suppliers, with each supplier responsible for one or more steps in the production process, which might encompass a single simple part or a complete subassembly. In fact, some companies outsource their entire manufacturing operations, buying finished goods in retail packaging from contract manufacturers. For example, Cisco, Microsoft, and Apple do not have any manufacturing facilities of their own - they only handle the design, marketing, sales, and supply chain of their products.

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Regardless of a company's level of vertical integration, the direct suppliers of the company are known as Tier 1 suppliers. Tier 1 suppliers would include the providers of steel or aluminum sheets and coil to Ford's stamping plants or contract manufacturers such as Flextronics International Ltd., Hon Hai/Foxconn, or Pegatron Corp, that manufacture computers, phones and tablets for Apple. A company's Tier 2 suppliers are the suppliers to the company's Tier 1 suppliers. Tier 3 supplies Tier 2, and so on. These echelons of tiers often correspond to the echelons of branches in the BOM tree.

Today's supply chains can be quite deep. For example, Intel traced tantalum, a metal essential its microprocessors, through as many as a dozen supply chain tiers back

through the makers of tantalum-containing electronic components to the metal processors, smelters, ore exporters, ore transporters, ore consolidators, and then to the artisanal miners. In some cases, the structure of the BOM is more complicated as companies both buy from and sell to the same company, or where one part may "visit" the same supplier more than once for different manufacturing processes, a situation that is common in the information technology industry.

Manufacturing and Services Locations: The "Where" of Supply Chains Whether vertically integrated or outsourced, supply chains can also vary by their geographic deployment - the "where." Manufacturers may choose to locate production facilities close to raw materials supplies (e.g., a chemical plant near an oil field), close to sources of labor (e.g., low-cost or high-skill regions), close to centers of demand (e.g., major customers or major population centers), in some industrial cluster location (close to other, similar manufacturers) or in a location influenced by government (e.g., via incentives and regulations).

The structure of the supply chain for acquiring and moving raw material and parts to final assembly (the so called "upstream supply chain") is determined by the choice of suppliers. At most manufacturing companies, the choice of suppliers is managed by the procurement organization. Naturally, engineering, finance, and logistics also contribute to the decisions in order to ensure quality, capacity, financial viability, and timely deliveries of parts and raw materials. Lastly, departments such as risk management, compliance, and corporate social responsibility also influence supplier choice and factory location decisions.

To get the product to market (the "downstream" part of the process), the supply chain encompasses the distribution function. Distribution determines the location and operations of the company's warehouses and distribution centers. Distribution also usually manages the movement of the finished products to customers - be they retail distribution centers, retail outlets, e-commerce fulfillment centers, or directly to consumers. Many companies outsource distribution, too, either by selling their finished goods to wholesalers who distribute the product, or by using logistics service providers to handle warehousing and distribution to their downstream echelons of retailers and consumers.

Going with the Flows: "How Things Move" in Supply Chains

All of these locations of supply, production, distribution, and demand are connected by flows - the fourth aspect of the supply chain. Supply chains encompass three essential types of flows: material, information, and money. The most salient and costly flows of a supply chain are the material flows. In general, materials flow downstream from mines and farms to factories that process raw materials, to the factories that make parts and subassemblies, to original equipment manufacturers (OEMs) that make finished goods products, to distributors and to retailers, and, finally, to end consumers. At each stage, companies add value to the materials, often differentiating them into many types of parts or products. Materials, parts, and products can travel on a variety of conveyances such as trucks, railroads, ocean freighters, canal barges, aircraft, and pipelines - the "how and where things move" in the sup ply chain. Intel, for example, manages 14,000 origin-destination "lanes" around the world, connecting the chipmaker to its suppliers, its network of internal facilities, and its customers.

At the same time that materials flow down the chain, money flows up the chain when consumers pay the retailer, the retailer pays the distributor, and so on. Information - in the form of, for example, forecasts, purchase

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orders, shipping notices, and invoices - flows in both directions to coordinate activities throughout the supply chain. In fact, both materials and money also go in both directions to some extent, as returns and defective goods travel back to the manufacturer, and as rebates and discounts flow from suppliers to customers. An increasingly important part of supply chain management involves the returns part of the supply chain, be it for responsible disposal, recycling, remanufacturing, or the return of packaging material.

