



Reducing Set-Up Times A Foundation for Lean Manufacturing

By

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“One of the most noteworthy accomplishments in keeping the price of [our] products low is the gradual shortening of the production cycle. The longer an article is in the process of manufacture and the more it is moved about, the greater is its ultimate cost.”

What probably does NOT surprise you of the above quote is that the CEO of a Fortune 500 company made it. What might surprise you about the quote is by whom and when it was said: Henry Ford, 1926. Ford was practicing Lean Manufacturing, Just-in-Time Production, and reducing set up times at least 20 years before Toyota and other Japanese companies “discovered” them. But, the most surprising thing about this quote is that few American companies have really taken these lessons to heart, even 75 years after the real “Master” introduced them.

On the surface, reducing set up time does not appear to provide a significant payback. In a typical manufacturing facility, set up time might only represent only about 5-10% of total processing time. Meaning, that if you completely eliminated set up time, your payback would only be an increase in capacity of 5-10%. Reducing set up time to ZERO can be an expensive proposition. So, why are major companies working so feverishly to reduce their set up times? Maybe these companies see benefits OTHER than increased capacity. Capacity IS indeed one important reason for improving set up time. If we look closely at our capacity issues, we are sure to find that most of our problems are due to the limited output of one or two machines or processes. This bottleneck limits the output of the entire facility, and is probably responsible for most of our late orders. Focusing our set up time reduction efforts and dollars on this one machine/department is going to be a good investment.

However, most organizations that really are effective in reducing set up times discover big benefits in lead-time reduction and increased responsiveness to customers. Lead-time (or, cycle time) is almost directly proportional to total work-in-process inventory (WIP). Reducing set up time allows us to reduce batch sizes, which results in an equal (percentage) reduction in lead-time. Set up times can usually be reduced by 50% without capital expenditures, and a 50% reduction in set up time can enable batch size reductions of at least 50%. So, in a relatively short amount of time and NO cash outlay, a company can reduce lead-time by more than 50%. You can now respond to your customer’s orders in say 4 weeks instead of 10 weeks, with late orders practically non-existent. And, the Accounting Department will be pleased that you will be able to invoice customers 6 weeks earlier.

But, the most significant payback of a set up reduction program is that it may be the most critical part (or, at least the first part to implement) of a Lean Manufacturing program. Without the reduced batch sizes that reducing set up time enables, none of the other components of Lean (like JIT, kanban, total quality management, pull systems, waste elimination, etc.) can be effectively implemented.

Our set up reduction action plan might look like this:

1. Put in place some measurements so you can tell if you are improving. Determine the following and display the data graphically. Be sure to update the graphs weekly.
 - a. Current WIP (measured in terms of \$\$\$ or total pieces – we prefer to use \$\$\$)
 - b. Current average lead-time (in days)
 - c. Average set up times (in minutes) of the “worst” 20% of all machines or processes
 - d. Average number of late orders at any point in time
 - e. Average batch size.
2. Implement a set up reduction project on the machine/process that’s the biggest bottleneck in the facility. Your initial goal is to reduce the set up time by 50% without spending money.
3. As soon as you’ve reduced set up time on the #1 problem by about 25%, begin reducing set up times on the next 2-5 worst offenders. Again, your initial goal is to reduce the set up time by 50% on each of these without spending money.
4. When complete with these initial set up reduction projects, reduce batch sizes by at least 25% on all products manufactured by these machines.
5. By the time you’re to this point, your lead-times should be down by 25%, and late orders probably won’t exist. Your WIP is also down 25%, along with corresponding inventory carrying costs. And, your cash flow will improve because you’re now able to invoice customers sooner. Now that most of the low-hanging fruit is gone, go back and review your original bottleneck. Where there any ideas suggested for reducing set time further, with small capital investments? If so, implement them, and reduce batch sizes correspondingly. If not, investigate other ways to increase the productivity of this machine (constraint management).
6. As soon as the facility is operating smoothly with a 25% reduction in WIP, reduce batch sizes again, this time by another 10-15%. Other issues (than set up) will come to light, exposing additional opportunities for improvement. For example, large batch sizes mask quality problems, machine downtime, absenteeism, material shortages, etc. Address these as they arise, one at a time, and continue reducing batch sizes. Keep in mind that set up reduction is a continuous improvement activity.

Two basic concepts/tips on reducing set up times include:

1. Make sure your definition of set-up is:

Time between the last good piece off the current run and the first good piece off the next run, while running at optimum rate.

2. Understand the difference between internal and external activities. Internal activities are those that MUST be done while the machine is NOT running. For example, on a welding machine, changing the welding probes is internal – you have to change them while the machine is stopped. External activities are just the opposite – activities that are done (or, could be done, but aren't currently) while the machine is running. For example, retrieving parts and tools for the upcoming order can be done while the machine is running. Now that you know the difference...
 - a. Make sure to actually perform external activities AS external activities. For example, if the machine operator is also responsible for getting parts for the next order, have someone else do this while the machine is still running. There are numerous examples of operators taking lunch or breaks during the changeover of a 6-digit dollar figure machine with limited capacity – have someone else fill in on the changeover and make “lunch” a truly external activity.
 - b. Change as many internals as possible to externals. Get parts, tools, etc. ahead of time. If the changeover is being held up pending first-piece inspection, do a study to determine the risk of running while first-piece inspection is being done. Specifically, if this part has NO history of failing first-piece, then go ahead and run, isolating parts just in case this is once-in-a-lifetime failure. Another example; if a part (die, mold, etc.) needs to be hot to operate properly, pre-heat it offline before the changeover begins.
 - c. Reduce the time it takes to do internals. Use two people to perform the changeover. Replace bolts with dowel pins or notches. Use quick disconnects.

Here are some more specific, basic suggestions:

- Use a *gopher* to do external tasks. Don't allow a \$100,000+ asset to remain idle for the sake of a \$10/hour material handler. Ensure that everything needed for the changeover is already organized and on hand BEFORE the changeover begins.
- Try to position and orient everything so that the changeover operator moves arms but not legs or torso.
- Color code to prevent mistakes and to readily identify required tools.
- Use guides and stops for quick placement of fixtures and dies. Eliminate variable adjustments (use block gauges).
- Put changeover tasks in a checklist. Revise the list as the set up procedure (i.e., time) is improved.
- Graph your progress. Set goals/objectives (50% reduction; 75% reduction; 10 minutes; etc.) and, draw these in on the graph.
- Do not allow deviation from die and jig standards.
- Videotape the changeover and review for opportunities for improvement.
- Use teams for additional ideas.
- Eliminate bolts – on those you can't eliminate, remove most of the threads. Use a few common sizes of bolts/nuts to reduce the effort/time required to find wrenches, etc.
- Organize work areas. Organize tool cribs.
- Pre-heat and install parts hot. Remove hot – a pair of asbestos gloves is cheaper than holding up a \$200,000 machine for a 1-hour cool down period.

Many companies find that set up times can be reduced to less than 30 minutes without significant investment. Set up time targets for many world class manufacturers is 9 minutes or less (also known as single minute exchange or dies or SMED).

Some excellent reference books include:

- *Set Up Reduction: Saving Dollars With Common Sense*, Jerry Claunch & Philip Stang, PT Publications, 407-624-0455 (ISBN 9045456042).
- *A Revolution in Manufacturing: The SMED System*, Shigeo Shingo (ISBN 0915299038). Available from www.amazon.com.