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Figure 1: Six tool sets are at the core of a lean enterprise program.

The Transformers

By Jorge L. Larco, Elena Bortolan and Michael H. Studley

Lean manufacturing can transform build-to-order, complex and variable businesses.

Today, most leaders of medium-size and larger businesses have at least some experience with lean manufacturing. Based on our experience, leaders in more than 50 percent of the companies around the developed world have read about, discussed and implemented at least a few lean concepts.

Back in 1999, when we published our first book, "Lean Transformation," business managers were just beginning to know what constituted a lean enterprise. Many U.S. companies were already implementing lean concepts, and a few companies in Europe were beginning to experiment with them.

Consequently, in that book, our primary goal was to create a tool that would explain in simple, everyday language the basic concepts and practices of lean production and to show practical examples of lean enterprises in action. Initially, the driving factors were the needs to reduce costs, be more efficient and offer higher service levels than competitors to gain market share and grow a business. For these reasons, most lean transformations at that time were related to production.

Basic Concepts

Why a lean enterprise? Global commerce has become very competitive. The competition isn't only about price, but also quality and delivery. More manufacturers are required to customize

products to specific needs and to efficiently produce small volumes.

The lean enterprise can meet these challenges. Companies that properly apply these principles can obtain in the first year:

- 30 to 50 percent improvement in productivity,
- 200 to 400 percent improvement in inventory turns,
- 40 to 60 percent reduction in quality problems, and
- 35 to 50 percent reduction in lead time.

These numbers are based on benchmark data for Japanese and U.S. companies and are confirmed by our direct experience in converting more than a 100 companies throughout the world to lean. Not all companies achieve these results. Success depends on top management's level of commitment and participation, the priority afforded the implementation and the achievement of the program's various goals.

There are six tool sets at the core of a lean enterprise program (Figure 1).

1. Workplace environment: The physical and information space is well organized, clean and safe, facilitating productivity and creating a world-class impression for employees and customers.

2. Flow: Value-added functions and activities flow and waste is relentlessly eliminated.

3. Quality or Six Sigma quality: Quality is built into every product and process by everyone in the organization.

4. Empowered teams: Decisions are made at the lowest possible level with no approvals from higher levels.

5. Visual management: Key performance indicators and information to support day-to-day activities are visually available to everyone.

6. Pursuit of perfection: Continuous pursuit of perfection is integrated as a process into an organization's fabric.

These should be applied systematically to an organization's production as well as to its indirect areas. If all of them are addressed, a company can fully transform into a lean enterprise.

Market Challenges

Whatever the industry, every customer wants something different. They want their goods and services to be of the highest quality, the lowest cost, customized to their needs and delivered on time. This has led companies across the globe to adopt the Toyota production system, also known as lean manufacturing. It allows them to produce the highest quality products at the lowest possible costs, and to deliver them quickly using pull scheduling—meaning products are not produced until an order is received.

A manufacturer that can deliver a high-quality customized product at a low price—and do so when the customer wants it—stands a good chance of becoming an industry leader.

But what if the products a company makes are complex and are offered in many different variations? Most people think that implementing continuous-flow, just-in-time manufacturing isn't difficult for manufacturers stamping identical widgets, but they believe that integrating lean into a complex manufacturing environment, such as a job shop, may be virtually impossible. After all, complex products present a host of challenges and offering them in different variations seems to make lean processes impractical. This is not the case. We wrote our new book, "Lean Manufacturing in Build to Order Complex and Variable Environments," to show examples and offer practical approaches to implementing lean in such environments.

In highly variable environments, establishing and maintaining flow is an important goal in the lean journey, and it's true that scheduling complex and variable products from order to delivery can be challenging. But it can almost always be accomplished using the right approaches and advanced scheduling tools and software.

A manufacturer that can deliver a high-quality, customized product at a low price—and do so when the customer wants it—stands a good chance of becoming an industry leader.

Most successful companies got that way because they presented potential customers with an irresistible offer. Take FedEx Corp., a vital $27 billion company. It began with an idea laid out in a Yale University undergraduate term paper by FedEx founder Fred Smith, which according to popular lore received a C grade from a skeptical professor. The company filled a huge need at the time because the United States Postal Service provided unacceptable results. FedEx became essential by making an offer businesses couldn't refuse—guaranteed overnight delivery.

What about your company? Customers want what they want when they want it, so it makes sense to offer speed and customization.

Price Pressure

There's another factor that must be considered: the ongoing pressure to provide competitive prices and often to lower them over time. After a while, a customer expects an item's price to go down. This has frequently led to "delocalization" because one way for a supplier to lower prices is to move production to a low-labor-cost country.

But calculating savings based on lower labor costs alone can be misleading. Moving production offshore may

The steps in a highly variable environment.

Fully understand what the facility will need to accomplish:
Where the market has been,
Where the market is headed, and
The company's strategic objectives.

Determine volumes by product or family of products.

Determine the various takt times.

Define number of stations required, labor content of each station, materials, tools, etc.

Design the lines/cells layout so that products flow.

Adapt or create a daily scheduling function to support the needs of lines/cells.

Train, train and train again.

not provide the competitive advantage hoped for when every factor is considered. It may be more convenient to transform into a lean enterprise and in this way optimize resources at an existing location. This approach may be particularly wise if a company is manufacturing relatively low volumes coupled with the need to offer product customization and rapid delivery. It may be possible to fulfill these requirements at a distance, but shipping costs and times, the issues associated with engineering a particular customer need and potential quality issues ought to be carefully considered.