Transportation carriers have their own operating strategies for how they handle and route freight. The two basic strategies are known as "direct operations" (DO) and "consolidated operations" (CO). In direct operations, a dedicated conveyance carries the cargo directly from origin to destination (like a taxicab). This is the case with full truckload movements, unit trains, and leased conveyances in all modes of transportation. Direct operations are not cost efficient for small shipments, however, so smaller shipments are usually consolidated geographically through transshipment hubs such as UPS's Louisville, FedEx's Memphis, or DHL's Leipzig terminal. Examples of CO modes (think public transit or passenger airline hubs) include less-than-truckload (LTL or "groupage"), boxcar trains, ocean container ships, and many others. CO also include in-vehicle consolidation, such as pickup and delivery operations in which shipments destined for a variety of places are loaded on a single vehicle for distribution (like postal service mail delivery).

Numerous factors - the economies of scale in conveyance size, the economies of scope underlying carriers' networks, the efficiency of handling modal transshipments, delivery time requirements, and the need to mediate between concentrated sources of supply (e.g., a large factory) and diffuse regional demand (e.g., a network of retail outlets) - all affect the choice of transportation mode in each specific situation.

The Story of Inventory: "Where Things Sit" in Supply Chains

Both the economics of production and the economics of transportation mean that products are typically shipped in batches of some minimum quantity. The economic order quantity is the production batch size (or shipment size) that has been optimized vis-à-vis inventory carrying costs and ordering costs. The batching of production and transportation implies that both manufacturer and customer must hold inventory - the manufacturer will hold finished goods inventory because of the efficiency of batch manufacturing and/or until it has produced enough for a cost-effective shipment; the customer company will hold this cycle inventory until it is sold off. In addition, each echelon in the supply chain may hold additional inventory - safety stock - to cover random fluctuations in customer demand or in parts' supply. Finally, because processes along the supply chain - especially transportation - take time, inventory also sits in trucks, on the high seas, or while undergoing some manufacturing process and is called the work-in-process (WIP) inventory.

Inventory is costly. It consumes capital on a company's balance sheet, consumes space for storage, and requires labor to put away, maintain, service, manage, and pick-and-pack. Inventory can de- grade over time (e.g., perishable food, medicines, and chemicals) or go obsolete (e.g., last-year's skirts or silicon chips). Consequently, companies try to minimize the amount of inventory they hold. In the 1950s and 1960s, Toyota pioneered the just-in-time (JIT) manufacturing and supply chain inventory management method as part of the Toyota Production System. The system was designed to reduce inventory along the supply chain while increasing product quality and service levels. This practice spread within Japan and then throughout the world. JIT and the related strategy of lean manufacturing/lean supply chain enable companies

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to operate with less inventory and be more responsive to changing market conditions.

Views on the Risks

Each of these five aspects of the supply chain offers respective in- sights into the many different risks in supply chains. The "parts" aspect of the supply chain is associated with materials availability, defective parts, and pricing risks associated with the various inputs to the final product or assembly.

The "who" and the "where" of the supply chain affect many geographic and operational risks such as natural disasters, supplier bankruptcies, and regulatory risks. Outsourcing - especially off-shore - reduces a company's level of control over the outsourced steps of the manufacturing process and can expose the company to geographic, legal/regulatory, and political upheaval risks. The "who" and "where" aspects also determine the natural resources footprints (e.g., energy, water, and carbon) and potential social responsibility risks in the supply chain.

The "flow" aspect of the supply chain depicts the range of connective risks in the logistics, financial, or information infrastructure that underlies the fabric of the chain. The material flow aspect includes risks in the timeliness of shipments and potential disruptions in key transportation terminals, lanes, and hubs. The information flow aspect highlights the vulnerability of global supply chains to information technology disruptions (e.g., computer failures, software glitches, or cyber-attacks). The money flow aspect depicts the vulnerability of commerce to financial crises, bankruptcies, and exchange rate risks. Finally, the "inventory" aspect of the supply chain includes geographic risks, product quality risks, and parts obsolescence. Yet, inventory also represents an opportunity to buffer many supply risks by allowing companies to maintain the flow of parts and products during a disruption.

