Manufacturers trying to keep up with changing markets are facing many challenges. Today's digital technologies provide solid answers.

Manufacturing, as we know it, began with the industrial revolution as water and steam power provided the means to move from small-scale, extremely local production. It took a major step as electricity made even larger-scale mass production practical. Then, automation made manufacturing more efficient, but mass production continued. Now, the next phase of industrial manufacturing, digitalization, is being utilized in many industries to realize benefits never achievable previously in manufacturing.

Author:
Doug LeVasseur
US Automation Business Developer
Siemens Industry, Inc.

usa.siemens.com/modernize
When implemented, digitalization brings a high degree of change. Mass production is now very common, but digitalization enables individualization versus simply throughput by simplifying the concept of mass customization.

In addition to meeting consumer demand, digitalization provides the means to differentiate in these key areas:

- Reduces time to market – Shorter innovation cycles, even with highly complex products and large volumes of manufacturing data.
- Enhances flexibility – Individualized mass production becomes far more practical making it easier to respond to volatile markets while maintaining high productivity.
- Increases efficiency – Energy and resource efficiency can be gained, making them key competitive factors.
- Continuous optimization and improvement – Horizontal and vertical integration provides the ability to make improvements throughout the value chain.

Using digitalization

Digitalization links together the five main phases of a product value chain:

- Product design
- Production planning
- Production engineering
- Production execution
- Services

But how does it work? Think about the first step of the process: product design. Producers are always looking for ways to ensure items with multiple parts work together as expected. When engineers describe fits and tolerances accurately, things work better, but there is always room for error. Comparing drawings side-by-side for related parts helps but critical points can be missed.

Digitalization changes the picture. The ability to create models of individual items and see how they interface while watching everything on a computer screen makes the process much easier. Complex shapes and interactions can be tested and adjusted without the cost and time expended making prototypes. And the scale can be expanded from one or two parts to an entire machine with hundreds or even thousands of components interacting.

Simulation, an element of digitalization that creates a digital twin of each component in a device or machine,
lets designers and builders explore what-if scenarios easily, inexpensively and quickly despite product size or complexity. Testing the interaction on a screen can verify a modification before new holes need to be drilled or something else moved. Designers of complex equipment have come to depend on this kind of capability.

“Simulation means I know it will work and construction plans mean I think it will work,” said Rainer Feuchter, CEO of Optima Machinery Corporation, a global builder of specialized packaging machinery. “There is a huge difference.”

Optima has embraced digital manufacturing because of its ability to simplify the design process and make it much faster. When everything from idea to execution can be simulated on a screen using one seamless platform, time to market can be shortened drastically, but that is only one element of the larger picture. Digitalization ties the entire manufacturing process together, from initial concept to field service.

Your manufacturing engineering team looks at the same simulations and decides the best ways to make the needed components. Those digital models can be loaded into machining centers to write the programs controlling cutters or making molds. The whole manufacturing process can be automated and integrated with these systems, breaking down the traditional silos and walls between different parts of the production chain. Vendors and customers can be integrated as well. Purchased parts can be included in simulations, and interactions with suppliers become part of the larger picture.

Humans, devices and systems are all connected along the value chain. This means information is available in real time across one end to the other, keeping suppliers, manufacturers and customers informed at every stage of the process. The result: any part of the value chain can be optimized constantly with respect to different criteria. Maybe the most pressing need today is cost, but tomorrow it may be resource utilization, or accommodating an emerging customer need.

A digital factory example: Siemens

Siemens is among the world’s largest manufacturers, and understands the need for manufacturers to build more flexible and scalable operations for faster time to market, lower operational costs and more design flexibility. Siemens has more than 300 production facilities scattered around the world, and one of its factories, the Electronic Works Amberg (EWA) is among Siemens most thoroughly automated factories. With its digitalized operations it turns out highly complex products. For example, three major product families come out of this location: SIMATIC S7 PLCs, the SIMATIC ET200 I/O platform and SIMATIC HMIs.

At EWA production is largely automated. Machines and computers handle 75 percent of the value chain on their own; the rest of the work is done by people. What’s notable here is that SIMATIC units control the production of SIMATIC units. About 1,000 such controls are used during production, from the beginning of the manufacturing process to the point of dispatch.

Additional details of production at EWA:

• Production quality is at 99.99885 percent, and a series of test stations detect the few defects that do occur
• 1,000 different products manufactured
• 50 million process items recorded and entered in SIMATICIT daily
• 1,000 Teamcenter managed product variants, and
• 60,000 customers supported from this site

“I don’t know of any comparable plant worldwide that has achieved such a low defect rate,” says Professor Karl-Heinz Büttner, who heads the EWA. The factory manufactures 12 million SIMATIC products per year. At 230 working days per year, this means that the EWA produces one control unit every second.

EWA is not a new facility. PLCs and earlier electronic industrial products have been produced there since it opened in 1966. Back then, like most manufacturing, it was operating under concepts of small-scale local production. By 1995, it had become more sophisticated and automated following lean production and connectivity using intranet and Internet networks kept things moving efficiently.

Now it is a showcase of the digital enterprise. Automation has moved to the point where PLCs are making PLCs. The labor force is small and highly skilled to maximize output at the lowest possible cost. Engineering and manufacturing are fully integrated vertically and horizontally, following a digital product lifecycle. Siemens customers routinely visit the site to see these capabilities working in an actual manufacturing facility subject to the same customer drivers and pressures.
A comprehensive technology offering

Siemens has developed a large suite of products and software to support all phases of manufacturing enabling digitalization, including:

- Engineering, design tools and simulation
- Lifecycle data management for products and production
- Digital manufacturing
- Manufacturing operations management
- Industrial control systems
- Asset management
- Industrial communication and security
- Sensors and actuators, and
- MRO and service.

As a complex machine requires many components, digitalized manufacturing calls on all these areas to help companies compete in this new environment. There are many specific product families and software platforms to support these functional areas, providing a consistent connection between the IT level and machine level.

Two software platforms, NX and Teamcenter provide the basic tools to move from a virtual component to a virtual product and on to an actual product.

NX provides key capabilities for fast, efficient and flexible product development. It brings advanced solutions for conceptual design, 3D modeling and documentation combined with simulation for structural, motion, thermal, flow and multi-physics applications. NX software helps design, simulate and manufacture products faster in an integrated product development environment. Teamcenter supports close coordination with suppliers and serves as the central data backbone to integrate all the engineering functions, which enhances flexibility to respond to market and customer needs.

For manufacturing, Siemens provides a huge variety of products, including manufacturing hardware, such as SIMATIC and SINUMERIK PLCs, HMI, sensors, motion control and industrial networking devices. All these elements are tied together through the TIA portal, enabling coordination and a common programming platform, which decreases engineering time and enables faster time to market.

At the enterprise levels, SIMATIC IT gathers information and provides mechanisms to perform analysis and create reports. This is where big data comes into play, where the facility can identify all objects and processes, record all process values, and perform autonomous process analysis. Plant managers can access MES information to monitor quality, plant production levels and overall company performance. As a result, continuous optimization and improvements can be made throughout the value chain.

The present and future of manufacturing

When all the barriers and disconnects between functional areas are removed, the benefits of digitalization can be realized. From machine building to digital enterprise operation, production can adapt to the changing demands of customers, improve profitability and long term viability in this an ever-changing and global environment.