Building smarter factories with innovative new workflows.

How machine learning and virtualization are driving the future of manufacturing.

By: Dr. Florian Baumann, Ph.D.
CTO, Automotive & AI, Dell Technologies

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The manufacturing industry finds itself at a pivotal juncture as technological innovation, coupled with changing social norms, are transforming the approach to best practices within the industry.

Advancements in machine learning for predictive quality and predictive maintenance have enabled the development of smart factories to enhance production quality and reach new levels of operational efficiency. Specifically, these new smart factories reduce unplanned downtime, increase equipment availability and improve product quality.

In addition, an increased emphasis on physical distancing and a contact-free economy has emerged to meet public health directives, challenging conventional manufacturing methods, and requiring a more innovative approach that also improves worker safety.

This eBook focuses on the workloads that manufacturers can implement and leverage to enhance operations, such as testing and training, to ensure that high levels of production quality are achieved, and adherence to changing social practices.

In this eBook:

Market overview—The need to modernize product testing methods.

Manufacturing workflows have undergone their share of transformation over the years, incorporating technological advancements, such as automation, big data, robotics, the Internet of Things (IoT) and artificial intelligence (AI). These methodologies and tools are leveraged to ensure that product quality objectives are met, both during and after production, as pass-fail testing traditionally occurs at every stage of manufacturing.

When looking at adopting the latest manufacturing methodologies, there are two workloads that should be considered prominent focus points. The first is the virtualization of Computer Aided Design (CAD) and Computer Aided Engineering (CAE) workloads. CAD/CAE workloads fall into the early stages of manufacturing during the design phase. They include conducting finite element analysis simulations, which could consist of thermodynamics, fluid dynamics, or a variety of other types of analyses and

processes. The second workload involves building a smart factory with predictive quality and predictive maintenance capabilities. Predictive quality involves using AI for ongoing testing to detect anomalies and the likelihood of product failure before the product leaves the manufacturing line. Predictive maintenance involves the use of AI to get ahead of any potential manufacturing equipment failures. The concept of predictive quality and predictive maintenance in manufacturing workflows is the same across industries, whether it's in the manufacturing of automotive parts or electronics components.

In an ideal world, a manufacturing line and hardware would consist of brand-new technology for testing and include sensors to measure external variables, such as vibration, temperature and humidity, that may affect production quality. However, no manufacturing line is 100 percent up to date. Many companies use the same machines they have relied on for decades. Part of the challenge is identifying the areas where technology can be added to these machines to increase manufacturing intelligence and ensure testing methods are as up to date and accurate as possible.

Combating challenges in manufacturing workflows.

Return on investment (ROI) is a critical performance measure for the success of any business. For many manufacturers, the most effective way to ensure that ROI is achieved is by relying on lean management principles, which focus on maximizing productivity while simultaneously minimizing waste within manufacturing systems. Gartner identified the "Eight Wastes of Lean Manufacturing" as defects, overproduction, waiting, non-utilized talent, transportation, inventory, motion and over-processing.[1]

There are several ways that manufacturers routinely combat waste in their workflows. For example, companies generally have a variety of CAD and CAE applications they employ, depending on the devices they design. Additionally, a product lifecycle management tool is used to index all parts and assemblies, as well as any associated revisions that are necessary. However, when leveraging a CAD or CAE tool to research an assembly process, which can consist of hundreds or thousands of individual parts, the end users encounter significant load times. The delayed load is in part due to bandwidth, and in part due to storage performance, as a multitude of engineers attempt to

access the network simultaneously. Such network bottlenecks lead to significant wasted time as engineers wait to access files.

Defects are another significant source of waste in manufacturing workflows. A common challenge in manufacturing testing is that routine tests may be conducted at every stage of production, with the part passing the test at each stage. When testing is complete, everything is switched on and the part now fails. It's unknown exactly why the part failed. But if parts are still failing even though they are within the defined tolerances, it indicates there are other key factors or variables that weren't measured during testing. Different parameters may need to be measured that may have been overlooked, such as temperature in the room.

