



SIEMENS

Ingenuity for life

Siemens Digital Industries Software

Leveraging lean digital manufacturing

Where digitalization meets optimization across the entire manufacturing facility

Executive summary

For manufacturers to create today's sophisticated products that include mechanical, embedded software and electronics, they must navigate a landscape of technological innovations. At the same time, manufacturing processes are becoming more challenging. Along with the ever-present need to make manufacturing more efficient, there is the rising trend of catering to a customer's preferences and needs.

Increased product personalization in the manufacturing process has reduced the average lot size, with some products becoming a lot of one. Lean digital manufacturing (LDM) initiatives are emerging to help reconcile the need to deliver greater customization while pursuing ever greater efficiencies. A lean digital factory focuses on optimizing the complexities of operations, products and methodologies.

Mike Scott

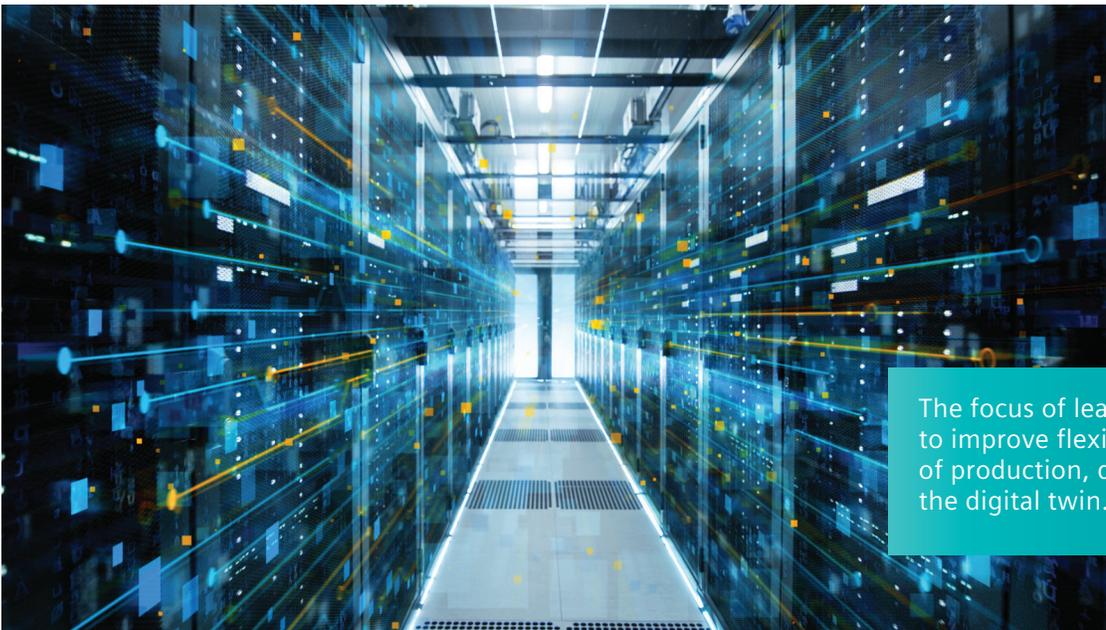
Abstract

Dealing with product complexity and personalization is becoming the new normal for many manufacturers. These requirements need to be met in a flexible manner as well in the event of unforeseen challenges.

LDM is enabled by a two-prong approach; first, there is the manufacturing automation and digitalization of production so the machines can digitally communicate amongst each other. Second, data is incorporated from an assortment of Industrial Internet of Things (IIoT) sensors and nodes. Digital data can be captured from these sensors, as well as machines, vehicles and meters connected to the manufacturing network. They are all used to optimize the manufacture processes. The results include reduced material waste (lean initiative), minimal machine downtime and the ability to virtually validate new machines, along with an almost limitless assortment of other metrics. Modeling these interactions holistically is only possible by using a comprehensive digital twin, capturing a digital twin of the product and the process and the performance of both.

The LDM process provides many benefits. Most importantly, LDM optimizes production throughput, while at the same time speeding development across the entire facility. Moreover, the ability to virtually commission means less facility downtime. It also streamlines scaling production to accommodate bursts in demand. Once running, more optimizations are continually uncovered with the aid of machine and sensor data to enhance and refine the manufacturing process.

Although the value of LDM is readily apparent to manufacturers, it is a complex process to implement. Many manufacturers are struggling with navigating the flood of innovative technologies and the specific steps needed to employ LDM. Siemens Digital Industries Software offers experience-driven consulting services, an expansive software portfolio and best practices to assist manufacturers to quickly ramp up and reap the benefits of running a lean digital factory.



The focus of lean digital practices is to improve flexibility and scalability of production, driven by the data of the digital twin.

