



# The Tears in the Deep Tiers

BY YOSSI SHEFFI

**Many leading companies have well-developed risk management and crisis management systems for their own operations. Yet for all their prowess of risk management of their own facilities and Tier 1 suppliers, the companies can miss significant risks deeper in the supply chain. In this article, Yossi Sheffi discusses that only by spreading the tools of resilience into the deep tiers can industries hope to prevent, detect, and mitigate the serious risks that lurk beneath.**

“The world is so connected that the feedback loops are more intense”, said Ellen Kullman, CEO of DuPont.<sup>1</sup> She explained, “Our supply chains are global. Our financial markets are global. So uncertainty in one part of the world infiltrates all parts of the world. These days, there are things that just come shooting across the bow – economic volatility and the impact of natural events, like the Japanese earthquake and tsunami – at much greater frequency than we’ve ever seen.” Many of these surprises are rooted in the deep tiers of the supply chain where companies have little knowledge of who those suppliers are and no influence or control over them. Worse, in some cases it means that unbeknownst to many companies, entire industries are dependent on a single deep-tier supplier or a region. The result is that alternative parts and suppliers may be unavailable. Consider the following three event examples, which show the deep risks that threaten global

supply chains and the actions which companies can take in response to them to achieve deep resilience.

On March 31, 2012, a tank filled with highly flammable butadiene exploded at Evonik Industries' cyclododecatriene (CDT) plant in Marl, Germany. Intense flames and thick black smoke billowed as 130 firefighters fought for 15 hours to contain and extinguish the blaze that killed two workers and severely damaged a portion of the plant.<sup>2</sup> CDT and its use in synthesizing cyclododecane, dodecanoic acid, and lauroctam may mean nothing to most readers. But CDT is a key ingredient in making PA-12 or nylon-12 plastics, which are prized by car makers and other industries for their chemical resistance, abrasion resistance, fatigue resistance, and fuel-efficiency-boosting light weight. In 2011, the average light vehicle used more than 46 pounds of nylon for plastic housings, fuel lines, and brake lines.<sup>3,4</sup>

Second, on March 17, 2010, Greenpeace posted a spoof ad video on YouTube that opened with a bored office worker shredding paper.<sup>5,6</sup> Next, the

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screen turned red with the text, “Have a break?” – a riff on Nestlé’s “Need a break?” ad campaign for its Kit-Kat candy bars. Next, the worker opened a Kit-Kat wrapper to find an orangutan finger – complete with tufts of orange hair – instead of a Kit-Kat’s fingers of chocolate. Two coworkers watched in horror as the worker crunched into the finger and blood dribbled from the corner of his mouth and onto his keyboard. The video closed with images of an orangutan in a tree and of a single tree in a cleared field. The video urged watchers to “Give the orangutan a break” and “Stop Nestlé buying palm oil from companies that destroy the rainforests.”<sup>7</sup> In a matter of weeks, 1.5 million people had watched the video.<sup>8</sup>

Greenpeace’s Kit-Kat attack caught Nestlé by surprise for many reasons, including: palm oil was only a trace ingredient in Kit-Kats;<sup>9</sup> Nestlé had no direct relationships with nor control over palm oil producers – it bought the oil on world markets; Nestlé had committed to a “no deforestation” policy;<sup>10</sup> and Nestlé was part of the Roundtable of Sustainable Palm Oil (RSPO).<sup>11</sup> The Greenpeace campaign targeted the Indonesian conglomerate, Sinar Mas Group, as one of the companies clearing rainforests to grow palm oil. Even after Nestlé cancelled contracts with Sinar Mas,<sup>12</sup> Greenpeace continued to assert that Sinar Mas palm oil was still getting to Nestlé indirectly, through brokers and other suppliers like Cargill.<sup>13</sup>

Third, in April 2009, John Prendergast, a human rights activist and founder of the *Enough Project*,<sup>14</sup> sent a letter to leading electronics firms, including Intel,

