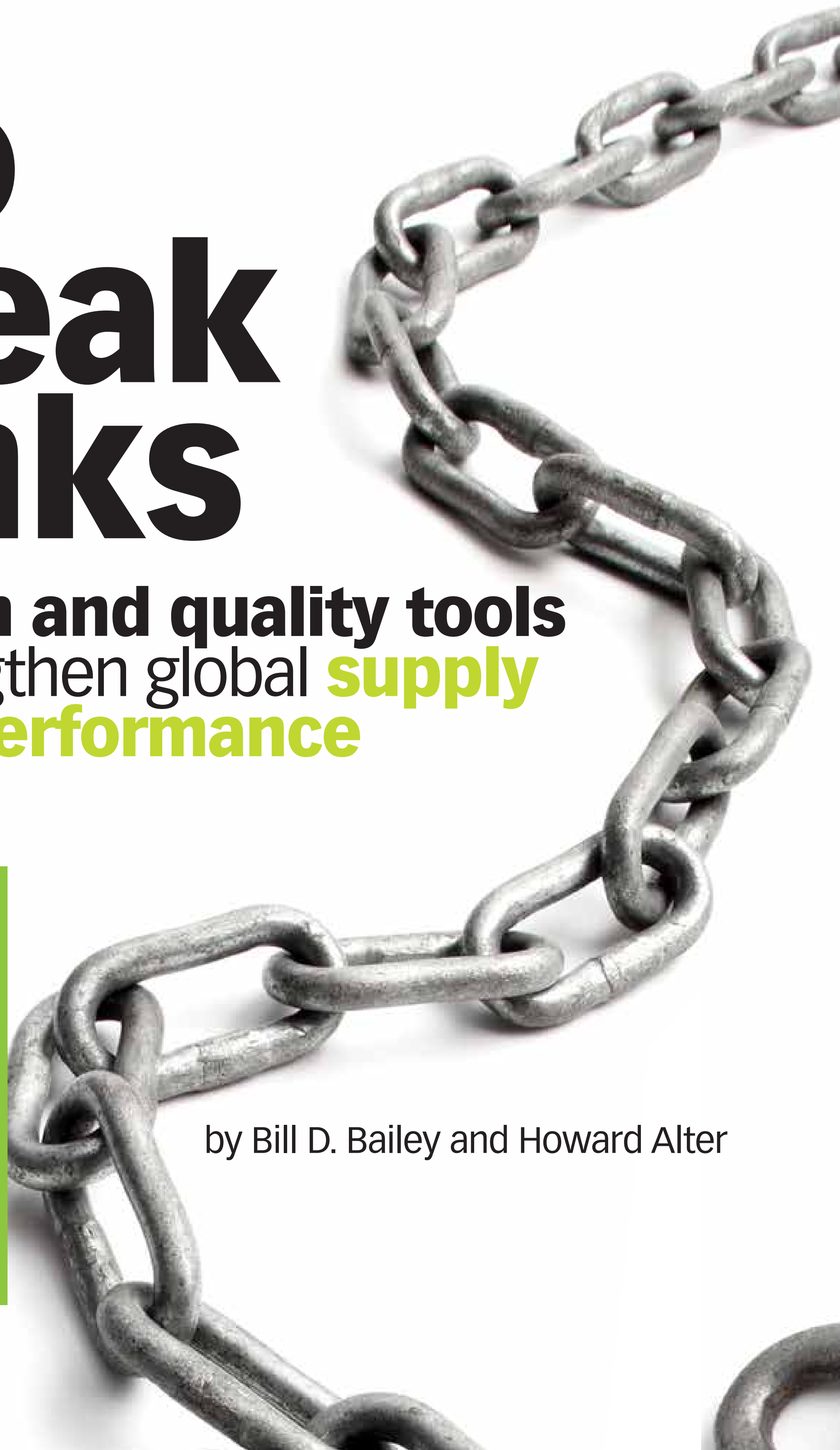
No Weak Links

Use **lean and quality tools** to strengthen global **supply chain performance**



by Bill D. Bailey and Howard Alter

In 50 Words Or Less

- When a global telecommunications organization began outsourcing manufacturing operations, it added waste to its supply chain, resulting in suboptimized performance.
- The organization employed tools such as value stream mapping, the eight rights and a plan for every part to evaluate the system to identify and remove inefficiencies.

