Douglas Electrical Components

Applying Lean Manufacturing To The Job Shop

Although lean has its roots in high-volume, low-mix factory environments, implementing lean in the Douglas Electrical job shop has produced a range of both company and customer benefits.

Lean production is one of the most important manufacturing strategies to emerge in the last century. By minimizing waste, which is considered anything that doesn't provide value in the manufacturing process, lean improves efficiency without sacrificing productivity, enabling manufacturers to deliver higher quality products to their customers at lower costs.

A perceived issue with lean, however, is that it's typically thought to work best in high-volume, low-mix settings—or manufacturing lines that churn out the same product day in and day out. While it's true that lean does have its roots in these kinds of operations, the idea that it can't be applied to other types of processes is a misconception. With the right strategy and planning, lean can be used in other manufacturing environments, including job shops that have a high-mix of products at relatively lower volumes.

Beginning in 2008, we have applied lean to our manufacturing operation, and it is now a pervasive force in improving the efficiency of our factory. Lean provides our customers with several benefits, including gains in safety, quality, productivity and capacity. In this paper, we'll dig into those benefits, as well as the lessons we learned by applying lean in a job shop environment.

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LEAN AND THE NATURE OF JOB SHOPS

Lean manufacturing is a systematic method for minimizing waste in manufacturing (see "A Brief History of Lean" sidebar). Lean breaks down processes as being value added or non-value added tasks. In other words, does a particular process physically transform a material or product into something the customer wants, which qualifies it as a value added task? Or does the process eat up time, materials, labor and floor space without physically transforming the material or product into something the customer wants, which would be a non-value added task? The purpose of lean is to eliminate those non-value added processes.

Traditionally, lean has not been applied to job shop operations, which often rely on batch operations and have frequent manufacturing changeovers. But that doesn't mean it can't be done.

In fact, we've applied lean manufacturing techniques to our entire line of hermetically sealed electrical components, which use proprietary epoxy formulations to create robust seals around connectors, wires, circuit boards, flex circuits and other electrical components. Our products are used in extreme applications and routinely encounter pressures above 5,000 psi, vacuum to $1x10^{-10}$ Torr and voltages in excess of 30 kV. And whatever the environment, these products have to provide true hermetic performance with leak rates as low as $1x10^{-9}$ cc-He/sec.

SEVEN SOURCES OF WASTE

1 TRANSPORT
Moving products that are not actually required to perform the processing.

2 INVENTORY
All components, work in process and finished product not being processed.

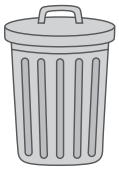
3 MOTION
People or equipment moving or walking more than is required to perform the processing.

4 WAITING
Waiting for the next production step.

5 OVERPRODUCTION
Production ahead of demand.

6 OVER PROCESSING
Resulting from poor tool or product design creating activity.

7 DEFECTS
The effort involved in inspecting for and fixing defects.



A BRIEF HISTORY OF LEAN

Although it has its roots in earlier manufacturing systems, lean as we know it today was developed and systemized by Toyota after World War II. In Japan's fragile Post War economy, industrial engineer and businessman Taiichi Ohno recognized that in order to avoid overproduction, manufacturing should focus on Pull (building to order), rather than Push (building to forecast or marketing targets).

Ohno's ideas culminated in the Toyota Production System (TPS), a "just-in-time" manufacturing strategy in which each process produces only what is needed by the next process in a continuous flow. By stamping out sources of waste, Toyota could quickly and efficiently manufacture high-quality vehicles that satisfied customer requirements.

Single-piece flow, a centerpiece of lean production, eliminates all non-value added tasks.

While we produce many standard products at high volumes for the automotive and industrial markets, we also produce a steady stream of shorter-run, custom products for military, aerospace, energy exploration and emerging technologies.

Before implementing lean, we employed more typical batch-and-queue operations to assemble the connectors, wires and circuit boards that go into our products. We likewise had batch operations to mix, cast and cure our epoxy encapsulants. Batching all these operations meant our lead times were longer, our work-in-process (WIP) inventory was greater and because QC was a separate department with batch processing, any quality issues remained virtually hidden until the end of the manufacturing process. But by implementing lean and modifying it slightly to match the demands of our job shop, we were able to successfully move away from this less efficient model—and unlock a range of benefits for both our company and customers.