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HP, Motorola, and AT&T.<sup>15</sup> The letter warned that the companies may be supporting atrocities, rape, and violence in the eastern region of the Democratic Republic of Congo (DRC) through purchases of four metals (gold, tantalum, tin, and tungsten) derived from “conflict minerals” – akin to blood diamonds. This reputational threat expanded into a regulatory threat with the passage of the 2010 Wall Street Reform and Consumer Protection Act (a.k.a. “Dodd-Frank Act”) that required all public US companies to disclose whether they use conflict minerals.<sup>16</sup>

Initially, Intel had no idea if conflict minerals were in its supply chain because Intel did not buy these metals directly. The company asked its suppliers about the minerals, and most suppliers did not know or did not respond to the request. Others claimed, “We don’t do that” but had no supporting evidence.<sup>17</sup> Simply to determine if Intel products *might* contain conflict minerals entailed delving more than six tiers deep into the supply chain.

Many other examples illustrate industry-wide risks buried deep in global supply chains. The 2011 Japanese earthquake and tsunami revealed that Japan makes 100% of the world’s protective polarizer film for LCD displays, 89% of aluminum capacitors, and 72% of silicon wafers.<sup>18</sup> North Korean tensions with South Korea threaten nearly 80% of the global computer memory supply.<sup>19</sup> When a small New Mexico peanut processor, Sunland Inc., had a salmonella contamination incident, 36 brand-name companies were forced to recall 300 different products.<sup>20</sup> And when the Rana Plaza garment factory collapsed and killed over 1,000 Bangladeshi workers, the murky world of contractors and subcontractors meant that many Western apparel companies could only hope their brands were not involved.

### The Root Causes of Deep Risk

Three root causes create deep risks that lurk over the horizon of individual companies’ sphere of supply chain influence:

1. Global suppliers. *Economies of scale* naturally favor the growth of large, efficient suppliers such as Evonik. In addition, the *constant pressure* that OEMs and retailers exact on their suppliers cause them to merge and grow.
2. Geographical concentration. The 2011 floods in Thailand that hit four of the top five hard disk makers and disrupted 35% of global disk production show that *economic clusters* create vulnerable regional concentrations in the supply base. In other

cases, *natural geographic concentrations* of the Earth's mineral and biological resources – such as conflict minerals in DRC, palm oil in tropical regions, or rare earth metals in China – mean that some industries are inextricably linked to risks in particular places.

- Proprietary parts and material. In many cases, only one company, or sometimes even a single plant, can produce certain inputs. *Unique capabilities* can create deep risk, such as when the 2011 Japanese earthquake disrupted production of Merck's Xirallic (a sparkly pigment used in auto paint) and affected manufacturing of certain colors of luxury cars at Toyota Motors, Hyundai, Chrysler LLC, GM, Ford Motor, BMW, VW, Audi, and other car makers.<sup>21</sup>

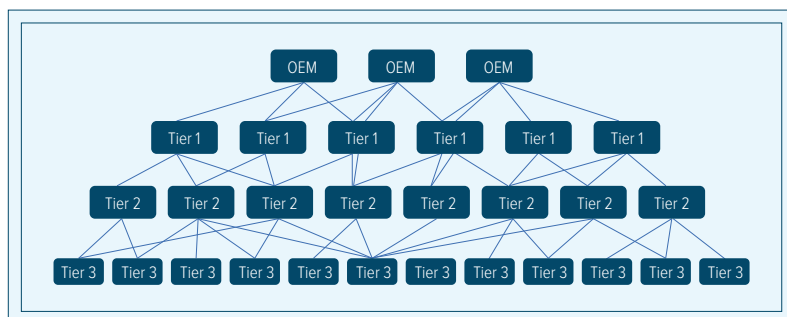
These three phenomena have always created some deep risks in companies' supply chains, but three ongoing business trends have amplified the deep risks to global scale.

The biggest trend that amplifies deep risk is the growing amount of global trade, spurred by declining logistics costs, expanding middle-class consumer populations, greater access to suppliers around the world, and global telecommunications. Second, just-in-time and lean manufacturing mean that suppliers in all tiers have less inventory and less spare capacity. Third, growing product complexity (e.g., car seats that now contain computer chips, electric motors, heating elements, high-tech textiles, exotic foam polymers, and specialty steel) make each product riskier – the greater the number of raw ingredients and components, the deeper the supply chain is and the greater the chance is that one of those items or its supplier will have a major problem. The result is that what used to be local deep risks for particular local product makers have become global deep risks that threaten entire industries.