DURING THE PAST 20 to 30 years, there has been an accelerated effort to move product manufacturing to the lowest-cost location. In the case of complex products and supply chains, this can lead to suboptimization of the supply chain system. Suboptimization may occur when the pursuit of the lowest piece price actually adds cost to the system.

A systems approach to analyzing an entire supply chain to determine nonvalue-added activity—some of which is introduced through the pursuit of low-cost suppliers—can help to optimize and rationalize a supply chain and result in cost savings and efficiency improvements.

Consider a case study involving Company X, a global telecommunications organization. Four years after outsourcing 80% (by revenue) of its product manufacturing, the organization faced price pressure because its manufacturing costs were higher than those of the competition. Years before outsourcing, the organization had implemented quality circles and *kaizen* events with some success. Labor costs were still too high, however, especially when competitors outsourced their products to low-cost countries, undercutting the prices offered by Company X.

Soon after implementing its outsourcing initiatives, some of the suppliers to Company X began conducting *kaizen* events that generated some cost savings. One *kaizen* event reduced labor costs on one product line by 40% with a 0.5% improvement in throughput yield. Chasing cost savings this way, however, did not address the waste built into the supply chain system.

Pursuit of the lowest-cost supplier added complexity and global distance to the supply chain. The optimization of component costs suboptimized the system, adding waste in movement and excess handling, which compounded the effect of quality problems. Quality problems, such as spring-plating issues and shipping damage, added to supply chain waste. Patchcord (a length of cable) throughput yield was calculated to be only 88.7% by the supplier.

After some research, the organization decided to use the lean tool value stream mapping (VSM), along with the "eight rights"[1] and "seven supply chain wastes"[2] to better understand its complete supply chain and to help avoid suboptimization.

Lean in the supply chain

Lean manufacturing grew in popularity in the United States throughout the 1990s. By the mid-2000s, U.S. organizations were increasingly outsourcing their manufacturing base to Asia and other low-cost labor locations. During this time, American manufacturing organizations greatly increased their supply chain investments. Because improving service response times to customers is a cornerstone of lean, many organizations saw value in applying the method to the supply chain.[3]

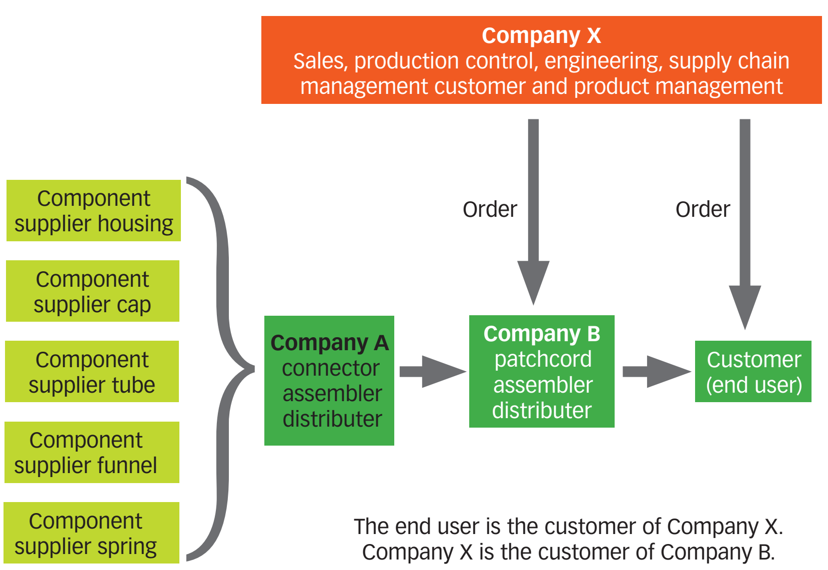
Customer-supplier relationships related to Company X's case study are illustrated in Figure 1. The supplier is responsible for purchasing components from the customer's list of approved suppliers and builds the product using the customer's processes, drawings and specifications. The supplier ships the completed product directly to the end user.

