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Smaller Manufacturers Get Lean with Artificial Intelligence

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Artificial intelligence is widely acknowledged as a crucial aspect of what is broadly referred to as Industry 4.0. While no one knows yet how artificial intelligence will be incorporated into the next phase of the Industrial Revolution, most agree that it will allow greater connectivity between people, machines, and information technology, allowing manufacturers to better optimize processes and predict problems.

How are small and medium-sized manufacturers (SMMs), who typically do not have the time or capital it would take to test emerging technologies, supposed to evaluate

how artificial intelligence could impact their organization — and play a role in preparing them for Industry 4.0?

Waiting for the manufacturing sector to decide, so to speak, is certainly not an option. A delay of one, two, or five years could cause a manufacturer to be left behind. The time to act is now, but the path forward isn't clear.

One way to address this is to evaluate artificial intelligence through an ongoing transformation that many SMMs have already embraced: lean manufacturing.

Putting the "Continuous" in Continuous Improvement with Artificial Intelligence

Central to lean philosophy is the idea of continuous improvement. It's a commitment to ongoing change. To do lean, a willingness to change must be maintained at all times so that when an opportunity for improvement is identified, it can be quickly implemented.

Lean improvements proceed through interventions. If a problem is identified, say in a process, work is halted. Team members are called in to observe, draw conclusions, make judgments, and eventually take actions that address the cause of the issue. This intermittent operation is how lean works, although its stop-start rhythm seems fundamentally at odds with the idea of continuous improvement. It's what is currently feasible, though — or at least humanly possible.

Now, what if you didn't have to halt work to perform a lean operation? What if you could do the bulk of the fundamental lean process (observe, draw conclusions, make judgments, take action) while work was happening, making the lean process more continuous? This is one of the main promises of artificial intelligence for manufacturing operations of any scale.

Where Lean Operations Can Start with Artificial Intelligence

Artificial intelligence is a vast field that includes a wide range of technologies — everything from algorithms capable of learning from data sets to robots that resemble something out of a science fiction story.

As far as small manufacturers are concerned, the type of artificial intelligence they should primarily be concerned with is a sub-discipline called machine learning. As Amit Manghani defines it in his "A Primer on Machine Learning (https://ce.uci.edu/pdfs/certificates/machine_learning_article.pdf):"

> Machine Learning is a form of data analysis. Using algorithms that continuously learn from data, Machine Learning allows computers to recognize hidden patterns without actually being programmed to do so. The key aspect of Machine Learning is that as models are exposed to new data sets, they adapt to produce reliable and consistent output.

Manghani goes on to outline four types of machine learning, all of which could have applications for lean manufacturing. This assumes, however, that a small manufacturer is willing to invest in the computing power to make the requisite data available for computational analysis:

1. Supervised machine learning
2. Unsupervised machine learning
3. Semi-supervised machine learning
4. Reinforcement machine learning

Let's explore each of these four opportunities to apply machine learning to lean manufacturing in a bit more detail below:

1. Supervised Machine Learning

In supervised machine learning, algorithms parse incoming data, assigning labels to any datum that meets predefined criteria. Lean manufacturers could use such a technique to automate quality control for complex parts, for example, assuming relevant part data could be recorded and made available to the algorithm.

2. Unsupervised Machine Learning

With unsupervised machine learning, there are no preordained answers an algorithm can use to sort data. Rather, the algorithm must observe and evaluate data as it accumulates, identifying patterns and creating emergent labels. This type of machine learning could be used by lean manufacturers to monitor a production machine — or a series of networked machines — for unusual behavior and thereby anticipate a malfunction.

3. Semi-Supervised Machine Learning

As the name indicates, semi-supervised machine learning mixes supervised and unsupervised approaches. In a semi-supervised scenario, there are some existing labels for data. Other criteria are also developed by the algorithm over time with the assistance of human supervision. A semi-supervised scenario could be useful for optimizing repetitive part production, potentially eliminating both part and process waste.

4. Reinforcement Machine Learning

In a reinforcement scenario, an algorithm projects which action, out of a set of possible actions, will result in the highest reward. SMMs engaged in a lean transformation

process could use this type of machine learning to weigh different paths toward process-oriented changes they envision.

Machine Learning Can Supplement Lean Manufacturing

Focusing on machine learning, one can start to see how there are applications for artificial intelligence that are useful and accessible for most manufacturers, no matter what their size. In some cases, pieces of the puzzle may already be available in the form of data harvested by already-installed machine sensors, existing information technology (IT) and operational technology (OT) infrastructure.

As SMMs begin to contemplate applications for artificial intelligence, it's important to remember that none of these scenarios automatically threaten the availability of jobs for humans. Rather, these ideas can be pursued in a way that is complementary to a worker-empowering lean process by giving employees access to real-time information and better tools for on-the-job problem solving and execution.

A useful analogy is current automobile sensor technology, which supplements human drivers' awareness and perceptions. Not only does this technology improve safety, it also helps ensure that there is less friction in the overall driving system by aligning the behavior of everyone on the road. In this way, car safety technology doesn't take anyone out of the driving equation — they make driving a safer and more efficient experience.

If we take this perspective, artificial intelligence can be viewed as just another tool in the lean toolbox — albeit one that has the potential to be very powerful.

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