The archetypal diagram of a supply chain shows a fan-out of direct or Tier 1 suppliers feeding each original equipment maker (OEM) company (See Figure 1a). Each supplier, in turn, has many other suppliers

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Figure 1a: The typical tiered structure of an industry's supply chain.



(Tier 2 to the OEM, Tier 1 to the supplier), and so on. The diagram seems to imply robust parallel sourcing, with many alternative suppliers in each tier. But, unbeknownst to the OEM, supply chains often have hidden vulnerabilities. A single supplier deep in the chain – such as the Evonik chemical factory or a socially irresponsible palm oil plantation – can play a keystone role that creates significant risks in all downstream tiers. “What we've found is that in Tiers 3 and 4, the convergence of underlying raw material supply starts to become really significant”, said Jackie Sturm, Intel's Vice President of Technology and Manufacturing and General Manager of Global Sourcing and Procurement.<sup>22</sup> Instead of a fan, the shape is more of a “diamond,” in which a risk in one deep tier supplier affects many intermediate suppliers and threatens all of the OEMs (See Figure 1b on the next page). Finally, the economic events of 2008 proved that the global financial system – the supplier of all the money that keeps everything running – was the biggest diamond of them all.

When the Tohoku earthquake and tsunami struck Japan on March 11, 2011, General Motors initially estimated that 390 parts from 25 Japanese suppliers might be disrupted. What was less visible were all the parts from non-Japanese suppliers that depended on components or raw materials are from deeper tier suppliers in Japan. Ultimately, GM needed four weeks to discover that 5,850 parts were affected. Although the scope of the earthquake's impact may not be surprising given the scale of the Japanese disaster, even seemingly small events in deep-tier suppliers can have expansive impacts. The Evonik fire, impacting just one portion of one industrial facility of one supplier in one location, nonetheless threatened supplies of 2,000 different parts at GM and also untold thousands of other parts at other automakers and companies that needed PA-12.

Industrial centers are not the only locus for deep risks. The Rhine River carries 16% of Germany's trade.<sup>23</sup> Recurring droughts,<sup>24 25</sup> an overturned barge in 2011,<sup>26</sup> and finding unexploded bombs from WWII<sup>27</sup> have all disrupted freight flows on the river. Similarly, US West Coast port labor issues, congestion in Chicago's rail network, fog in Shanghai, and Icelandic volcanoes are among the litany of logistics disruptions affecting entire industries.

## Deep Resilience: Mitigating Over-the-Horizon Risks

As detailed in my new book, *The Power of Resilience: How the Best Companies Manage the Unexpected* (MIT Press, October 2015), many leading companies have

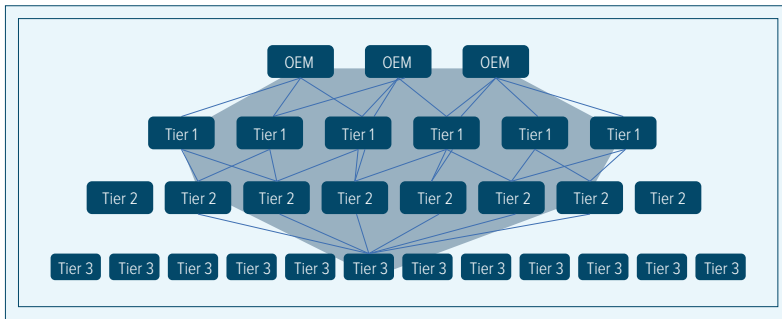


Figure 1b: Deep risk: a "diamond"-shaped supply chain network

well-developed risk management and crisis management systems for their own operations. These companies avoid sole source suppliers whenever possible, assess supplier health continuously, and develop strong supplier relationships. These companies invest in disaster detection processes through monitoring the news and weather and using software that can quickly estimate the impact of disruptions on manufacturing and customers – translating the disruption to metrics such as value-at-risk. They also have clear processes for assessing and escalating potentially disruptive events. Finally, these companies invest in resilience assets such as emergency operations centers, communications gear and protocols, flexible manufacturing systems, inventory, and disaster response training and emergency drills. Yet for all their prowess of risk management of their own facilities and Tier 1 suppliers, the companies can miss significant risks deeper in the supply chain. The examples of Evonik, Nestlé, and Intel illustrate how companies and industries can improve their deep resilience.