To combat this, machine learning, artificial intelligence and real-time analytics play a critical role. Robust data collection must occur at each stage to build a model of the manufacturing line to identify or predict when parts will fail, and then improve quality or to estimate the remaining machines' runtime. As data is collected over time, analytics may be run on the data, and patterns may be identified and used to predict the likelihood of a part failing and at what stage.

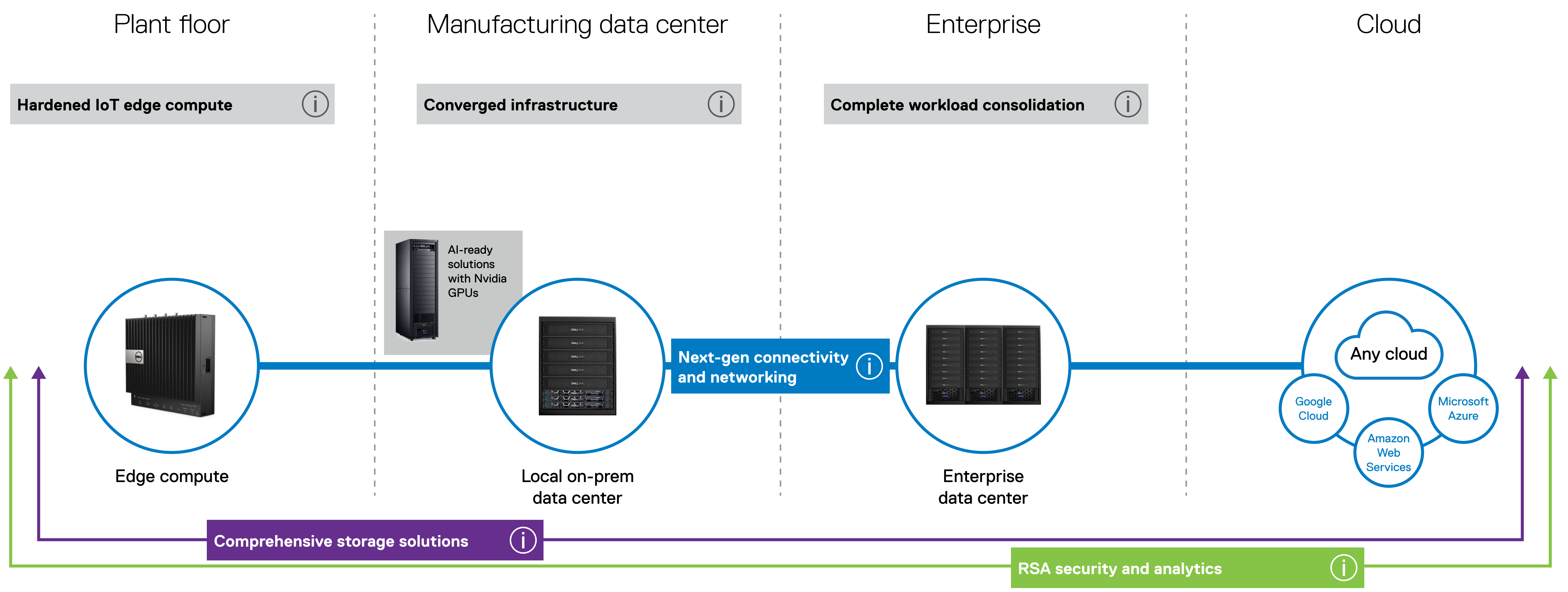
Effective solutions across the manufacturing process.

Virtualized CAD/CAE applications

To address high load times with CAD applications, VMware Horizon leverages GPU acceleration via data center processing. This enables GPUs to be timeshared across many users, allowing faster load times for high-end graphics, improved interaction among users and enhanced flexibility.