Becoming Lean

The future is defined by high customization, low cost, quick turnaround and ever diminishing volumes. But how does a company accomplish these and still be lean?

Perhaps a company builds something complicated, such as trucks, trailers, airplanes, machinery or automobiles. Perhaps some configurations call for features or subassemblies that can add many hours to a build, thus hopelessly disrupting an assembly line's cadence.

Sequence	Description			Lead time cumulative
		Operation 1	Operation 2	Operation 1
		minutes	minutes	minutes
Day 1				
1	Activity 1	60	0	60
2	Activity 2	48	0	108
3	Activity 3	61	0	169
4	Activity 4	47	0	216
5	Activity 5	9	0	225
6	Activity 6	45	0	270
7	Activity 7	113	43	383
8	Activity 8	44	57	427
Day 2				
8	Activity 8	42	57	42
9	Activity 9	225	0	267
10	Activity 10	26	0	293
11	Activity 11	134	0	427

Figure 2: Standardized work instructions divided by day.

Despite these challenges, complex products already are being built to order in lean environments where layout of manufacturing lines and processes take into account product variations. Additionally, because job volumes can be as small as one, it is usually not possible to have a dedicated line for a particular product. More and more companies often need a universe of machines that can be employed in many different combinations.

In the past, specialized products generally cost considerably more than standard, off-the-shelf models, but this is not always true today.

Each company must implement basic lean principles—the six tool sets—even if they must be tailored to the specific situation.

In such environments, the following concepts must be carefully designed.

■ Standardized work is a requirement. However, with high variability, it may be tricky to determine what to standardize and how to lay out the lines to ensure the continuous flow of value-added activities. To help machine operators, standardized work instructions for the complete manufacturing process must be created (Figure 2). In addition, visual tools are needed. For example, use callouts on an image to convey process information rather than writing it out.

■ Balancing may not always be possible or even practical. If parts or products are made only once, the cost of balancing may be prohibitive. So, some assumptions need to be made to be able to schedule production.

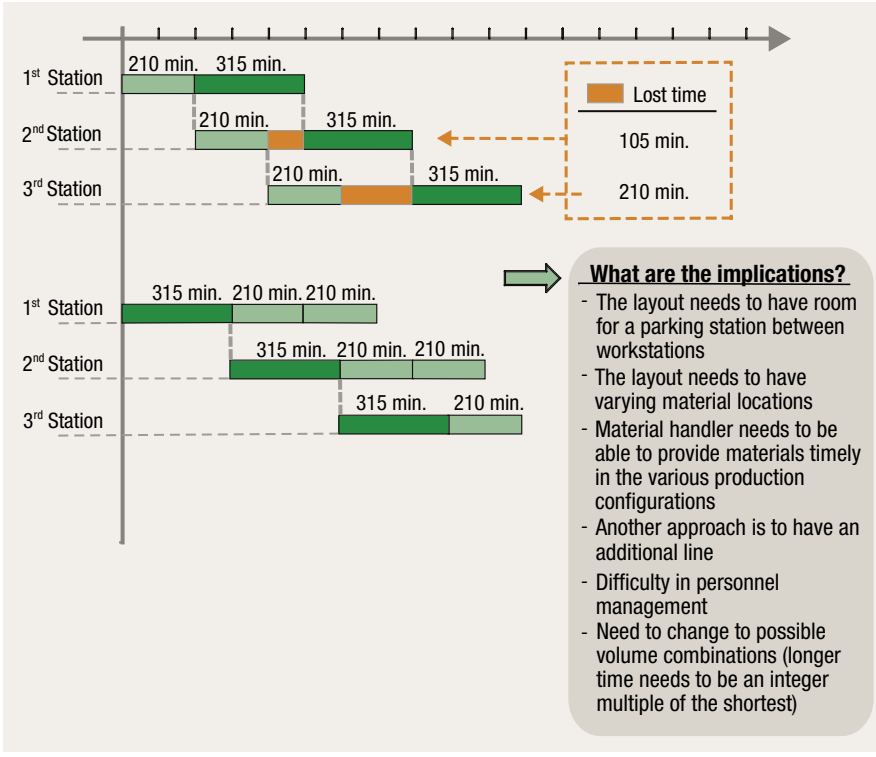

Figure 3: An optional scheduling sequence (lower half) when products with different takt times are run through the same line.

■ Flowing, which is a must, can be scheduled daily with a software-supported scheduling process. This is particularly true for products with different takt times that are run through the same line (Figure 3). Takt is German for the rhythm of a musical score. In lean production, it is the rate of sales in the marketplace—the drum beat of consumption.

The effort required to become a lean manufacturer may seem overwhelming. But think about this. The options are limited for companies facing the issues described previously. One option is to do nothing. Just keep doing what you have been doing and hope for the best. But all it takes are a couple of competitors willing and able to offer high quality, customization and quick turnaround with prices similar to or lower than yours, and your company could be driven out of business.

Having transformed many businesses, we've found that in all likelihood, the only viable option is to transform into a lean enterprise. Cost efficiency will improve dramatically. Quality will improve. Lead times will be cut. You will be able to react to the market faster and to offer just what the customers want at prices competitors will find hard to beat. CTE

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