Success in a lean supply chain depends on trust between supplier and customer.[4] Lean supply chain improvement project changes often result in smaller lot sizes and reduced inventories. These are important benefits, but there is cost involved in making these changes. If the supplier is expected to absorb the costs and the customer captures all of the gains, this may threaten the sustainability of the supplier-customer relationship and of the entire supply chain system.[5]

Lean thinking leads to an understanding that in a constantly changing environment, there is always room for improvement by evaluating all the steps and removing waste.[6] It is necessary that the entire supply chain be evaluated as a system from top to bottom. The overall objective is to remove waste and its resulting cost.

After an organization decides to apply lean to its supply chain management, it must recognize that all production process steps in an organization and its supply chain are inherently tied to the end customer. In this case, Company X managed the supply chain. Its product manager defined quality and delivery requirements and price points, and acted as a representative for the end user.

Touchless supply chain / FIGURE 1



When evaluating a supply chain, remember that "the supply chain is not just the movement of products, but the linkage of steps required to provide value" for the end user.[7] Key considerations include total cost impacts resiliency and opportunities to improve overall value for the final customer and shareholders of Company X.

Resiliency includes the mitigation of risk in the supply chain. Understanding cost impacts requires systems thinking and evaluation of the total cost of ownership, including logistics, export and customs, inventory carrying and supplier product costs. Table 1 shows a list of wastes typically found in any supply chain.[8] The list has been modified for this case study. These wastes generate significant costs in a supply chain and can be detected easily using a supply chain VSM.

Supply chain wastes / TABLE 1

Type of waste	Example	Measurement
System complexity	The use of multiple suppliers in multiple locations, and attendant inventory storage and transportation waste.	The cost of the system or the delays created by excess complexity.
Lead time	Generated by procurement when negotiating lead time with supplier or delays built into the transit process.	Cost to the system for the delays and waste of excess inventory.
Transport	Wasted effort to ship product or wasted distance in the transportation process.	Dollars wasted in transport.
Space	The space needed to transport product on a trailer or store product in raw material inventory prior to use.	Can be measured in cubic feet of space or dollar value of that space.
Inventory	Inventory beyond what is needed to serve customers and satisfy the process.	Dollar value of excess inventory and the cost of maintaining it.
Human effort	Wasted movement and motion of a worker or workers, or losses due to accidents.	Wasted time and workers' compensation insurance costs.
Packaging	The costs associated with over or under packaging resulting in waste or product damage in transit.	Cost of repeat shipping and product replacement.

Eight rights

To understand the supply chain, it is necessary to evaluate many characteristics of supplier performance. Specifically, eight characteristics of products and services in a lean environment—known as the eight rights—must be evaluated and understood.[9] The eight rights include:

1. The right product.
2. The right quantity.
3. The right condition.
4. At the right place.
5. At the right time.
6. From the right source.
7. At the right price.
8. With the right service provided.

While there isn't a one-to-one relationship between the eight rights and the seven supply chain wastes, the supply chain wastes collectively can be seen as root causes of poor performance on the eight rights.

The most common tool used to address the eight rights is a plan for every part (PFEP).[10] PFEP is used in the planning for all new parts and suppliers. It is a holistic tool in which all supply chain performance characteristics of a purchased component are documented. A PFEP allows an organization to drill down into details of the supply chain and determine optimal methods to manage suppliers so complexity can be driven out.

The eight rights are a subset of a PFEP in that they allow for the measurement of critical performance parameters of purchased parts for every shipment received. Each right is measured by the percentage of successful executions. The "perfect execution score" is derived by multiplying together percentage (proportion) of successful executions for each of the eight rights.

