

Lean Manufacturing

Every manufactured item must have things about it that the customer values more than they valued the original raw materials. When a manufacturing company transforms raw materials into a finished part we say that they have added value to the raw materials. In life we measure value in many different ways but we most often express the value of physical things by associating them with some monetary unit. We may say for example that a Haas MiniMill is worth or valued at \$34,995. We know in fact that that is the value of the MiniMill to Haas automation because its the selling price of that particular machine tool at the time of this writing. We also know that Haas's customers value the machine tool at least this much, they tell us so every time they buy one.

It may be, that the manufacturer or reseller of an item sets its price but the customer always sets its value. They do so every time they make a purchase.

For us to succeed as manufacturing engineers we need to work for successful companies. For companies to succeed they need to be profitable. Profit for the sale of a manufactured item is defined as:

$$\text{Profit} = \text{Value} - \text{Cost}$$

Where the cost is typically calculated as the cost of purchasing the raw materials, and the cost of performing the manufacturing process. It is important to note that the sale of an item can be profitable while the company itself is not. Accountants refer to the cost detailed above as the cost of goods sold where the overall profitability of the company also includes company's overhead expenses.

Overhead expenses include things like:

- rent and or real estate taxes
- maintenance of the facilities
- lights
- people answering the phone
- sales people, and
- of course us, the engineers.

As manufacturing engineers if we intend to be successful then we need to ensure that we work for profitable companies. There are two ways we can significantly impact the profitability of any company we work for:

1. increase value to the customer, and
2. reduce the cost of manufacturing.

Lean Manufacturing is a system that allows companies to identify and characterize the costs of manufacturing processes with the intent to drive those costs to zero. The system is really set of management tools that help manufacturing companies better understand costs relative to value, identifying wasteful [processes and process steps minimizing their impact while maintaining the value the customers expect.

The objective of lean manufacturing is to reduce cost while maintaining and improving value.

The term “Lean Manufacturing” was coined by James Womack in 1990 in the book “The Machine

that Changed the World” but the principles have been used in manufacturing for centuries.

Much of what we refer to today as lean manufacturing and many of the lean tools we use today are based on the Toyoda Production System, TPS. Interestingly enough Sakichi Toyoda, who created the foundations of the TPS, credits much of the beginnings of this system that has revolutionized modern industry to principles learned when he read Henry Ford’s book and visited the Ford manufacturing Facility in Highland Park Michigan.

Lean Tools

I stated earlier that lean manufacturing is at one level a collection of tools, mainly management tools, tools that help manufacturing companies increase their profits.

It is more than simply a collection of tools though; it’s a philosophy, a style of management, a way of life even.

Lean manufacturing promotes the principles of:

- teamwork
- communication
- efficient use of resources and the elimination of waste, coupled with
- continuous improvement.

Using the lean principles and the understanding that the people who actually make the parts companies sell often understand best what is good and bad about the manufacturing processes that make the parts.

In this short introduction it would be a mistake to try to cover all of the lean manufacturing tools available to manufacturing engineers and managers but below we will look at a few of the most often discussed lean tools.

I was first introduced to lean concepts while a graduate student at WPI in the late 1990s. At the time I had had some industry experience, owned and operated my own business, and was working as a consultant. I attended a seminar series hosted by the Society of Manufacturing Engineers SME. I

still remember my initial reaction. I thought “this is just a bunch of buzz words created to talk about things that are commonsense.” Then I remembered two important things: commonsense is not that common, and I had never seen all of this particular commonsense grouped together before.

Below we will look at some of the most often talked about lean tools and why they are important so that you as manufacturing engineers will at least know some of the buzz words and be able to talk about them as an expert.

5s

Although not considered to be one of the original pillars of the TPS the concepts of 5s are likely the most important of the lean tools, they are really the foundation on which the rest of the tools are allowed to function. The Ss after translated to English are as follows:

- Sort
- Straighten
- Shine
- Standardize and

- Sustain

The ultimate goal of the 5ses is to give everyone doing work a clean organized work area that they know how to use. If you have ever been in a hurry to get something done, something really important, and not been able to find one of the things you need to do the job you know how important that can be. Wasted time is one of the largest unnecessary costs of most companies seeking to increase profits.

Below we give a quick description of how to use the 5s to create such a workspace in an existing scenario.

Sort

A wise man once said “where you is - is where you is” the corollary in examining a workplace is “what you’ve got is what you’ve got. The first thing you need to do is know what you have to work with.

Sort out the “stuff” in the space into logical groupings, tools, stock material, finished parts, and unneeded “junk” frequently referred to as crap.
(add or remove categories as needed)

Until you have done this sorting, until you know what you have you will not be able to do the next steps.

Straighten

Once you know what you have, you need to organize it. As you do this you should think not only about what you found during the sorting but consider any thing that the operator needs and was missing. I was once working for a company as a lean consultant. One of the things they wanted me to do was observe the process they used to setup CNC machine tools and identify any waste. Then they wanted me to suggest how it could be eliminated.