Rising Vulnerability on all Sides of the Supply Chain

Intel's vulnerability to the Japanese earthquake, and the many examples in the rest of this book, arise from a series of trends that have pushed companies toward more complex, broader, longer, and more fragile supply chains.

More Trade, More Distance, Longer Lead Times, More Players

The leading driver of this growing vulnerability is the explosion of global trade. Global merchandise exports surged from $7.38 trillion in 2003 to $17.93 trillion in 2012. Rapidly declining costs of communications and growing efficiency of logistics are enabling all this trade, with the resulting lengthening of supply chains. Digital communications mean companies can more readily work with facilities, suppliers, and distribution centers on the other side of the world.

Containerization and larger conveyance sizes aid global trade by reducing transportation costs. In 1999, the largest container ships carried 8,700 TEU (twenty-foot equivalent unit) although 90 percent of container ships were 4,500 TEU or smaller (in order to fit through the Panama Canal, known as "Panamax" vessels). With the growth of trade came demand for bigger ships and the efficiencies they bring. By 2013, the largest ships carried 18,270 TEU and nearly 50 percent of the total fleet capacity was in post-Panamax ships. Larger ships, larger airplanes, longer trains, and larger trucks are all more efficient per ton-mile than smaller vehicles. Indeed, the trend in the industry has been to increase conveyance size in every mode of transportation, reducing the cost of long-distance trade in products. With the increase in size, however, comes a greater concentration of risk.

Global competition motivated companies to hunt for the best price and performance in global markets. As companies outsourced their manufacturing operations to distant lands and distant suppliers, lead time from order to delivery lengthened, meaning that there was more opportunity for things to go wrong. More actors were involved - from suppliers to service providers to multiple governments and regulatory regimes - thereby further increasing complexity and the probability of failure.

More Variety

Global trade, global competition, and the need for differentiation in the marketplace mean that companies now sell more varieties of each product - what companies refer to as SKUs (stock keeping units). For example, Colgate - one of the more than 16 competitors selling toothpaste in the United States - advertises 14 types of toothpaste. Higher SKU counts mean that each variant sells in relatively small quantity,

making the problem of predicting demand difficult. The reason is that product demand is often subject to random variations.

The relevant measure of the variability of demand is the coefficient of variation: the ratio of the standard deviation to the mean. As the average sales of each SKU grow smaller, this ratio increases (owing to a linear decrease in the mean but only a square-root decrease in the standard deviation), resulting in more difficulties in forecasting demand, and leading to overstock/under- stock and higher costs. The first rule of forecasting - that forecasts are always wrong - is truer today than ever before.

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More Technology, More Complexity

Many products have become more complex through the addition of embedded information and communications technology. Automobiles now contain between 30 and 100 microprocessors, with each subsystem of the car having its own controller and software. Every headlight, airbag, rearview mirror, seat, and door has its own dedicated microprocessor. Even simple products such as coffee makers and other home appliances use microprocessors and associated electronic systems. And new technology includes more than just electronics; products now rely on a growing variety of engineered materials, additives, pigments, and treatments that enable high efficiencies, performance, and market acceptance.

With product complexity comes the need to use more suppliers, who, in turn, may use more suppliers, leading to more complex supply chains. A car seat used to be like a piece of furniture and depended only on suppliers of cloth, leather, stuffing, and some metal or plastic framing. But modern car seats are technological gizmos that also include switches, motors, heating elements, sensors, and the ubiquitous microprocessor to control them. Even the seat materials themselves are more advanced, with high-tech foams and more durable, fashionable, and sustainable textiles.

Complex, Broad, Long, and ... Vulnerable

Computers may make complex global supply chains more efficient and they work constantly to make them easier to manage, but they don't make them less risky. Companies can more readily manufacture complex products using complex supply chains, but the systems are inherently more fragile precisely because modern computers and communications enable tighter coordination and lean, inventory-less operations.

While such controls and processes make a company more competitive in normal times, they also make it more fragile to any event that disrupts the finely tuned global network of business machinery. In addition, complex supply chains mean "deep" bills-of-materials and thus many tiers in the supply chain. While companies may be able to pressure their direct suppliers to help manage risks, companies have little knowledge of these deep-tier suppliers and, in most cases, almost no influence over them to demand more resilience or adherence to a code-of-conduct.