One-of-a-kind manufacturing partner

Siemens has always been a manufacturing company. Having successfully negotiated the transition from primarily mechanical or simple electromechanical devices, today Siemens produces the full range of products – from purely mechanical products to complex mechatronic devices. It has developed and acquired extensive software capabilities that are used not only to design products but also to drive state of the art manufacturing in our own factories and available to our customers.

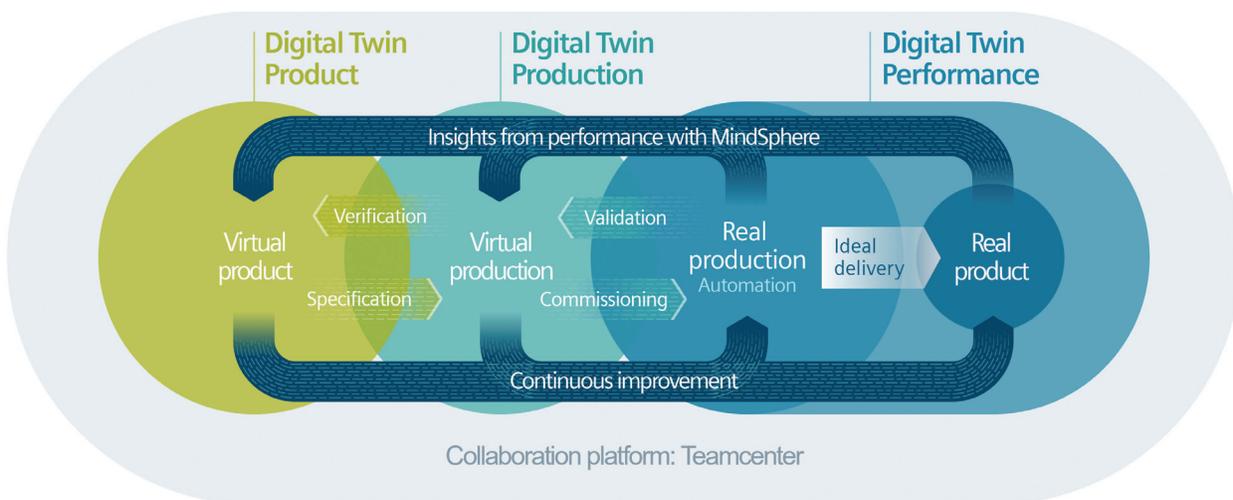
The Xcelerator portfolio of software from Siemens Digital Industries Software helps companies of all sizes create and leverage a comprehensive digital twin that enables the digital factory – from integrated drives and smart controllers to industrial communication and industrial automation systems. Siemens’ comprehensive offering for automation technology and the digitalization of production is focused on increasing productivity, efficiency, speed and quality, enabling companies to become more competitive. Siemens has more than 30 factories that are at the forefront of the most advanced implementation of digitalization, deployment and optimization of the full spectrum of Siemens digital factory hardware and software along with an advanced network of IIoT sensors. The result is the successful implementation of LDM.

First-hand knowledge

The main manufacturing facility for Siemens programmable logic controllers (PLC) in Amberg, Germany is one of about 30 sites that has adopted these LDM principles.

The Amberg facility produces more than 1,200 products on a 100,000 square-foot floor, requiring almost constant reconfiguration to produce that variety (up to 350 changes a day). Normally, this would be a highly laborious process requiring time and resources. LDM cuts that investment by implementing the comprehensive digital twin to virtually characterize the product, process and performance. Initially, this is done by attributing generalized scenarios to the digital twin that bring together multiple aspects of our products. System data and process revisions alter these scenarios as development and production advance.

The comprehensive digital twin is required to fully characterize the product being made, the production process being used and the performance of each. Each model can be used independently to optimize its respective area, but merging all of them into a comprehensive digital twin enables greater insight and ability to optimize. A single unit for production can be tracked from raw material, or base form, through production



The comprehensive digital twin comprises models of the product, production and performance for more complete insights.

(both virtually and physically) and out into the hands of a customer. A smart factory captures information on manufacturing, but a lean digital factory captures information across product, production and performance in both digital and physical environments.

Using that information is the key to a successful LDM initiative, but the biggest challenge is often the LDM implementation. Siemens understands that because we have done it at dozens of our own factories so we can help you implement LDM.



The Amberg manufacturing facility is the main producer of Siemens PLCs, with over 1,200 different models coming from a single site.

Best practices

During our initial development of the comprehensive digital twin solution for manufacturing, Siemens encountered many of the problems associated with evolving a manufacturing process. This improved our understanding of the process to the point we have developed a set of proven best practices for implementing a lean digital manufacturing process.