The percentage calculated for perfect execution can be used as a simple overall combined measurement to monitor supplier performance and be used to determine receiving inspection metrics and supplier performance scores. Remember, though, that this doesn't necessarily estimate the percentage of parts that are perfect for all eight rights simultaneously because the eight rights aren't necessarily statistically independent of one another.

A PFEP is a living document and requires updating based on the perfect execution scores. Specific actions should be taken when a supplier's perfect execution score indicates an execution problem. Table 2 (p. 18) shows the perfect execution scores before (current state) and after (future state) improvement in this case study.

Value stream mapping

VSM is used to evaluate the entire supply chain for opportunities to remove waste and cost and to mitigate risk.[11] A VSM is a visual map similar to a flowchart that shows the path and flow of physical products and electronic information in a supply chain—from raw material inception through delivery to the customer. A VSM consists of symbols that represent each step in the process, such as a storage point or transportation method. Transportation lines are detailed to show physical products and information.

The PFEP tool has been used in conjunction with VSM to create a comprehensive supply chain management evaluation tool. The PFEP tables (Table 2) provide measurements of supplier performance for the eight rights. When poor performance is identified, VSM is used to identify the seven wastes, which may be the cause of the poor supply chain performance.

Plan for every part performance / TABLE 2

Current state

	Connector	Spring	Connector	Connector assembly
Lead time	21 days	6 weeks	8 days	**25 days**
Average inventory	25k	200K	45k	33k
Batch size	5k	300K	5k	5k
MoQ	5k	300K	5k	10K
Perfect execution	**99%**	**55%**	**98%**	**89%**
Right quantity	100%	100%	100%	100%
Right product	100%	100%	100%	99%
Right place	100%	100%	100%	99%
Right time	100%	80%	98%	98%
Right quality	99%	95%	100%	98%
Right source	100%	100%	100%	99%
Right cost	100%	90%	100%	97%
Right service	100%	80%	100%	99%

Future state

	Connector	Spring	Connector assembly
Lead time	21 days	2 weeks	**8 days**
Average inventory	25k	100K	10k
Batch size	10k	100K	5k
MoQ	10k	300K	5k
Perfect execution	**99%**	**~100%**	**95%**
Right quantity	100%	100%	100%
Right product	100%	100%	100%
Right place	100%	100%	99%
Right time	100%	100%	98%
Right quality	99%	100%	99%
Right source	100%	100%	100%
Right cost	100%	100%	100%
Right service	100%	100%	99%

MoQ = minimum order quantity

Plan-do-check-act

The plan-do-check-act (PDCA) cycle also can be used in conjunction with PFEP and VSM to evaluate a supply chain and remove waste. The plan phase begins when the PFEP and current-state VSM are created by a cross-functional team representing all departments involved with supply chain management. If a perfect execution score does not exist, it can be established based on existing data, such as on-time delivery and receiving inspection metrics.

The team performs root cause analysis of suppliers that exhibit a poor perfect execution score and evaluates the VSM to identify potential wastes. Some areas in which waste might be found include:

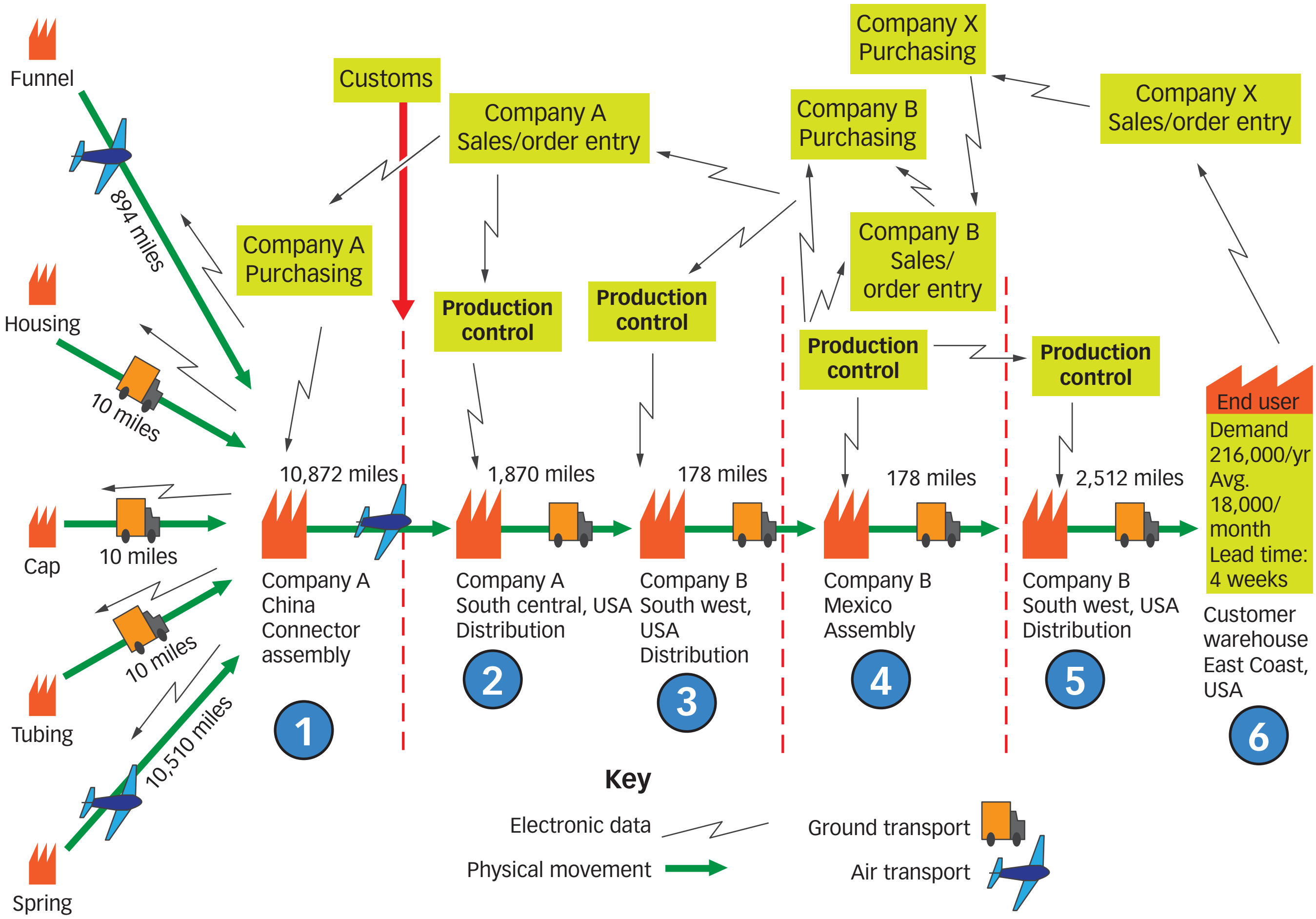
- Distances between suppliers and customers, including international barriers.
- Modes of transportation.
- Warehousing needs.
- Inventory quantity and costs.
- Lead times.
- Container costs for overseas shipments.
- Special packaging needs.

In the do stage, the team selects improvements to be implemented based on estimated cost reductions (to be achieved by minimizing transportation) and risk. The team creates a future-state VSM based on the selected improvements.

The check phase includes a review of the plan and do phases. The cross-functional team evaluates each proposed change to verify potential cost savings and ensure changes will not adversely affect product and service quality, or add complexity or other wastes into the system.

The act phase is used to implement the selected changes and measure the results. These changes may initiate the qualification of new suppliers and would prompt communication of new requirements through

Current-state value stream map / FIGURE 2



the supply chain as needed. Data are typically gathered and used to revise the eight rights, perfect execution and receiving inspection, and to verify supplier performance targets.