For example, the Evonik fire went unnoticed by the world's automakers until a supplier of fuel lines and brake lines – TI Automotive – raised the alarm. The industry immediately convened an emergency summit on April 17 that was moderated by a neutral third party, the Automotive Industry Action Group (AIAG).<sup>28</sup> Two hundred people from 58 companies attended the summit, representing eight automakers, their Tier 1 suppliers, component makers, polymer resin makers, and on down to deep-tier chemical makers such as Evonik and BASF.<sup>29</sup>

The participants formed six committees to quickly create action plans and host technical follow-up meetings to mitigate the impacts of PA-12 shortages on component and vehicle production.<sup>30</sup> This collaborative effort tackled three tasks requiring the collective expertise of the entire industry. First, they mapped

and quantified the current state of global PA-12 inventories and production capacities throughout the automotive supply chain. Second, they brainstormed options to extend current PA-12 capacities and/or identify alternative materials or designs to offset projected capacity shortfalls. Third, they identified and recruited industry resources in order to technically vet, test, and approve the alternatives to PA-12.

This multi-faceted collaboration overcame the challenge. Within a week of the meeting, the top OEMs had a jointly-drafted plan to expedite parts validation.<sup>31</sup> Harmonized validation ensured that suppliers didn't need different validation processes for each OEM. Suppliers from other industries, such as carpet maker Invista Inc., lent their capacity to automotive applications.<sup>32</sup> In the end, cars continued to roll off the line even though the Evonik factory was down for nine months.<sup>33</sup>

After Greenpeace waged its graphic viral video campaign against Nestlé's Kit Kat, the company decided to better understand the parts of the palm oil supply chain with whom it had no direct relationship. To do this, Nestlé partnered with The Forest Trust (TFT), an NGO (Non-Governmental Organization) dedicated to deforestation issues. In the earliest phases of the partnership, TFT mediated between Nestlé and Greenpeace, helping each to understand what the other was willing and able to do.

TFT mapped Nestlé's palm oil supply chain for "almost all" of its products that contained palm oil in the bill of materials,<sup>34</sup> starting with the brokers that supplied Nestlé and progressing upstream to the groves that supplied the broker mills. In 2010, Nestlé implemented a set of responsible palm oil sourcing guidelines (RSG); TFT acted as an auditor for deep-tier suppliers of raw materials.<sup>35</sup> TFT also provided technical aid on the ground to help the plantation operators meet national legal compliance and international certification when applicable. Recognizing Nestlé's efforts,<sup>36</sup> Greenpeace both ceased its campaign against the company and publicly thanked Nestlé for changing its policies.<sup>37</sup>

In the third example, Intel addressed the threat of conflict mineral risks by starting with an analysis of tantalum, the mineral which Intel had the most chance of managing because electronics applications dominate the tantalum industry. Intel mapped over 90 percent of its microprocessor supply chain, identifying 130 unique tantalum smelters. Intel employees traced the sources of tantalum ore by visiting 13