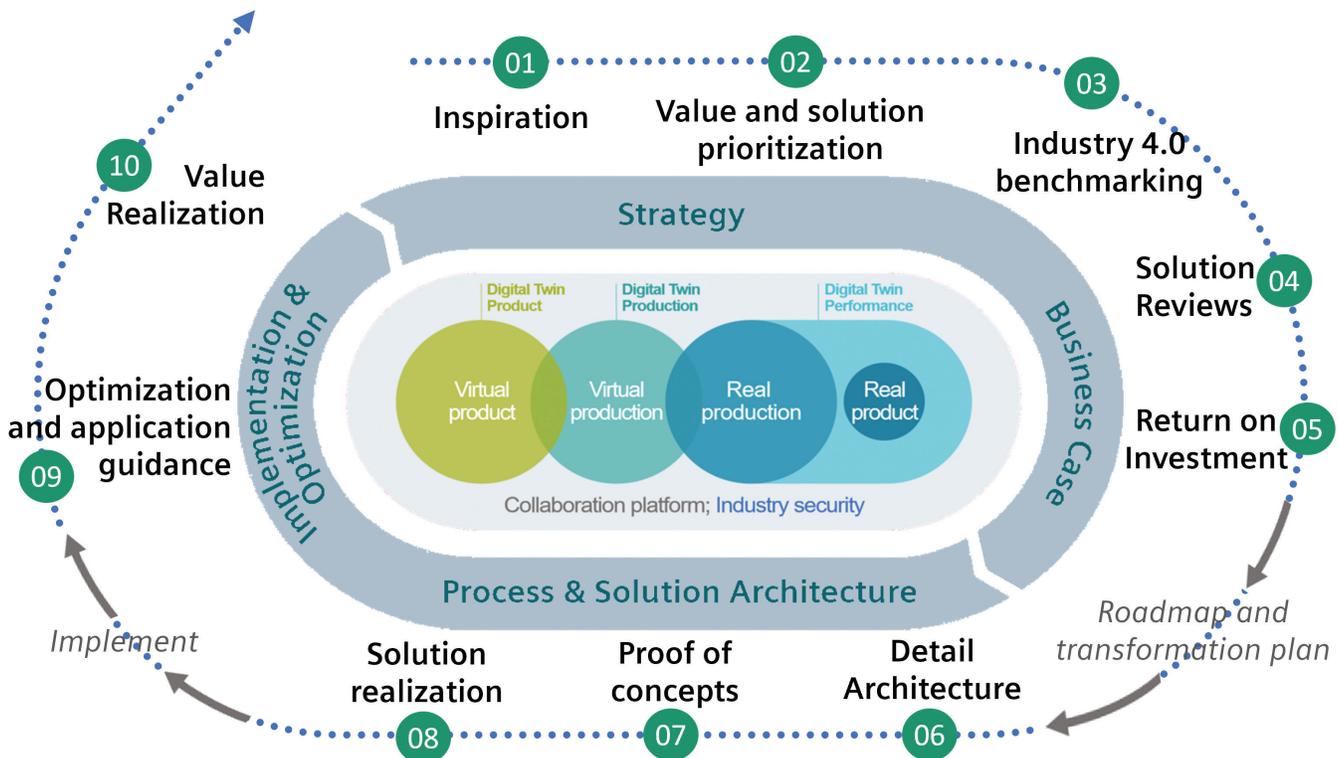
A customer’s transformational journey is like a racetrack and can be entered at any point. Some companies feel they already have a strategy in place but need assistance with their architecture. Others might be deploying LDM processes but require support for implementation. The four general regions of the racetrack (strategy, business case, process/solution and implementation) correlate with macro journey steps for companies adopting LDM processes and the comprehensive digital twin. This white paper will explore the four areas a manufacturer initially must consider when adopting digitalization and LDM.

Strategy for a digital transformation

If a company is just starting an LDM initiative, it begins with the strategy phase. Here it is important to focus on identifying current production problems, the status of all equipment and processes as well as the purpose of the production processes being upgraded. Perhaps there are multiple projects running. If so, you will need a strong design office to coordinate multiple activities in a complex, highly integrated environment. The goal in this phase is to roughly map out what the digital transformation journey is going to look like, in what order changes should occur and clearly define a strong business case to justify these changes.

Business case

After creating a rough map for how the digital transformation will occur, it is important to establish a baseline for production at the current facility. This will be used as the starting point for facility optimization. The next



step for establishing the business case is setting targets for improved production; for instance, what amount of growth is required to make this transition a success? How will the facility compare to industry competitors? These targets will become the chief financial metric while working through the business case.

Since almost no manufacturing facility operates completely independently, soliciting stakeholder input on the transition map and deployment is key. For ease of implementation it is good practice to prioritize stakeholder input, which will sort needs in accordance with maximized efficiency. If there are any aspects of the proposed plan that cannot reach consensus by an in-house department or external supplier, revisions will need to be made. Once the revisions are agreed upon, it is time to explore process and technology possibilities. This can include researching the best manufacturing equipment if it is a new facility or an expansion. The exploration may also include plant clustering to fit the production speeds of different manufacturing areas to hopefully harmonize the entire process.