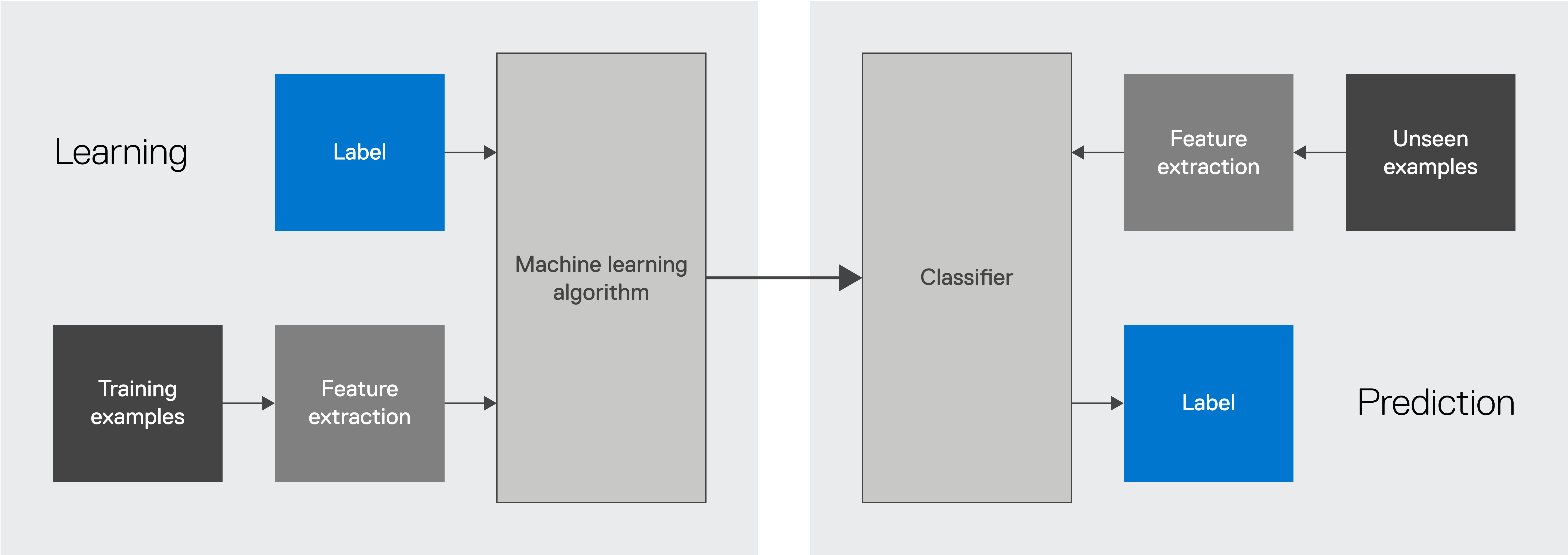
Deploying virtualization with CAD has proved effective by providing high-speed networking to combat slow network traffic. It provides massive parts databases that are housed within Dell EMC PowerScale in the data center. There is a dedicated 40GB network connection between the servers and PowerScale within the network. Everything is virtualized on the servers, with a thin client enabling very low amounts of data transferring to the engineers to make everything run much faster. Additionally, managing a server eliminates the need for an expensive workstation and allows for an inexpensive terminal to be shared by many users. This also allows for improved synchronization and security. Data doesn't leave the data center, because everything is kept there, with only the graphical interface being sent across the network. All that's required is a keyboard and a display. The USB ports are disabled, with no data physically on the remote device.

Virtualization of CAD and CAE workloads allows more efficient use of engineering time, as it enables quicker check-ins and significantly reduces wait times. Engineering efficiency is increased, security of the data is increased, and administration of the network is decreased.


Plant floor
Manufacturing data center
Enterprise
Cloud
Hardened IoT edge compute
Converged infrastructure
Complete workload consolidation
AI-ready solutions with Nvidia GPUs
Edge compute
Local on-prem data center
Next-gen connectivity and networking
Enterprise data center
Any cloud
Google Cloud
Microsoft Azure
Amazon Web Services
Comprehensive storage solutions
RSA security and analytics

Predicitve quality driven by machine learning.