In the end, the rise of global trade means that companies have more moving pieces stretched over greater distances and with less slack in the system. And with a growing global population and a growing global economy, significant supply chain disruptions are inevitable. Thus, when a quake hits Japan or anywhere else unexpectedly, the companies of the global economy find themselves shaking, too. •

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Protectors of the BRAND

In a world where Tweets go viral, supply chain professionals are charged with more than having two sources of supply. They must also have strategies and processes in place to deal with a new world of risks that can leave their organizations reeling.

BY HANNAH KAIN

IN AUGUST OF 2015, Chipotle was riding high. Perceived as a healthy food choice for its use of local, farm fresh ingredients, the Mexican food chain was one of the three most respected limited service restaurants in the world. Neither diners, who flocked to its locations, nor investors, who drove the price of a single share of stock to more than $750, could seem to get enough. Of course, that was before an outbreak of Norovirus in Simi Valley, Calif. that affected nearly 100 customers.

As if that was not enough, the California outbreak was followed by more outbreaks of food borne illnesses linked to Chipotle locations in at least 12 states. The low point may have been reached in February 2016, when the chain temporarily closed all of its locations to address the issue.

Soon, Chipotle's stock had dropped 47%. The company had lost $10 billion in market capitalization along with its reputation as the healthy restaurant choice. Now dubbed "the most dangerous restaurant stock in the industry," it was among the least respected restaurant brands among investors. While the Centers For Disease Control and Prevention looked for the culprit, a sign posted in the window of one Chipotle identified the cause: "FYI: We are sorry, but we are temporarily closed due to a supply chain issue."

The sign, and the damage to Chipotle's image, are stark reminders to supply chain managers that risk is everywhere, regardless of the industry. Whether it's faulty air bags forcing Takata to the brink of bankruptcy or Samsung's stock price taking a nose dive due to exploding smart phone batteries, negative news stories can lead to lasting damage to a company's reputation as well as its stock value.

Supply chain managers, especially those involved in risk mitigation and risk management initiatives, are no longer just tasked with making sure to have two sources of supply; they are now protectors of their organization's brand and value. In this article, we will examine this broader definition of risk management.

3 rules of risk management

Supply chain history teaches us that there are three risk-related rules:

Rule No. 1: The overlooked risk often presents the most immediate danger.

Rule No. 2: The risks keep coming and require constant vigilance.

Rule No. 3: Risk and complexity go hand-in-hand.

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Lessons learned

Supply chain history teaches us that there are three risk-related rules:

- **Rule No. 1:** The overlooked risk often presents the most immediate danger.
- **Rule No. 2:** The risks keep coming and require constant vigilance.
- **Rule No. 3:** Risk and complexity go hand-in-hand.

In fact, complexity drives risk. While risk can exist without complexity, risk factors increase disproportionately with increased complexity.

This is important because complexity in supply chains has increased tremendously in the last decade—a trend that is likely to continue. More than anything else, it has given birth to risk management as a supply chain discipline. Regrettably, practitioners of that discipline have largely focused their efforts on avoiding supply chain disruptions following earthquakes, weather-related events or

the loss of a key supplier. But risk avoidance can also result in the kind of micro-management that can stifle the supply chain. Simply put, a sustainable supply chain cannot be built primarily on risk avoidance.

A quick look back at the last 20 years may provide some perspective. For many companies, complexity arose with the advent of outsourced manufacturing to low-cost and low-wage regions of the world. The perceived risk then was the inability of a company to compete if it continued to produce in high-cost labor markets. The overlooked risk—Rule No. 1—was a string of quality problems. In those early years of outsourcing, companies spent significant resources to mitigate quality issues. But while outsourcing avoided the risk of high labor costs, the significant physical distance between manufacturing and markets prevented nimbleness; it was increasingly difficult to react to swings in demand and inaccurate forecasts—it's important to remember that risk avoidance can stifle the supply chain. It also became clear that the supply chain had become vulnerable to disruption because each of the many layers in the supply chain had created its own global supply chain for its suppliers and its operations. A disruption in a Tier 2 supply chain could bring a Tier 1 supplier to a halt.

The associated risk affecting brand value and customer loyalty has a significant and measurable impact on financial results and shareholder value. The supply chain has become a primary factor in reputational management.