With concrete plans on what needs to be changed, when it needs to happen and how well it will integrate with the current facilities, it is time to quantify the value of the new processes. At a simple level, this is done by comparing increased production efficiency against the cost of implementation. If the return-on-investment (ROI) is not great enough, the process may need to be revised to better fit the business value.

Process and solution architecture

Once a practical business case for digital transformation has been completed, a detailed architecture needs to be established and proposed production concepts validated to realize the solution. Often there are LDM capabilities already deployed in the manufacturing plant, such as IIoT sensors and edge computing, but they are under-utilized and not fully optimized. What is required is solution architecture to be fully defined and verified for the facility that takes full advantage of the capabilities. If the production facility does not have IIoT sensors and edge computing solutions, these devices will need to be installed and validated at this stage. The comprehensive digital twin of the production will streamline this process by relying on virtual validation. That enables existing manufacturing processes to remain functioning through the transition.

After selecting the machines for the defined production process, it is important to understand how they interact with production cells and lines in a digital environment. Virtual commissioning enables testing and validating of new machines and their PLCs prior to installation. This translates into less downtime and fewer unforeseen problems when installing new machines or moving existing ones in the production lines. In this evaluation it is also important to uncover and mitigate production gaps that can result in lost product traceability. Here again, a digital twin of production is an invaluable aid in analyzing performance.



Lean digital practices are especially important for businesses requiring third party manufacturing services or those with diverse supply chains.

Once a solution architecture is agreed upon, a readiness analysis should be conducted to validate the functional architecture design. Without this, shortcomings in the design will only become evident during implementation, which only adds more work and may reduce overall efficiency gains from the LDM initiative.

Implementation

With the production processes defined, the bill-of-process (BOP) is digitally captured and sent to a manufacturing execution system. An optimal job sequence can be planned based on plant availability or other possible manufacturing restrictions. Any work instructions, technical or safety information is automatically generated and available to all employees in production. A comprehensive quality management system ensures immediate detection of quality variations, enabling proactive resolution.

For the company that has already completed each of the previous phases and has an LDM facility up and running, implementation often means expanding the process to other facilities. Unless the process was simplified and enacted holistically, expanding to a new facility with different manufacturing devices or processes is a challenging goal. Fortunately, we have a wealth of experience here and a firm grasp of how to expand beyond the first LDM facility.

The implementation phase of LDM is critical. Once the process is running and valuable manufacturing data is being collected, many of our services as a software and manufacturing partner can be fully utilized. We can provide application guidance and even co-development. With process information constantly refining the comprehensive digital twin, method optimization and performance analysis become far easier. In the event of errors and inefficiencies, we are there to troubleshoot and provide the best manufacturing process for your facilities.

Conclusion

No matter where a company is on the path to lean digital manufacturing, Siemens can help. The Xcelerator software and services portfolio and world-class factory automation solutions are an invaluable combination for companies responding to the pressures of greater mass customization. No matter where they are on their digital transformation journey, manufacturers can benefit

greatly from the best practices and solutions accumulated from our experience at Amberg and our other facilities around the world. Now manufacturers can confidently address where today meets tomorrow, implementing LDM initiatives to provide a robust path toward enhanced optimization and flexibility in the world of production and manufacturing.

Siemens Digital Industries Software

Headquarters

Granite Park One
5800 Granite Parkway
Suite 600
Plano, TX 75024
USA
+1 972 987 3000

Americas

Granite Park One
5800 Granite Parkway
Suite 600
Plano, TX 75024
USA
+1 314 264 8499

Europe

Stephenson House
Sir William Siemens Square
Frimley, Camberley
Surrey, GU16 8QD
+44 (0) 1276 413200

Asia-Pacific

Unit 1601-2, 1604B, 16/F
Tower A, Manulife Financial Centre
223-231 Wai Yip Street, Kwun Tong
Kowloon, Hong Kong
+852 2230 3333

About Siemens Digital Industries Software

Siemens Digital Industries Software is driving transformation to enable a digital enterprise where engineering, manufacturing and electronics design meet tomorrow. The Xcelerator portfolio helps companies of all sizes create and leverage digital twins that provide organizations with new insights, opportunities and levels of automation to drive innovation. For more information on Siemens Digital Industries Software products and services, visit www.sw.siemens.com or follow us on [LinkedIn](#), [Twitter](#), [Facebook](#) and [Instagram](#). Siemens Digital Industries Software – Where today meets tomorrow.

www.sw.siemens.com

© 2020 Siemens. A list of relevant Siemens trademarks can be found [here](#). Other trademarks belong to their respective owners.

82100-C4 6/20 N