DEVELOPING Lean Culture in the Process Industries

To be successful in adapting lean practices from one industry or culture to another you should learn the theory of lean enterprise thinking and use it to thoroughly understand how lean is practiced in the original applications. With a theoretical understanding of the examples that exist in other places, you can use the theory to create your own examples and a form of lean practice that will be especially appropriate to your business.

Although directly translating existing lean experiences from mechanical manufacturing to process industries is a valuable use of lean theory, another important element of enterprise thinking is to assess lean practices to determine if some lean tools are inappropriate for use in liquid manufacturing. For example, at one liquid process company we examined the operating differences between mechanical and liquid manufacturing, and determined that the lean tool *andon*, or “line stop,” which is immensely valuable in mechanical manufacturing, is inappropriate for use in most process manufacturing because our processes do not stop and start in the same way as theirs do. Similarly, many liquid manufacturers, such as petroleum refineries, do not transition their operations among products, and so the tools for improving that practice are not applicable. Formal recognition that these popular lean tools are fundamentally inappropriate for liquid processing in a way that is

While the lean tool known as the *andon cord* is commonplace in the auto industry, it is inappropriate in liquid processing industries, where work does not start and stop in the same way.

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fully consistent with lean theory is a valuable part of the conversation as your process manufacturing team engages with lean practices.

An equivalent opportunity exists to determine if new uses of lean theory might be found to create a special form of lean practice that is uniquely appropriate to your business. Through innovative use of the lean theories, we can go beyond translating what others have done and create new capabilities of our own.

For example, mechanical industries often have many small and separate steps, with discrete units of labor-intensive production that move between those steps. As a result, mechanical manufacturers have many opportunities for small accumulations of inventory, transport, or other forms of waste between process steps. These accumulations alert operators or managers to the presence of small problems internal to their operation, and provide frontline teams with many opportunities to recognize small problems in real time and create small event improvements at the frontline of the business. Enabling many people to address many small problems is a powerful force multiplier for any manufacturer and an essential attribute of lean manufacturing.

Because there is enormous benefit derived from people throughout the business participating in improvement activities, at Exxon we searched for an equivalent method and benefit that we could enjoy in process industries. Once we understood the implications that arise from the structural differences between mechanical and process industries, we also understood that resources other than inventory, transport, and labor might naturally accumulate in process manufacturing to accommodate the problems that arise which are unique to our industry.

Manufacturing that occurs in small discrete steps will accommodate many small problems by accumulating the resources that are abundant in mechanical operations. In the process industries, we tend to accumulate the resources that are abundant in our industry: technology or engineers, capital equipment, and operational support such as maintenance or laboratory technicians. Searching work in progress, material handling, or direct labor internal to our operations to identify small improvement opportunities is less useful in the process industries. Searching for other small accumulations or wastes that are abundant in our industry actually has real value.

Most of these small problems and small accumulations may be resolved by autonomous action at the frontline, in the same way that small accumulations of work in progress or direct labor enable frontline improvement in the mechanical industries. This represents a new source of improvement for process manufacturers, which can be added to more traditional improvement methods.

In exactly the same way that mechanical manufacturers engage people to identify and resolve small problems using inventory as the indicator of a problem, we in process industries can achieve the same outcome by using other accumulations as the indicator. Here is one from among many examples of this process in action.

In continuous-process chemical operations, it is common to have spare pumps. Although heavy-duty, high-volume chemical pumps that are often made of an exotic corrosion-resistant material are expensive, they are a relatively small part of the assets of a large chemical plant. Owning spare pumps is very inexpensive compared to the cost of allowing a large continuous operation to stop production as the result of a pump failure. As you walk around a large chemical plant, it is common to see pump stands where it is obvious that there are two pumps for the same service: one in operation and one standing by as a spare.

When a pump that is in service fails or is otherwise taken offline, the spare pump is brought into service and the plant continues to operate normally while the original pump is repaired. Although it is common to see pump stands with a pump in service and a spare pump available, it is much less
common to see a pump stand with three pumps ready for the same service: a pump in service, a spare pump, and a third pump as backup for the spare. For engineers to create such a situation, it must be reasonably likely that the spare pump, when activated, might fail before the original pump can be repaired and returned to service. Since a chemical pump that is well designed for its service normally lasts for months or years, the presence of three pumps was an indicator that something abnormal was being accommodated.

After we launched our lean activities, searching for small but unnatural accumulations, one of our employees questioned the fact that in some places we had three pumps for the same service. One spare seemed to represent a normal contingency against failure, but two spares must represent an unnatural accumulation. What problem was it covering?

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We were greatly embarrassed when we investigated this unnatural accumulation of capital resources. First, we found that indeed it was not only possible but also quite common for the spare pump to fail before the original pump was returned to service. That was very odd because, once a pump began to operate routinely, it often ran a long time before failing. Yet once the primary pump failed, it was common for the spare pump to fail soon after.

It turned out that although we were doing a lot of preventive maintenance on the spare pumps to ensure that they would be available for service, we were doing it incorrectly. In this particular service, the start-up viscosity to get the material moving was extremely high. Once the material was in motion it moved well enough, but it was hard to get it moving.

When we designed our preventive-maintenance program for these spare pumps, we had applied industry-standard maintenance practices instead of designing maintenance routines that were particularly suited to the exact operating context for this equipment in this service. Included in those standard maintenance practices was a commonly taken step to prevent idle electric motors from getting a “flat spot” on the rotors. Flat spots on the rotors are a common problem for large electric motors that are not in service for long periods. The preventive maintenance practice to prevent flattening of rotors is to rotate the drive shafts of idle motors periodically. For an installed motor, the technicians had adopted an easy way to achieve this rotation, which was to turn the motor on and let it run for a few minutes each week.

The practice of rotating electric motors that are not in service is a good idea if done correctly. In this situation, however, the motors were not in storage, they were installed and connected to pumps. By starting the motors, we regularly exposed them to the extreme stress of overcoming the high start-up viscosity of the material in the pump. Each time that we started the motors, they experienced the most severe operation that they would ever experience. By frequently starting and stopping the motors, we were actually doing the one thing that was most likely to cause the motors to fail when we needed them.

These maintenance practices seemed like a good idea, but once we assessed the problem, we stopped doing them in the same way. From that point forward, we continued to rotate the motor shafts as part of our preventive maintenance plan, but we did it by hand rather than by starting the motor. With that modest change, the problem of premature pump failure in this application was eliminated.

As with small improvements in mechanical manufacturing, finding and resolving one such problem quickly led us to many others that were similar or related. Because of this small change in maintenance practices and several other changes that were functionally similar, we were able to redeploy many high-cost chemical pumps to new service rather than purchase additional pumps. We were also able to eliminate the cost of rebuilding motors that should never have failed. Of even greater importance, when we had two spare pumps, we applied our improper maintenance practices equally to both spares. Therefore, even with two spare pumps, we periodically experienced an event where a main pump failed and both spares also promptly failed. When this happened, we had to stop production at a very high cost. By recognizing and correcting the relatively small problem identified by examining an unnatural accumulation of spare pumps, we avoided the bigger problem of bringing down a production train.

About the Author

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