The impact of supply chain disruptions became more apparent as companies started practicing Lean principles. Buffer stock and WIP were no longer maintained in large enough quantities to save the day. Instead, supply chain managers who forgot Rule No. 2 were buffeted by stock outages in one location and excess inventory in another. At the same time, SKU proliferation, customization and new fulfillment strategies like vendor managed inventory and smaller and more frequent deliveries added to complexity—Rule No. 3.

That describes the world that was. In today's world, with the growth of customer expectations and social media putting company practices under a potentially viral microscope, risks that may have been overlooked in the outsourced supply chains of the past are now potentially front and center. There is now an expectation that OEMs will manage multiple layers of their supply chains, including end-user facing. Omni-channel strategies, with their emphasis on delivery speed, customization and localization, add even more complexity. If manufacturers play to win, they must have a strategically-positioned delivery system. The perfect order is the order that is delivered to today's standards, in all that that entails.

Local laws and regulations, trade agreements, cross border regulations, associated tax laws and supplier compliance also exert a heavy impact on supply chain organizations. With the complexity and integration of other business areas, the responsibilities of supply chain organizations continue to expand. Gradually, supply chain scope includes new areas such as the responsibility for being a good corporate citizen or the responsibility for converting currency on the fly while processing orders around the globe. This scope creep within the supply chain organization has created new sub-disciplines; however, with few (if any) senior professionals trained in these areas, the profession is missing senior leaders who can develop talent.

Supply chain gets attention

Something else has changed. For years, supply chain managers felt ignored and underappreciated by senior management. Now, with CEOs getting called on the carpet when their stock value drops following a supply chain disruption, supply chain is getting the attention it has long sought, but for all of the wrong reasons. The message, delivered loud and clear from the C-Suite isn't "great job." It's "don't mess up."

The much craved attention has become a double-edged sword for many supply chain pros. Yes, the board is now interested in supply chain, but that also means that risk avoidance has become a significant element of the job. The pendulum has turned: It is increasingly difficult to find supply chain pros who are willing to stick their necks out. The stakes have gone up for everyone. Yet, in the midst of the decision paralysis, nimbleness and fast reaction times are crucial.

Reacting to new risks

To understand the new risks that supply chain pros face, we must face that we live in a world of transparency and instant communications. Simply put, our new vortex is the juxtaposition of the social media and instant communication combined with a highly complex supply chain.

The associated risk affecting brand value and customer

loyalty has a significant and measurable impact on financial results and shareholder value. The supply chain has become a primary factor in reputational management. Reputational risk, in turn, has become a major element in a company's success as measured in brand loyalty and in stock value. The more valuable and important the brand, the higher the reputational risk. When consumers feel that management has broken the unspoken but perceived brand promise, the punishment can become severe. These new risks include:

Labor in the supply chain. Labor conditions have been a major issue for manufacturers. One corporation took a major reputational hit online when one of its second tier suppliers employed garment workers in an unsafe building that collapsed. Another corporation struggled with worker suicides at a contract manufacturer. Customers do not want to align themselves with companies that abuse workers. The connection is made instantaneously between the viral videos and their large corporate customers.

We are seeing regulations regarding labor conditions in the supply chain, including in California where corporations with more than $100 million in sales in California must publish how they keep the supply chain free of indentured and child labor. It is a daunting task; yet with between 20 and 30 million indentured workers and an unknown number of child workers worldwide, it is one that the public expects to be met. A major corporation was caught having indentured fishermen tricked into slavery. Reacting quickly and resolutely, the company was able to avoid the impact of a PR disaster.

Consumer safety issues. Consumers and business customers are not just concerned with worker safety; they also expect that the products they purchase are safe to use and, in the case of Chipotle, to consume. One need look no further than the hit to Toyota's sterling reputation following a handful of accidents initially attributed to the Prius braking system or the fallout to the auto industry over the ongoing airbag disaster. Recalls of unsafe children's products especially enrage consumers.

Cybersecurity. In one cyber-disaster after another, millions of credit cards have ended up in the hands of criminals because a supply chain partner had a security breach. The attack on Target's point of sale system sent the retailer into a tailspin for months. It's no surprise, then, that many supply chain executives have cited cybersecurity as their biggest concern—especially because lack of connectivity is not an option.

