

The lean replacement of bearings, pumps and motors

[Timothy R. Weilbaker](#), Allied Reliability

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Unnecessary downtime is not just an operations problem. The time that it takes to change out a bearing, a pump or a motor can add up over time to equal significant losses in production output. Eliminating non-value-added steps in the changeover of these parts will reduce scrap, improve equipment utilization and reduce labor costs while increasing total production output. The multi-step process includes eliminating waste in the process, identifying work that can be completed while the equipment is running (external work), and improving the reliability of both the internal and external work steps.

Improvements are ensured by creating effective work procedures and using workplace organization principles. Reductions in changeover time are typically 20 to 50 percent, or greater, depending on various system characteristics.

Introduction

The principles of lean manufacturing are well known. The components of the methodology as well as the overriding philosophy have been written about exhaustively. What is left upon which to expound is the application of the lean methodology to more and greater diversity of manufacturing scenarios. This article endeavors to explain the major tenets of lean manufacturing and how certain lean tools might be applied to a common maintenance activity in order to generate significant improvements in overall business performance. The improvement from utilizing lean tools influences all business metrics – not just maintenance or operations.

The scene

At 7 p.m., Bob received a call that a critical reactor pump was making a terrible noise. Never mind the fact that he was already working on a piece of equipment that operations said was critical (that is a scenario for a different article). The clock was ticking on this new problem and, like a well-mannered doctor, Bob hurried to the “patient’s bedside” to perform an initial examination. His diagnosis was that the pump was definitely near catastrophic failure. In fact, he thought it might not last until the end of the shift if it was allowed to continue to operate.

Bob asked the operator to shut down the affected reactor, explaining that he would need to replace the failing pump. The operations group reassigned the operator to another job. Production output dropped accordingly and, even though operations knew how long the job always took, the area manager called Bob just to confirm that the diagnosis and prognosis were as suspected. Somehow the situation felt old and familiar to Bob. In fact, it felt too old – and too familiar.

Bob had been a maintenance technician for 10 years and was quite good at it. He paid close attention to detail, took great pride in the quality of his work and was generally open to new methods for increasing both the quality and quantity of the work that he was able to produce. Recently, he had been spending greater lengths of time contemplating how he could get more work done in a single shift. He already worked hard, but the work seemed to be coming

quicker in recent months than he and his co-workers could sustain. There had to be a better way he thought as he began the work of replacing the reactor pump.

The old process

Bob retrieves his toolbox and begins the process of removing the pump so that the new one can be installed. From experience (he has replaced pumps just like this one so many times that he can nearly do it without looking), he knows that the job will take eight hours from start to finish. Sometimes, of course, things do not go so smoothly and the job can run into several shifts of downtime.

As Bob begins work on the pump removal, he begins to wonder if there is any way that the pump replacement process could be improved to reduce the time required. He knows that the job is not performed frequently, but it seems that it always has to be performed just when other assets are crippled and production demand is at its highest. Murphy's Law, he supposes. Still, if the process time could be reduced, it would help maintenance and operations both. It occurred to him on his second trip to the stores area that one immediate improvement would be to eliminate these frustrating trips to retrieve tools, fasteners and other required parts that become necessary when the situation becomes abnormal.

During years of replacing these pumps, Bob has learned what common tools are required for the job. Of course, he carries these tools in his toolbox. However, his toolbox would be the size of a truck if he tried to carry every special tool and fastener that he might need for any job in the plant. He was definitely ready to make some improvements that would lower his frustration level.

The principles of lean

Over the past several months, Bob's friend had been telling him about this methodology called lean manufacturing that companies were using to eliminate problems in their manufacturing environment. Bob's friend told him that he thought some of these techniques would help Bob make improvements in his own job. Bob was skeptical but his friend finally convinced him to read some articles and a couple of books explaining the lean manufacturing concept.

The concepts he read about seemed quite radical and almost too simple for him to believe that they could really produce the benefits that they claimed. Nevertheless, he found some of the concepts curiously intriguing. In a last-ditch effort to make some sense of all of it, Bob decided to summarize for himself everything that he had learned so far. Then, he thought, he would give it one shot at work (when the time was just right, of course) to see if he could reap some of the reward that his buddy had been bragging about. If the methods did not work, he was not going to waste his time with this "lean stuff" any longer. On a piece of notebook paper, Bob wrote: Principles of Lean. Under this heading, he began to list them as he understood them from his reading. When he was finished, his list looked like the one below:

Principles of Lean

1. Eliminate Waste (there are seven types of waste)
2. Waiting
3. Overproduction
4. Transportation
5. Rework or Reprocessing
6. Defects

7. Inventory
8. Excess Motion
9. Achieve Continuous Operation
10. Use Only One-piece Flow
11. Organize the Workplace
12. Continually Improve (one improvement every day, no exceptions)
13. Work Together (get ideas from anyone and everyone)

One thought crossed Bob's mind immediately. This is certainly a simple philosophy – only six major tenets as he saw it. He was beginning to think that there might be some merit to this methodology. In fact, he decided to simply identify some ways that he could try to apply some of the lean concepts to his work activities.

After looking over his ideas and spending a few days continuing to work in the current environment, Bob thought to himself that he might as well find out if these crazy ideas would work. After all, if they really worked to reduce operations downtime it would certainly be viewed as a great benefit for the business and reflect positively on him. He would start small and work slowly through the first exercise. If his lean activities did not produce improvement, he would revert to the old methods and cut his losses.