The company had one employee qualified to do this work and he also happened to be the shift supervisor with several machine tool operators reporting to him. I watched him for one 8 hour shift taking notes and shooting video. In that one shift he set up one job. Setting up a job on a CNC Machine tool requires several unique steps and mistakes can cost anything from a few dollars to tens of thousands of dollars.

While he set up the job he was interrupted 24 times. Nine times he was interrupted by one of the operators asking what they should do next. Eleven times he was interrupted to walk to his tool box and get a tool that he needed to use to perform the step he was working on. Four times he was interrupted when he had to stop the program because he realized the tool room had given him the wrong tool.

Each time he walked away from the machine to get a tool from his tool box other things he had to take care of came up. If he had stayed at the machine during those eleven interruptions I estimate he would have completed the setup in three to four hours instead of the seven and a half it took.

One of the things we do during the sort phase of completing a 5s upgrade to our facility should be logically organizing all of the tools needed to complete a task at the location the task will be completed.



Figure 3 an example of a manufacturing cell at FastCap, LLC

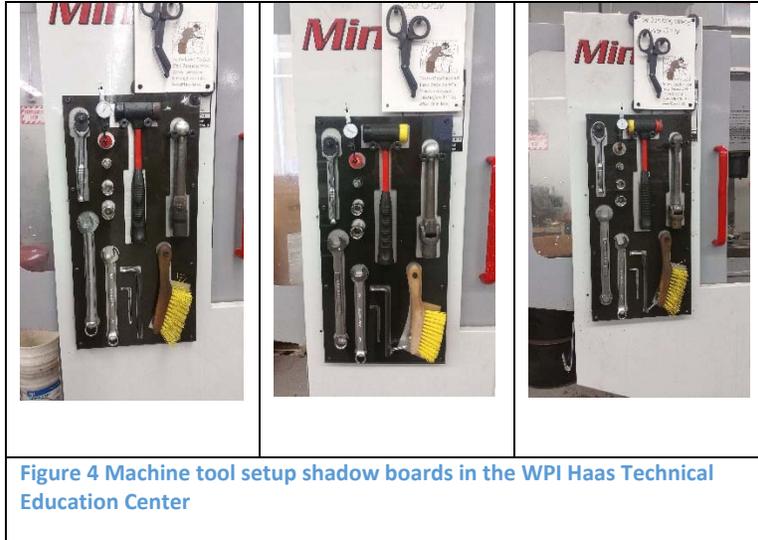
Shine

Once you have sorted and organized your work area. You need to clean it. A clean workspace is a safe workplace and nothing is more wasteful in manufacturing than not finishing a job because the operator that knows how to complete the job is out because of an injury that could have been prevented.

Standardize

When you've got a clean organized work area that only contains the things your operators need to do their job you will need to standardize your system. If you have two, three, or three hundred work cells that are for the same activity they should all be

identical. The operator from one should be able to transition to another with no training.



Although the three machine tools pictured in Figure 4 are within a few feet of each other they are all supplied with identical tools and shadow boards. Any operator familiar with the system can operate any of the machines and all three can be operated and setup at the same instant, no waiting for your colleague to complete a task so you can use the tool you need.

Sustain

Many people and companies find that this can be the most difficult step in the implementation of any new system.

In order to sustain this system or any other for that matter you and your company will need to rely on the first two Lean manufacturing principles – teamwork and communication. You will need buy-in from the entire management team and the shop floor employees. As I said earlier lean is more than a set of tools and buzz words it is a philosophy and everyone needs to believe and participate.

5s Case Study

A great example of a company that has implemented the 5ses and many other lean tools is FastCAP LLC. They have an excellent video presentation that I encourage you to review.

https://youtu.be/jYby_HczyDA

Other Lean Tools and Examples – An Exercise for the Reader.

There are literally thousands of books and courses on lean manufacturing and it would be outside the

scope of this text to attempt to cover any number of lean manufacturing tools in any detail, so as an exercise for you the reader I would like you to put down my text and reach out to other resources to find descriptions and examples of other lean manufacturing tools and techniques.

Before moving on to the next section of this book search for information about and write a one paragraph description of at least 5 additional lean manufacturing tools and concepts.

A good place to start might be the video:

https://youtu.be/zUUVy59J_54

When you are researching look for things like:

- Single part flow
- Pokiyoke
- Value stream mapping
- Just in time manufacturing, and
- Six sigma

[Lean is not just for manufacturing](#)

Lean manufacturing is not just for manufacturing.

People around the world have been applying the

lean principles and using lean tools for years in other area.

The class that this book was written for was designed using lean principles,

Hospitals and insurance companies have been working to transform the US medical industry for years by applying lean principles and using lean tools, specifically reducing waste processes and mistake proofing procedures and work areas.

And the bestselling book “The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses” by Eric Ries has been changing the face of entrepreneurship and starting companies.