However, the cybersecurity threat is about to get much worse. As the Internet of Things grows, medical, personal, environmental and other sensors will be embedded into our everyday products. Remember when a Jeep driven by a reporter for Wired magazine was taken over by hackers while he was behind the wheel? The hackers found a vulnerability in the Jeep's entertainment system that allowed them to play with the radio, the windshield wipers and ultimately the transmission. Technologists fear that these "new technology" companies simply do not have the expertise to prevent intrusion. Once cybercriminals have gained a foothold in the consumer's world—perhaps through sensors embedded in an athletic shoe—they can then move on to create severe havoc.

Traditional technology companies haven't fared much better than consumer companies. Over the years, millions of home routers from leading technology companies were sold with software that was vulnerable to hackers. When breaches like that can happen due to an oversight by established technology companies, imagine what can happen when your mattress has technology to track your sleep patterns, your car is self-driving and your refrigerator is tracking the food on its shelves.

Corporate citizen. Sustainability and environmental issues are other areas where brand names are vulnerable. Originally, everyone could wash his or her hands once a product was outsourced. Now environmental concerns and corporate culpability are discussed on social media.

Originally, everyone could wash his or her hands once a product was outsourced. Now environmental concerns and corporate culpability are discussed on social media.

Just think about the impact of the 2014 Elk River chemical spill in West Virginia on Freedom Industries. Within a week of the spill the company filed for Chapter 11 bankruptcy and faced mounting lawsuits.

Consumers expect their favorite brands to be good corporate citizens. They expect diversity among suppliers, staff and executives; community involvement; and a reasonably equitable market strategy. Pharmaceutical companies such as Mylan and Turing have endured hits to their reputations after significant increases to the cost of life-saving drugs. Supply chain professionals must be conscious about whether their suppliers and their employees are being treated fairly, and whether their suppliers act as good corporate citizens. Volkswagen's

disclosure of its software rigging emission test results is an example of a broken brand promise at a time when consumers take pride in supporting the environment. The company just settled for $15 billion but is not done with lawsuits and reputational damage; recovery will be long and expensive.

Temptations to shortcut laws. It goes without saying that corporate citizenship at a very minimum means following laws and regulations, no matter how cumbersome and difficult that might be. Throughout the supply chain, managers need to solve these issues in real-time while grappling with stressful practical, ethical and business dilemmas. If you have promised delivery to a wholesaler that launched a big promotional campaign, how do you deal with the corrupt Customs officer who is demanding an under-the-table payment? For U.S. corporations, it is clearly illegal to comply with the request for a bribe under the Foreign Corrupt Practices legislation. Yet, when the yelling starts, it may be tempting to let the local subsidiary or brokers take care of the problem. Another temptation faced by companies involves how to declare products for border crossings: If the Customs charges brings the product's price point into a non-competitive zone, is it acceptable to declare the product "slightly" wrong to avoid the Customs charge, for instance as a slightly different commodity subject to smaller Customs and duties charges? Don McCabe, a professor of management and global business at Rutgers University, found that 74 % of undergraduate business students had cheated during their studies. It is not farfetched to assume that they would cheat to achieve business and career goals later in life. Without clear direction, local managers may make the wrong decisions—even with the best of intentions—thinking that they in fact are looking out for their employer.

Supply chain professionals must ask themselves how the public will perceive each of their decisions. No doubt, there may be different levels of judgment based on whether any deviation from acceptable practice came about due to deliberate actions, negligence or an unfortunate coincidence.

In the internal or external parts of the supply chain, the temptation to circumvent safety, security, laws and ethics in order to expedite product or save money is one of the major risks that supply chain executive must face. In fact, many still speculate that the desire to be seen as a problem solver was what ultimately caused Volkswagen employees to develop deceptive software for their certification.

Supply chain professionals must ask themselves how the public will perceive each of their decisions. No doubt, there may be different levels of judgment based on whether any deviation from acceptable practice came about due to deliberate actions, negligence or an unfortunate coincidence. Assuming that supply chain professionals don't take deliberate actions to upset their constituents, it is tempting to simply focus on negligence. However, for prominent brands the presumption is that a high level of due diligence is exercised and that they avoid even the slightest coincidental exposure.

