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LEAN brings results

Manufacturers can no longer suffer waste, inefficiency.

By Anil Kumar and C.K. Yin

Idle time, overproduction, product defects, inefficient machine processes are just some headaches for manufacturers. In the past, process engineers tolerated idle time and allowed overproduction as the inevitable side effects of mass production. And all the while, engineers wrestled with reducing product defects and improving machine process efficiency. However, times have changed to such an extent that manufacturers can no longer suffer any form of waste or inefficiency.

Lean manufacturing has been around industrial settings for almost 50 years, but it is a relatively recent addition to the electronics manufacturing services (EMS) sector and electronics in general. Sometimes known as the Toyota Production System, named after the automaker that first popularized this approach to product assembly, lean manufacturing seeks to eliminate waste (muda) and increase value throughout the supply chain. By definition, waste is any activity for which the customer is unwilling to pay.

Spirent Communications' SmartBits line of test equipment experienced too much work in process (WIP) inventory accumulating at workstations along the manufacturing line and too many pieces of WIP that required rework to correct defects from initial production. To resolve these problems and meet a mandate for dramatic improvement in quality, flexibility, and delivery, production had to go to lean manufacturing. In the process of transforming the Spirent line, one goal was to improve the current quality yield of 83.9%.

Before implementing lean manufacturing, incomplete Spirent build kits piled up on the production line. After implementation there is much less clutter in the factory.

Out of sync

With $1.9 million worth of WIP inventory tied up on the plant floor at any given time and a manufacturing cycle time of eighteen work days, Spirent SmartBits testers took unnecessarily long to produce product. The traditional batch method of processing board and box builds posed too many out-of-sync steps and overlapping logistics problems.

In a batch-and-queue process, straight-line printed circuit board assembly (PCBA) setups did not permit the component placement function at one end of the line to communicate with the test-and-debug function at the other end, resulting in missed opportunities to correct problems as testers made the boards. Instead, if a repetitive manufacturing defect occurred during a board run, the entire batch ended up at the testing station before they detected any problems, which would lead to an entire batch of board rework. In a lean manufacturing environment, only one board would need rework because workers would catch defects before WIP buildup. The result: An overproduction of PCBAs with too many product defects (only 87% passed visual inspection) overwhelmed the testers.

The commitment

Implementing lean manufacturing at an EMS operation requires the commitment of the entire production team as well as senior management. For the Spirent production line, we identified the core team members who would require training in the precepts of lean manufacturing techniques and resources. After preliminary training, the team could readily identify the different forms of waste in the supply stream.

With all personnel properly briefed, the objective was to reduce the problems of idle time, overproduction, and product defects—the three major forms of waste on the Spirent line. Then we pinpointed details for each of the manufacturing activities. But before we could implement a lean manufacturing model, we developed a "spaghetti" diagram that showed the original complexity of the workflow with its many starts, stops, jumps, and backtracks. Our challenge: Untangle the strands of spaghetti.

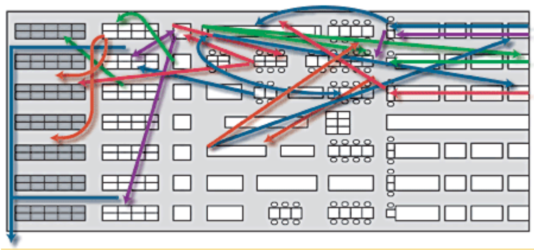
Straighten it out

Key to untangling this spaghetti of manufacturing processes was value stream mapping, which assessed the worth of every step in the process as value-added, value-enabling, or nonvalue-added. After categorizing each nonvalue-added step into its appropriate breakdown of one of seven different types of muda—i.e., overproduction, product defects, idle time, overprocessing, excess motion, built-up inventory, or unnecessary transportation—the end result was that only 2% of the original batch process actually added value. Another 10% of the process enabled the potential for added value, meaning that 88% of the entire process was pure waste.