In smart factories, machine learning algorithms are trained to recognize what a defect looks like and inform the algorithm how to identify an example of a failure, and accordingly, discard the defect. To train machine-learning models, a library of examples of defects and non-defects must be built. Then, a data scientist or developer is assigned to find the best features to describe the detection task. They will extract the features or traits that indicate if the product is defective or not, and ultimately, train the machine-learning model to pass the test, solve the problem and achieve a successful result.



The training data sets can consist of millions of examples of defects and non-defects, which are then randomly divided into batches. For example, for face detection, millions of examples of faces and non-faces are collected to train the algorithm. Data scientists extract the desired features out of these images to train the algorithm to ultimately detect a face successfully. This can require different algorithms to solve the problem and achieve the desired result. Using these examples, positive and negative tests are run and serve as input for the algorithm and training model to measure against the expected output. After each iteration, the model output can be compared against the expected output, and KPIs may be calculated. For example, 90 percent of the positive examples are correctly detected, while 10 percent are incorrectly detected, meaning you need to retrain the model.

Learning about all these different variables further informs machine learning algorithms to identify patterns that are important to identify when a part is going to fail. This can apply in real time on the manufacturing line or over longer periods of data collection, such as months or years after a part has been manufactured. Should a part go all the way through the manufacturing line and then fail, that data can be collected and fed back into the algorithm to retrain the model to identify another pattern that correlates to failure. Then, the manufacturing line or method can be updated.

Predictive maintenance allows companies to continuously monitor the equipment they're working with to identify when tolerances are growing and help predict when it's going to fail. Robust data collection and availability in real time are critical to monitor the manufacturing line as the parts are being produced. Additionally, being able to access the same data with data that was collected long ago is crucial and creates a larger data set.

Dell Technologies recently introduced its Streaming Data Platform with the goal of offering a bundle of software tools and hardware to jump start real-time analysis of sensor data. By leveraging open source technologies, such as Pravega for Ingest and Storage, along with persistent storage based on PowerScale, the enterprise-grade platform addresses the need for low latency enabling analytics to run on the input data in real-time and include historical data. This is well suited for predictive maintenance because events that occurred long ago must also be considered as factors that could affect product quality and reliability.

Dell Technologies—solutions built for manufacturing.

AI-ready solutions

Everything you need to accelerate the adoption of A.I. driven workflows. These predesigned and prevalidated solutions bring together PowerEdge servers, PowerScale storage and NVIDIA GPUs to help you gain faster, deeper insights into your manufacturing workflows.
Learn more about Dell EMC AI-Ready solutions

Dell EMC PowerScale storage

PowerScale offers the performance, scalability and concurrency to support continuous data input and rapid access required for the training, testing and inferencing of machine learning and deep learning algorithms.
Learn more about Dell EMC Powerscale

Dell EMC Streaming Data Platform

Harness real-time and historical manufacturing data in a single, auto-scaling infrastructure and programming model. Put your sensor data to work and achieve innovation across your entire manufacturing ecosystem.
Learn more about Dell EMCs Streaming Data Platform

Dell EMC PowerEdge XE2420

The PowerEdge XE2420 is a robust edge server that provides the best performance for complex edge applications by meeting the fluctuating demands of compute, latency and bandwidth.
Learn More about Dell EMC Poweredge XE servers

VMware Horizon

VMware Horizon is a modern platform offering secure delivery of virtual desktops and apps across hybrid cloud environments including support for GPU accelerated graphics, making it ideal for intensive virtualized CAD and CAE workloads.
Learn more about VMWare Horizon

What to expect next.

The implementation of machine-learning models and real-time analysis of sensor information into manufacturing workflows will enable manufacturers to enhance testing and training methods, better predict the likelihood of product failure, and achieve higher levels of quality. But where these models can be implemented in their specific workflows must remain top of mind for decision-makers within the industry. There remains much room for innovation, growth and achievement.

Learn more about automotive data storage solutions

1 "Five Strategies to Achieve Lean IT in Manufacturing," Ivar Berntz, Gartner IT Symposium, Oct. 20-24, 2019. Retrieved June 25, 2020.