Proactive and reactive risk mitigation

Now that we have identified some of the new and complex risks that supply chain managers must contend with, what can be done to mitigate those risks? We believe that there are proactive and reactive strategies that supply chain managers and their organizations should consider.

One simple solution is to decrease complexity. While much complexity comes from outside sources, a few elements can be controlled within the supply chain organization. For instance, SKU proliferation can be reined in, the number of suppliers can be controlled, the location of warehouses can be optimized and concessions to customers can be done collaboratively with supply chain involvement. When new complexities are inserted, we must make sure that the gain in supply chain value justifies the increased risk.

Risk mitigation can and should be proactive, especially in established public companies. The first step is to identify the risk. Using tried and true FMEA and other risk assessment tools, we can certainly rate the risks and then put in place processes to mitigate them. Beware: As easy as that sounds, it is a daunting task.

The first problem is identifying the risk. Remember Rule No. 1: The danger comes from the overlooked risk. The second problem is that some situations simply spread like wildfire on social media with the potential to cause irreparable harm to the company brand. While it may not be game over, the damage can persist for years. Most analysis tools do not consider how to react to very rare but catastrophic events. The third problem is to identify up front which risks

are important to mitigate. Being proactive requires corporations to employ highly qualified supply chain professionals. It also requires a long planning cycle. It may take years to qualify new suppliers, and most corporations are very conservative when it comes to adding new suppliers because of the high cost. The result is an opportunity cost in lost nimbleness.

Reactive risk mitigation must also be considered because the agility required in supply chains makes it virtually impossible to proactively and systematically identify all risks. Reactive risk mitigation requires constant vigilance internally and externally, empowerment and high-level involvement. Customer service oriented companies are now monitoring social media and taking complaints and individual concerns offline. Reactive risk mitigation involves the fast elevation of issues that can or are about to go viral, followed by expeditious and honest responses. One example of fast intervention occurred when Tesla's CEO Elon Musk contacted Tesla owners whose cars had caught fire and then sent Tweets about his conversations.

The strategy requires PR savvy and it is not enough to respond. When lululemon shipped sheer yoga pants to its stores and customers, the founder and CEO implied that the unfortunate see-through problem only happened to fat customers. The outrage knew no end and the CEO is no longer associated with the company.

Supplier management beyond questionnaire of the week

Supplier management relies heavily on technology to identify supplier related risks; most risks are identified by sending out questionnaires but with little follow-up. This is quite understandable as larger corporations deal with 10,000 or 100,000 Tier 1 suppliers. Thus suppliers are used to filling out endless questionnaires that require hours of valuable time to answer diligently.

Supply chain professionals think that they need to prove due diligence. Yet, they are faced with the questions of how to prove due diligence without micromanaging. A more strategic solution is to emphasize value alignment in the supply chain. Supply chain research has proven that the value alignment and relationship building approach generates higher profit for all parties. Instead of focusing on price points, procurement's role shifts from cost reduction to risk management and value creation. Indeed, some supply chain professionals are actually walking this walk. However, most companies are still looking for the lowest bidder and measuring their purchasing staff by how they lower unit costs and not on mitigating risk or lowering total supply chain cost or increasing value.

Creating a sustainable supply chain: Lessons for executives

In most companies, supplier management is now on a track to create a staid, non-flexible supply chain that is simply not sustainable. The heavy-handed approach precludes the nimbleness and innovation that creates winning supply chains.

It is clear that just getting product out the door at the lowest possible cost doesn't cut it—especially if that means using suppliers that create brand disasters.

Supply chain executives simply have to review how they maintain control without stifling innovation. The supplier relationship and the oversight must change accordingly.

In the end, the shareholders, the board and the executives define what constitutes a job well done. It is clear that just getting product out the door at the lowest possible cost doesn't cut it—especially if that means using suppliers that create brand disasters. VW found itself in hot water because of executive pressure to meet U.S. requirements for diesel engines. Somewhere, somebody must have felt that the goal justified the means.

That should be a lesson for executives: As they push cost reduction as the primary goal in the supply chain, they may sacrifice a much broader risk that could affect their brands and put them out of business. Just as important, not all supply chain failures are the result of nefarious actions, like cheating to meet emissions requirements. Chipotle had the best of intentions when it used local farmers to source fresh ingredients rather than the larger corporate farms used by its competitors; what it lacked was the supply chain processes to identify and mitigate the risks presented by those suppliers, and a plan for how to respond if and when a problem arose.