One pivotal example of waste found within the Spirent manufacturing line involved the process for kitting all the components for a SmartBits board build. With 163 separate Spirent stock keeping units (SKUs) in the manufacturing resource planning system, it was vital that all the correct parts be staged together for product assembly. In addition, many parts in a particular SKU saw use occasionally, resulting in a scenario where 102 of the 163 SKUs underwent a single build in the prior six months. Incomplete kits remained in the staging area, generating idle time while the program manager waited for delivery of missing components. At one point, nearly $800,000 worth of inventory sat in raw materials—almost half as much as WIP.

Other times, the program manager released incomplete kits to the production floor, expecting a supplier to deliver as promised. Unfortunately, parts did not always arrive on time and board builds sat unfinished on the line, creating yet another choke point where inventory accumulated. In the extreme, one board build required five different kit pulls for five missing parts. This resulted in extra trips from the staging area to the line—all instances of unnecessary transportation and a waste of time and money.

Of course, board build constitutes only part of the production process for the SmartBits testers. Once workers completed them, the PCBAs needed to go into their corresponding chassis. Many chassis kit builds also experienced parts shortages. And because the PCBA and chassis builds were out of sequence, WIP inventory increased again.



A "spaghetti" diagram shows complexity of the workflow.

A CFM line lays out in a U-shape or racetrack configuration.

Needed change

To stop the madness, one simple rule became effective: The program manager will release a Spirent box-build work order if and when the PCBA and chassis kits are complete and ready for staging. Once that hemorrhaging was under control, we analyzed where WIP inventories were occurring on the production line, and for each nonvalue-added step we verified that idle time and product defects were indeed two of the primary forms of waste. Based on this analysis, we identified the root causes of waste and developed a future-state map for material and information flow to improve the manufacturing process step-by-step.

Two sides, not one

Part one of converting from a batch-and-queue process to a continuous flow manufacturing (CFM) process necessitated that two separate one-sided batch lines be consolidated into a single, continuous two-sided CFM line. This required some additional equipment to meet the time requirements (takt time) to produce a board.

The second stage of transformation entailed the layout of the CFM line in a U-shape or racetrack configuration. This increased the information flow among production workers to troubleshoot and solve product defects. Also, with the knowledge that WIP buildup is at times necessary due to an imbalance of testing and upstream assembly processes, grouping together several testing functions (initial test, burn-in test, functional test, etc.) enabled the operators to flexibly shift from one testing task to another as the pull of the line dictated.

Instituting a pull-based CFM process is one of the crucial elements to making lean work for a product line with high order variability and high sensitivity to overproduction. Only when a new-order signal (kanban) comes from the customer does production occur. Once the pull signal stops, the line stops, which eliminates the possibility of overproducing WIP.

Results-driven

The initial deployment of the lean manufacturing model reduced WIP inventory for the Spirent SmartBits line to $380,000 and cut cycle time to three days, which enabled the team to more accurately project delivery times and quantities. In addition, quality output increased to a total process yield of 92.2% after initial visual inspection, and Spirent's final inspection yields improved to 99.7%.

By conducting further small, incremental process improvements, known as kaizen, the company aims to improve results even more, especially as they begin to collaborate with suppliers.

Behind the byline

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Skinny on lean

Because the idea behind lean manufacturing started in earnest at Toyota, many commonly used terms were in Japanese. To this day, most if not all lean practitioners freely use these terms in English, Spanish, or whatever language found in the workplace. Here are some key lean terms:

Kaizen – Continuous, incremental improvements of an activity to create more value with less waste.

Kanban – A small card attached to boxes of parts that regulates pull by signaling upstream production and delivery.

Muda – An activity that consumes resources but creates no value, i.e., waste.

Takt time – The available production time divided by the rate of customer demand. For example, if customers demand 240 products per day and the facility operates 480 minutes per day, takt time is two minutes. Takt time sets the pace of production to match the rate of customer demand and becomes the heartbeat of any lean system.