

The Seven Wastes in Engineering Design A New Look at Lean Manufacturing

By Mike Simms

Executive Summary

One of the key initiatives within lean engineering is the identification and elimination of waste. Waste is often subdivided into seven categories, as defined by Taiichi Ohno's "Seven Pillars of Waste."¹ Each of the seven can easily be identified within the manufacturing production process. However, the seven wastes also occur within the manufacturing design process -- and they are often overlooked. The following article surveys the wastes by defect, overproduction, inventory, transportation, waiting, motion and overprocessing when applied to mechanical engineering design environments.



Almost every successful manufacturer today has implemented a "lean manufacturing" initiative within their organization. From a simple 5S program to a full-blown lean implementation, they are all based upon a simple principle: identify and eliminate waste in the production process. In this way, manufacturers can better focus on improving quality and reducing production time.

As lean practitioners, we are trained to spot waste in a production line as if it were painted bright red. The task is fairly simple, since it is based upon things that are visible: machine organization, product flow and plant layout all give us visual cues to bad processes. Video is often used to illustrate the movement of people and products through the production area. It's all right in front of our eyes.

While waste on the production floor is easy to see, it's not the only place waste occurs. What about waste in the engineering design department?

Do You Have Waste in Your Design Process?

Learning to see the waste in engineering design departments is less difficult than we assume. The following questions uncover design waste almost as effectively as our vision:

- Are the designs we make consistent with our workflow on the factory floor?
- Do we institute Poka Yoke (mistake proofing) in our assemblies? [how does this connect to design]
- Do we strive for simplicity in design?

- Do we re-use designs or use standardized parts?
- Do designers strive to understand the manufacturing process of their designs?
- Is there a direct line of communication between the design department and the production department?
- Is design documentation easy to understand?

The answers to these questions provide a fairly accurate assessment of the amount of waste we're incurring. Few companies can answer all of the above questions with a resounding "yes." Many companies may not even understand the questions.

In order to remain competitive in our global economy, these questions must be addressed.

Seven Types of Design Waste

With no obvious physical movements to observe, engineering design waste is hard to see. Also, consider the fact that most engineering departments are "isolated islands," and scrutiny of internal processes may be met with stiff opposition.

This combination -- processes lacking measurable movement and departmental isolation -- render design waste invisible to the naked eye.

Over the last ten years, there has been an explosion of new design software platforms, all aimed at increasing the speed, ease of use and quality of engineering design work. If "invisible design waste" remains uncorrected, however, the benefits of these new software solutions are weakened considerably.

If you were to consult the "Seven Pillars of Waste" as outlined by Toyota's chief engineer Taiichi Ohno, you would find that the average design department is guilty of most, if not all, of the following forms of inefficiency.²

1. Defects

Quality defects prevent the customer from accepting the product produced. Improper information on a drawing, missing views and incomplete information are all defects that can be avoided through document standardization and proper training of engineering staff.

2. Overproduction

Overproduction is the production or acquisition of items before they are actually required. For the engineering department, it would be the unnecessary documentation (modeling or drawing) of a part before it is needed.

Designers and draftsmen are frequently guilty of this form of waste. An example would be the parametric modeling of a family of parts. Some are needed, and some may not be needed. In the interest of making a library complete, many designers get sucked down that wasteful path, tempted by the vision of a complete library of like parts.

3. Inventory

All drawings or models are inventory. We invest time to make them, update them and manage them. They are stored, like inventory, on our hard drive. If we draw something before it is actually needed, we are adding to that inventory, thereby incurring waste. The time it took to make a part that is yet unneeded, may or may not be re-couped. That same time could have been spent reducing our current workload.

4. Transportation

The paper trail of an engineering change order (ECO), or the approval process for new or changed products can often take longer than the engineering time itself. This form of waste is often called “transportation” because carrying, mailing, or even e-mailing documents stop the design process and add time to the overall design cycle.

5. Waiting

Waiting refers to the time spent by the workers or engineers literally waiting for their work to arrive. By having an unbalanced workflow, some designers are done with their portion of a design long before their teammates. They busy themselves on another project or create inventory waste to fill in this time gap. Meanwhile time stretches out on all of their projects.

Waiting also refers to the time spent by designers waiting for approvals before the entire model can be submitted for production. Good, balanced collaboration, efficient processes, and multi-skilled designers can reduce the waiting time significantly.

6. Motion

In the engineering process, this waste form is the one that we usually equate with the efficiency of the software. The number of clicks of a mouse button, or the number of routines it takes to build a part, are motions that can be quantified and improved upon. However, the cost of the motion study can exceed the value gained, in light of all the other waste in the design system as a whole.

There are, however, other sources of motion waste. One is the old-fashioned “plot and stamp” method of obtaining multi-departmental approvals or revisions to a design. In such cases, we can spend thousands on new software that will save us an hour a day, only to have a project go through several hours of plotting and transportation to get to other departments for review.

Even the process of printing to a PDF and e-mailing it as an attachment is a wasteful operation. True collaboration gives everyone in an approval group real-time access to the information that is critical to their job, eliminating significant amounts of waste through motion.

7. Over-Processing

This basic waste form can be either software or design-related. For example, it's common to see manufacturers using software that has function (and cost) beyond what is needed. For instance, the main customer of a machine shop may use a software package that costs \$20,000.00 per seat, and they may have made it their “standard.” Hoping to be a compliant vendor, the machine shop adopts the same software, only to find that they use a mere 10% of the capability. They bought it to be compliant with their customer, and the cost of it, multiplied by a number of seats, and added to the additional operator costs (expensive software takes expensive employees) equals major losses in profit.

Another example of over-processing would be the creation of designs that are too complex. Simplicity is the cornerstone of lean. Fewer parts and fewer operations make for higher quality on the shop floor.

Lean Design – Headwaters of the Profit Stream

While your company may have spent countless thousands on process improvements on the shop floor (and they were probably dollars well spent), the design, development and engineering departments probably got only a quick dusting, if anything at all.



Design and engineering are at the headwaters of the profit stream. Nothing can be made until it's designed. Nothing can be made correctly until it's designed correctly. Nothing can be made simply until it's designed simply.

It is vital that we apply the same lean principles used on our shop floor to our design/ engineering department. Not paying close attention to the lean aspects of design can send a company's profits adrift like a boat down a river.

Endnotes and Additional Resources

1. "Toyota Production System," Wikipedia (http://en.wikipedia.org/wiki/Toyota_Production_System). Accessed 10/11/07.
2. "Muda (Waste)," Wikipedia ([http://en.wikipedia.org/wiki/Muda_\(Japanese_term\)](http://en.wikipedia.org/wiki/Muda_(Japanese_term))). Accessed 10/11/07.



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