He made a second list that described specific ways that these concepts could help him be more efficient without compromising either safety or quality. This list was really going to be simply a "To-Do" list for his next pump replacement job. His second list looked like this when it was completed:

Lean Action Plan

1. Map each step of the entire process identifying purpose of the step and how much time is consumed by the step
2. Identify which steps contain waste and which type of waste
3. Identify a way to eliminate (or, at least, reduce) the waste
4. Organize the area immediately around the reactor pump (make a place to store everything needed for the pump replacement job – including common and special tools)
5. Look for ways to utilize quick-release features (e.g., fasteners, plumbing connections)
6. Document the new process so that it can be repeated

Armed with this list, a notebook and some markers (for creating a process map), and a healthy dose of skepticism, Bob headed for his manager's office. If he could convince his manager of the potential improvements of a lean environment, he would be ready to start work on his first lean implementation exercise.

The new process

After Bob's first round of improvements he was convinced that the tools of lean manufacturing could actually work to make improvements in both the quality of the work he was doing and the time required to complete that work. As he reviewed the new process, he realized that his notes echoed what he had been studying in the lean texts.

The new process was visibly different from the old process. The area had shelves and pegboard installed with labels identifying exactly what was to be located and where it was to be located. The contents on the shelves consisted of tools, fasteners and other items that were always (or nearly always) needed in the process of replacing a reactor pump. The shelves and

other storage features were located as near to their points of use as reasonably possible. Bob found that this activity alone removed a significant amount of time from the total process time.

The safety guards that were in place in the reactor area were another visible change. Bob was able to determine that the safety guarding was merely to prevent accidental ingress into unsafe areas of the reactor pump system. Consequently, there was no need for the guarding to be fastened with threaded fasteners which required excess time and energy to remove and were a periodic source of additional downtime as the threads would eventually be ruined and require more time for repair. In place of the threaded fasteners, Bob installed some quick release toggle clamps that were stocked in the stores inventory. He even managed to find a way to utilize quick connect couplings to speed the process of removing and installing the pump. Again, he was able to remove several minutes from the total cycle time through this simple change.

Finally, during his improvement exercise, Bob identified several steps of the pump replacement process that could be completed prior to stopping the production process. The total process time required to replace a reactor pump was measured from the moment the production process stopped until the moment it was restarted with the new pump. Therefore, Bob realized that performing as much work as possible prior to stopping production output would reduce the operations downtime.

Once he moved those tasks from internal to external (an internal task is one that can only be accomplished when the asset or production process is stopped), he found that he could make them a bit more efficient. This reduced the pump replacement time yet again. This was clearly a positive improvement.

From the efforts of his first improvement exercise, Bob identified several more ideas to implement in "Round 2." He was certain that he could reduce the pump replacement time even further. In fact, he believed that his most radical idea would reduce the time required by an additional 50 percent – maybe more. He was convinced that if he could find a way to implement the model used by auto racing's pit crews, the pump replacement job could be performed using less than 20 percent of the time that was originally required. By his calculations (and with some help from the accounting department) he determined that the time saved would more than pay for the extra maintenance labor required for his "pump pit crew" idea. By now Bob is also certain that every technique that he has used to reduce pump replacement time can be applied to motors, bearings and, for that matter, any other work that he performs.

Results

The results that can be achieved through an implementation of the lean methodology vary dependent upon several factors. For example, in an environment where minimal improvement effort has been experienced historically, significant improvements will typically be realized immediately. Environments where a continuous improvement philosophy has existed for many years may achieve smaller improvements as a result of previous work. It is critical to note that, even in facilities where lean has been rigorously utilized for several years, there are still improvements gained each time an exercise similar to the one described in this paper is carried out. This is explained by the dynamic nature of manufacturing and the natural movement of all systems toward higher entropy.

In general, utilizing the tools of lean will generate improvements in four fundamental areas of any manufacturing or processing business. First, fewer inventories will be required as a result

of a company's flexibility to meet changing customer demands. Less inventory and increased flexibility lead to improvements in a second category – faster delivery times. The third area that receives a boost from using the lean tools is quality. This includes the quality of product, processes and assets. Finally, shorter changeovers for production processes and reduced replacement times in maintenance work ultimately lead to reduced downtime which subsequently produces higher productivity. The target achieved by many companies for equipment setups or asset replacement activities is to perform them accurately and repeatedly in less than 10 minutes.

Quantifiable results from lean typically fall into the ranges shown below:

- 30 to 50% less human effort required throughout the plant
- 30 to 50% fewer defects in finished product
- 25 to 35% less engineering time required
- 45 to 55% less floor space for the same output
- 5 to 15% less inventory (applies to product and spare parts)
- 20 to 50% (or greater) reduction in changeover or asset replacement time

Of course, as previously mentioned, these results can vary dependent upon the unique situations of each plant that endeavors to implement the tools and philosophy of lean manufacturing.

Summary

The principles of lean manufacturing are really quite simple. At the heart of lean is a relentless drive to remove waste from any process. The targeted process can be virtually any task, job or project in a maintenance and reliability environment.

Companies utilizing lean techniques obtain improvements in flexibility, quality, delivery (or timeliness) and productivity. These improvements are recognized throughout the enterprise. This includes a company's product and its processes including the work processes required for effective asset management.

This article has attempted to demystify the principles of the lean methodology. In addition, some of the more prominent tools are discussed and one possible application of the tools is described within an asset management environment. Finally, the results typically experienced by companies that implement lean are presented.

References

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About the author:

Timothy R. Weillbaker is a discipline leader at Allied Reliability Inc. For more information, visit www.alliedreliability.com.