Company X case study

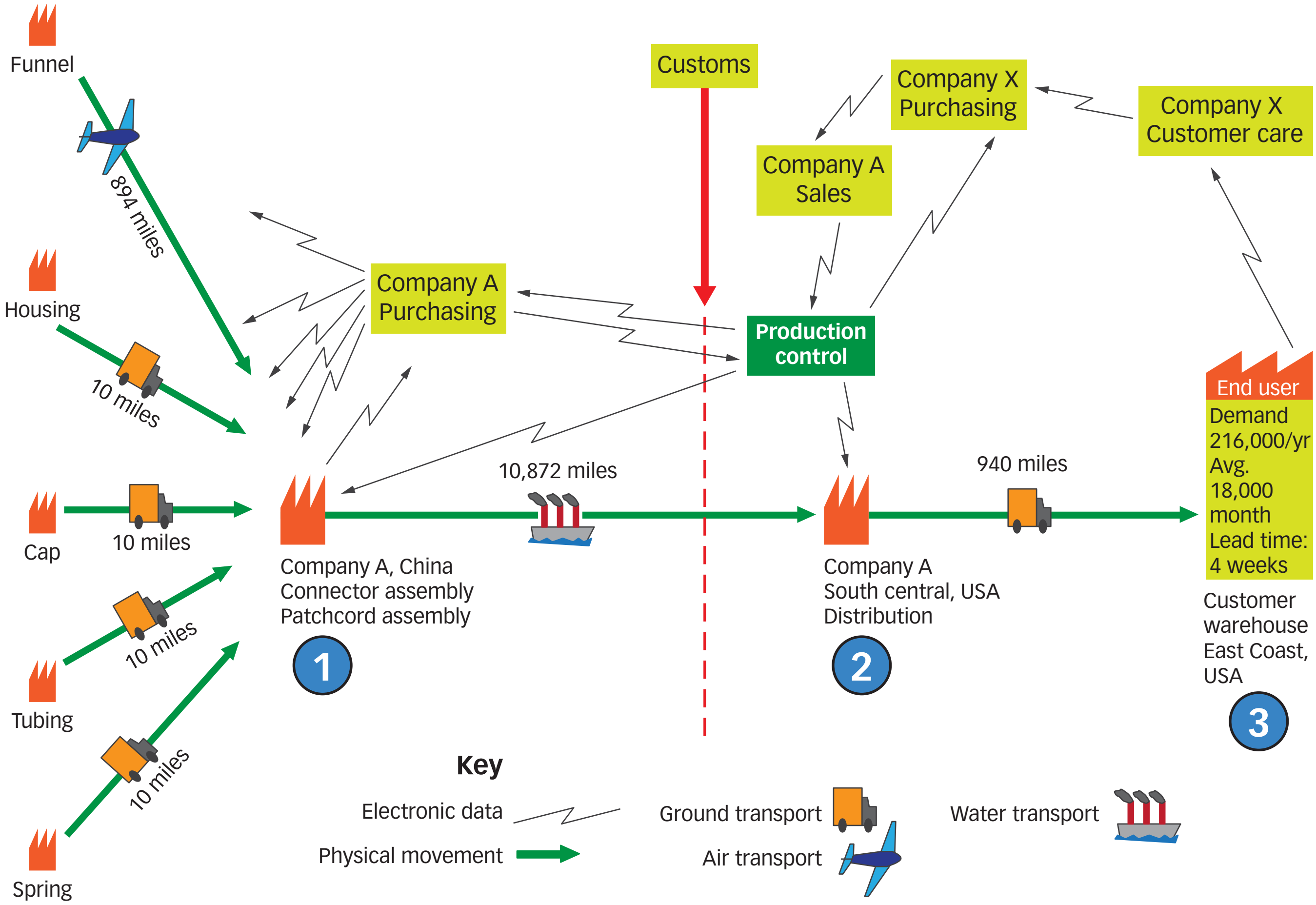
When Company X launched its improvement project to drive waste out of its global supply chain, it was operating a touchless supply chain. This is one approach to global sourcing and can be explained as: "Rather than actually touch the product, large brands will simply orchestrate all the moving parts that comprise their supply chain."[12]

A touchless supply chain was developed by Company X during a previous outsourcing effort. Company X handles information and manages its suppliers, but never takes possession of the product. Company X places an order with Company B.