Conflict Minerals



Palm Oil



Rare Earth Metals

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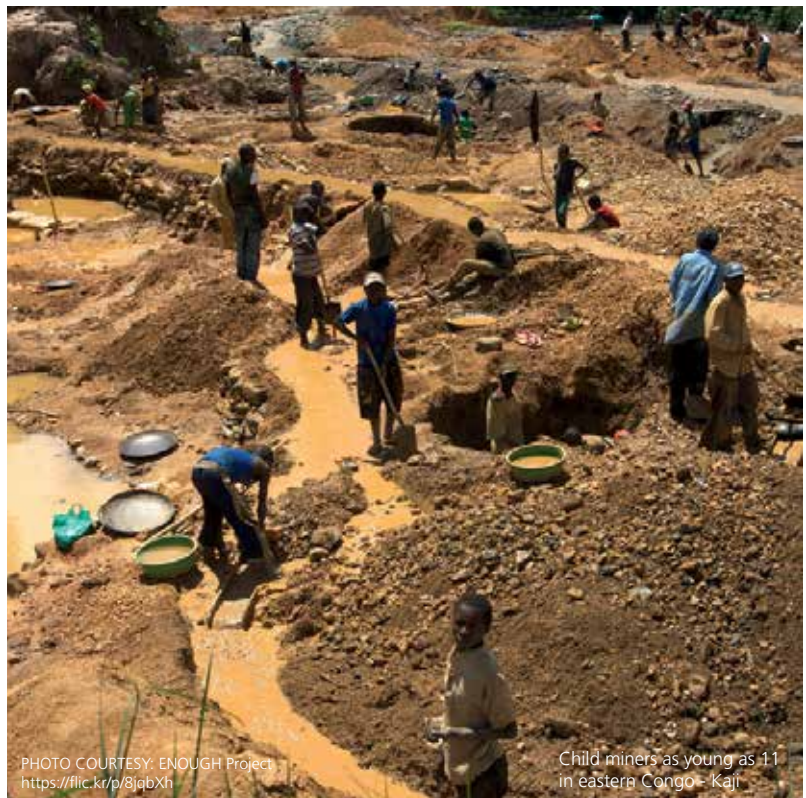


countries, conducting more than 50 smelter reviews, and touring some of the thousands of small mines with NGOs. Smelters were the last stage in the supply chain where the source of the ore could be identified.<sup>38</sup> Given the relatively small number of smelters, one logical strategy for controlling conflict minerals was to create a pool of certified smelters who ensured the provenance of purchased ores.

Identifying smelters of tantalum was one thing, but gaining their cooperation on conflict minerals was another. Why would a Brazilian tantalum smelter care about the different sources of Congolese ore or about an American chipmaker that's not the smelter's customer? Smelters sat six to seven tiers deep in Intel's supply chain, far outside the usual span of business influence that buyers have on their suppliers. To motivate smelters to cooperate with the certification program, Intel and others realized they needed to work with other companies in the electronics industry to drive change. Intel helped found the Electronic Industry Citizenship Coalition (EICC) consisting of chip-making equipment suppliers, chip-makers, contract manufacturers, and electronics OEMs.<sup>39</sup>

EICC developed a standardized social responsibility code and smelter certification process to avoid having each company try to push its own idiosyncratic codes and certifications onto deeper tier suppliers. Intel and others worked to simplify and standardize the certification process and even to reimburse smelters for some certification costs. Intel also worked with NGOs to avoid unintended consequences of responses, such as banning all DRC-sourced ore, an action which would have decimated the country's legitimate miners and further destabilized the region. As part of an effort to help legitimate miners in the DRC, Intel worked with the US Department of State to fund the Public-Private Alliance for Responsible Minerals Trade.<sup>40</sup> In January 2014, Intel announced that its entire 2014 line of microprocessors would be conflict free for all four minerals.<sup>41</sup>

The overall lessons are that companies now face greater levels of hidden deep risk due to broad and deep global supply chains. "There's no reason to think the trend towards more unforeseen events [affecting supply chains] is going to end", said Bo-Inge Stensson, vice-president for purchasing at SKF, the biggest maker of industrial bearings in the world.<sup>42</sup> Direct visibility and control may be impossible due to the complex web of indirect connections and suppliers' reticence about proprietary supply chain data. And yet three tactics can



make companies more resilient to deep risks.

First, mapping deep supply chains can help uncover key chokepoints and loci for managing risk (e.g., certifying smelters), even if dynamic churn in the roster of suppliers-of-suppliers means that any specific map will need to be continuously updated. Second, companies can partner with industry associations and NGOs (e.g., TFT, AIAG, EICC) to bring in outside expertise and knowledge of supply chain tiers far removed from the company. These collective organizations can also create critical mass for changing deep-tier supplier behavior over which a company has no direct control. Third, companies can cascade a standardized supplier code-of-conduct and risk management tools to deeper tiers – helping suppliers to become resilient and helping suppliers help their suppliers do the same.

The power of resilience cannot just reside at the level of individual firms, because firms are so dependent on a very deep web. Only by spreading the tools of resilience into the deep tiers can industries hope to prevent, detect, and mitigate the serious risks that lurk beneath. **EBR**

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