ACHIEVING SINGLE-PIECE FLOW

Our first step in implementing lean was to transform our batch operations to a more lean-friendly manufacturing style. That's where single-piece flow comes in. This centerpiece of lean production essentially eliminates all non-value added tasks and sources of WIP between steps, such as the time wasted if a product needs to be set down, for example. In a single-piece flow system, production of individual products takes place in manufacturing cells. Using Standardized Work Instructions (SWI), we're able to design detailed production flows on paper, keeping in mind the quality and consistency of the finished product, process throughput, operator safety and customer needs. We then make the design a reality on our shop floor and begin manufacturing the product—all within the span of a few days.

One of the only exceptions to single-piece flow in our factory has to do with our ovens, which we use to cure the epoxy in our components. This process is one of the only compromises we've had to make in adopting a true lean factory model. In addition to a few material preparation processes—wire cutting, for example—it is one of the only remaining batch operations in place in our factory.

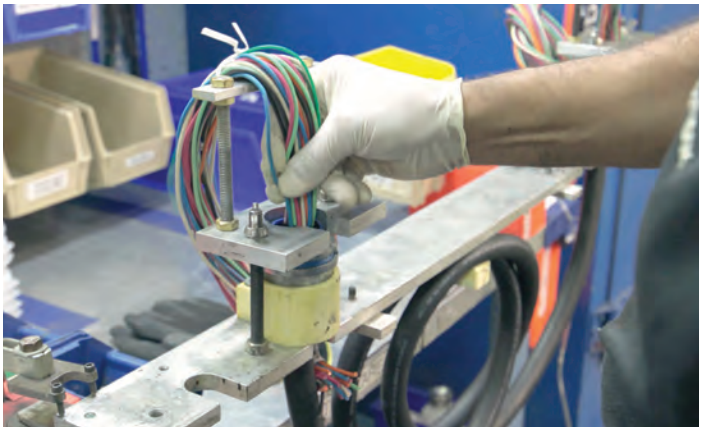
THE POWER OF TEAM-BASED KAIZEN

In addition to maximizing single-piece flow, we have also embraced other traditional lean principles, such as *kaizen*, an organizational philosophy based on continual improvement. To help us brainstorm, design and implement single-piece flow systems, we organized kaizen events, in which we tasked teams of people from across the organization with solving specific problems related to leaning out specific manufacturing cells.

Our first kaizen, for example, focused on our largest single product line. By the end of the week, after implementing our new strategies, we were able to reduce labor costs on this particular component from $140 per piece to less than $50. Through this event and all subsequent events like it, we are able to identify and eliminate non-value added labor wherever possible. Each time we go back, we find more, making kaizen-related improvement a never ending process.

The benefits don't end there. Thanks to lean, since 2008, we were able to reduce:

- Labor content by 50 percent.
- Indirect labor costs by 20 percent.
- Our work-in-process inventory from $650,000 on a daily basis to under $200,000.
- Our finished goods inventory by 70 percent.



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HOW A LEAN MODEL BENEFITS OUR CUSTOMERS

Lean has enabled us to achieve a just-in-time delivery system, and our customers have seen a dramatic improvement in our ability to deliver parts to them as needed. Because our manufacturing processes are faster and more efficient, our customers have experienced improvements in the following areas:

- **Speed to market.** Using SWI, we can design and deploy manufacturing cells for individual products within a few days of receiving a customer order. As a result of our faster manufacturing process, our customers get to market more quickly.
- **Manufacturing at scale.** Lean makes it cost-efficient to produce goods at relatively low volumes. As products scale to higher volumes, we can then seamlessly scale the size of our manufacturing lines. Moving from product prototype to low-volume production to high-volume production therefore becomes a cost-efficient and friction-free process.
- **Higher product quality and yields.** Thanks to single-piece flow, quality issues that arise on the production line are no longer hidden: once a problem is identified, steps are taken to strengthen the process and prevent the mishap from occurring again. As a result, higher quality products can be manufactured in higher quantities and at faster speeds—while at the same time, reducing rework costs.

For more information contact the engineering team at Douglas Electrical or visit www.douglaselectrical.com.