Supply chain professionals at all levels must understand and monitor risk elements to fill this new role as protector of the brand. More importantly, the companies they work for must support them with the development of proactive and reactive risk strategies. Ignorance is no longer bliss as the world expects diligence and responsibility. •

Using Prescriptive Analytics to Decrease Supply Chain Disruptions

While other areas of operation like marketing or manufacturing have relied on advanced analytics for years, supply chain management has been slower to adopt.

BY NARI VISWANATHAN

According to Deloitte, 79 percent of companies with high-performing supply chains achieve above average revenue growth. Yet, very few companies include supply chain managers in their boardrooms.

While other areas of operation like marketing or manufacturing have relied on advanced analytics for years, supply chain management has been slower to adopt. However, businesses that have applied big data analytics to their supply chain functions have seen a reduction in costs, improved risk management, shorter cycle times, more accurate forecasting, and an overall improvement when it comes to making informed decisions.

Still, supply chain managers are apprehensive when it comes to replacing existing tools. Many wonder if this is just another round of software evolution. Does it require product investment? Can this really help improve the quality of the supply chain? Many feel wary of adopting new technology due to their experience in massive endeavors, such as implementing enterprise resource planning and warehouse management tools.

Implementing prescriptive analytics technology is not a major endeavor supply chain leaders should fear. It's actually a crucial analytics approach that can help supply chains decrease disruptions, improve efficiency, and drive profitability for the business as a whole —which, together, could land supply chain managers that well-deserved seat in the boardroom. Below are four areas where prescriptive analytics can and has helped truly transform supply chains.

Connect the Dots Between Supply Chain and Finance

Correlating supply chain output to the financials of the business is one of the most impactful methods supply chain managers can employ. The problem with existing tools and infrastructure is that they don't allow visibility between the supply chain and the finance department, making it difficult to accurately depict the supply chain's impact on the bottom line.

Adding advanced analytics to supply chain reporting is the only analytics method that allows management to consider different financial factors, such as the variable rate of return for cash flow. Once these aspects are considered and identified, you will be better equipped to develop a solid supply chain management plan that is also financially valuable.

Become More Agile and Accurate When Making Decisions

The dynamic environment of business requires a lot of decision-making done, more often than not, in a short time frame. Each decision has implications in terms of how customer demands are met, how factories are run, how employees get paid, and so on. While legacy supply chain systems have their place and are essential to running the company, they don't really give managers the ability to make better, more informed decisions. Most of these tools focus on the operational aspects of the supply chain, rather than the value and impact of the operation.

In order to make informed decisions, supply chain managers need to account for constraints that reflect reality. Advanced capabilities like prescriptive analytics provide a platform to make decisions more fact-based. Supply chain managers will better understand the implications of decisions by running different scenarios, ultimately settling on the outcome that best impacts the entire company. This process is extremely hard to do unless you have an integrated model and an advanced platform that allows for certain constraints and scenarios.

Improve End-to-End Visibility

End-to-end supply chain visibility solutions continue to increase as companies adopt more robust advanced analytics platforms. As a natural progression of implementing prescriptive analytics and considering the impact of decisions, integration and collaboration increase, silos are eliminated, and supply chain managers start to adopt an outside-in way of thinking. Enhanced end-to-end visibility leads to reduced costs, fewer risks, more accurate forecasting, and the agility to face changing market demands and unexpected disruptions.

Supply chain managers play a more strategic role as they collaborate across the organization.

Improve Your Supply Chain—and the Lives of Those Who Run It

Not only does advanced analytics benefit the entire company, but it also betters the career of supply chain staff. Employees become more empowered as they make decisions that are of global impact to the company. They become more efficient as they rely on a digital assistant of sorts to help them make more informed decisions. Supply chain managers play a more strategic role as they collaborate across the organization.

While many companies are making great strides in implementing prescriptive analytics in their supply chain operations, there is still a long way to go. The market is ripe for the next round of supply chain technologies, and businesses will only continue to improve efficiency, increase savings, and improve the lives of their supply chain staff as they take a more strategic approach to their data.•

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