Value stream map improvements / TABLE 3

Improvement	Status	Benefits
Qualify a new spring supplier that is in close proximity to the connector assembly plant.	Implemented	Saved 10,500 miles of freight (for each trip, every six weeks) for springs. Improved "perfect execution" score from 55% to nearly 100%.
Qualify the connector assembly plant to assemble the final product: patchcord assembly.	In process of being implemented	Saved an additional 3,628 miles of transport costs. Allowed the assemblies to be built using lower cost labor. Saved 10% on transportation costs. Saved on customs fees and delays into and out of Mexico. Saved on transactional fees and administrative fees by eliminating one supplier.

Future-state value stream map / FIGURE 3



Company B extends the order to upstream suppliers (Company A) and also ships directly to the end user (Figure 1, p. 16).

The current-state VSM (Figure 2, p. 19) shows the touchless supply chain for a connector assembly made up of a connector and a final assembly patchcord (depicted in the illustration). The patchcord is the finished product delivered to the end user. The current-state VSM (Figure 2) shows six major steps in the supply chain.

Step one is the connector assembly process performed in China by Company A. Company A used five local Chinese suppliers to provide the components for the connector assembly process. In step two, the assembled connector was shipped to the Company A distribution center in south central United States. The Company A distribution center then shipped the connector to the Company B distribution center in south west United States (step three), which sent it to a contract manufacturer in Mexico (step four) for final assembly into the patchcord.

After the finished product (the patchcord assembly) was assembled, it was shipped back to the Company

Patchcord assembly

Spring and tubing are hidden by housing.

B distribution center in south west United States (step five). In step six, the patchcord assembly was shipped to the end user's warehouse on the East Coast.

The current-state VSM (Figure 2) shows the flow of physical products and electronic data. The connector component suppliers are on the far left of the VSM, and the end user is on the far right. This arrangement reflects the flow of materials. The flow of information goes from the end user to Company X to Company B and back through the supply chain. The shipping distance in mileage is shown beneath the truck and airplane symbols. Note the map is not to scale.

Table 3 (p. 19) shows supply chain improvements identified through the VSM process. The new supply chain process contains only three major steps instead of six. The connector and patchcord assembly are performed in China by Company A (step one). Company A sends the patchcord assembly to its warehouse in south central United States (step two) and on to the end user on the East Coast (step three). The new process completely eliminates Company B and three of the six steps.

Although sourcing the patchcord assembly to Company A may not have resulted in the lowest cost for that particular step, the reduction in complexity has resulted in significant improvements in the system. The future-state VSM (Figure 3) shows these improvements. The overall savings between the current and future VSMs are 14,298 miles annually.

The poor supply chain performance for the spring was a result of the compound effects of the lack of perfect performance on time, quality, cost and service. The perfect execution (Table 2) for the newly sourced spring improved from 55% in the current state to nearly 100% in the future state. The connector assembly improved from 89 to 95%. Total lead time was reduced from 96 to 43 days. Connector assembly quality increased from 98 to 99%, and performance on right cost improved from 97 to 100%. In addition, the 14,298 miles saved has an impact on the organization's overall carbon footprint.

Future improvements planned

Quality and delivery levels for Company X also can be improved through less product movement, and future improvements will include reduced inventory levels. A next step in lean implementation might be a *kanban* system to manage product flow. *Kanban* is a visual or automatic signal system that triggers replenishment of materials.[13] This will facilitate a change to a pull rather than a push system to align production more closely with customer requirements, and further eliminate waste and reduce work in process inventory.

These savings will be calculated after the improvements have been qualified and implemented. Additional improvements, including expanding this approach to other products, are being developed.

This case study demonstrates the value of systems thinking in supply chain management. Keep in mind that this study focused on a single assembled product, so it represents a small sample of the entire Company X supply chain. What the organization learned from this project can be leveraged across all its product offerings for greater efficiencies and even greater savings. QP

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