

DIGITAL INDUSTRIES SOFTWARE

Six keys to success with **digital manufacturing**

Integrated manufacturing planning and validation for production excellence.

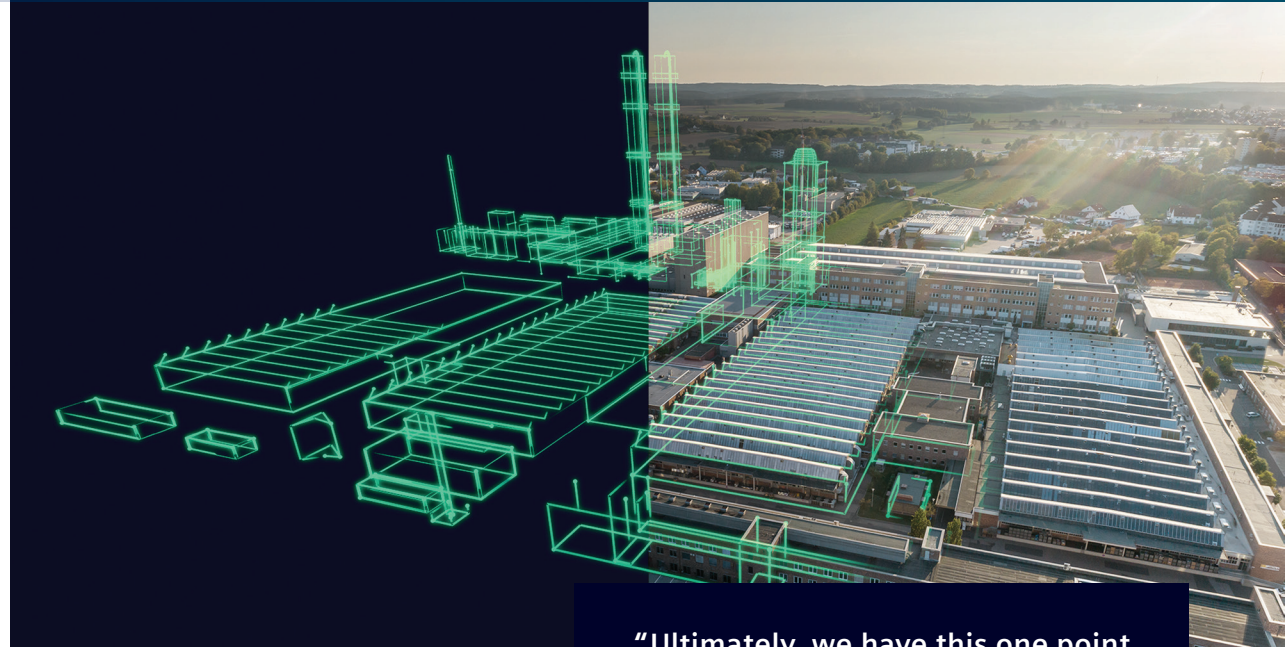
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What it takes to become a digital manufacturing enterprise

Today's extraordinary market forces make it clear: to thrive, manufacturing businesses must become digital enterprises. Further, they must build this enterprise to include a digital manufacturing solution. Indeed, digital manufacturing has evolved from a novel approach to an indispensable practice as manufacturing engineers seek to accelerate innovation, achieve flawless production, ensure quality and efficiency and orchestrate data-driven production excellence on their shop floors.

What is needed for your company to successfully implement digital manufacturing? In our expansive work with manufacturers of all sizes, locations and product portfolios, Siemens Digital Industries Software has identified six key elements that comprise a comprehensive solution, one that goes deep and wide to cover all aspects of manufacturing planning, validation and execution. In this ebook, we share these key elements as well as the manufacturing engineering software solutions we have innovated so you can use them to enhance your business vitality.



Standalone digital systems have taken manufacturers a long way down the paths of innovation, efficiency, quality and cost; but for most industries, these siloed systems have reached their limit. In today's competitive environment, you must quickly convert design data for each new product or variant into manufacturing processes optimized to efficiently produce high-quality finished products. Only an interconnected digital ecosystem can keep up with this demand.

Digital manufacturing, the union of manufacturing engineering and manufacturing operations, is how forward-looking manufacturers are achieving

“Ultimately, we have this one point of truth. Our digital factory solution based on Siemens software is the right way forward for BSH, especially because our overall goal is closed-loop manufacturing.”

*Philipp Winter
IT Business Consultant, Global Digital
Services Department
BSH Digital Factory*

digital continuity between innovative product designs and best-in-class performance.

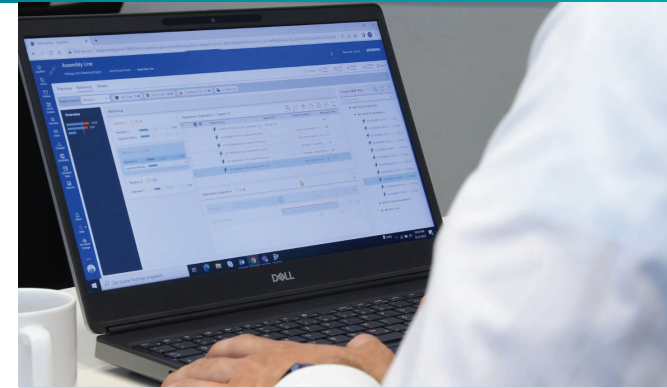
For example, BSH Home Appliances, is standardizing process planning across its 40 plants by leveraging an open, web-based, easy-to-use manufacturing planning solution from Siemens. BSH planners and manufacturing engineers use Teamcenter® Easy Plan software and the Tecnomatix® portfolio along with integrated TiCon software from MTM Association for time management of operations to continuously adapt production lines. This includes planning and line operator tasks to accommodate hundreds of product variants and optimizing lines for maximum performance. Their digital manufacturing solution is improving planning efficiency by a double-digit percentage.

Digital manufacturing addresses today's manufacturing challenges:

- Addressing disruptive technologies and growing demand for mass customization, using digital manufacturing accelerates innovation, speeding new product introductions and quickly incorporating design and process changes
- Accommodating smaller lot sizes and faster, more frequent production changeovers, digital manufacturing enables you to drive first-time-right manufacturing that anticipates every issue and resolves it virtually before the first production run
- Replacing old approaches that addressed tighter margins by compromising quality for efficiency or vice versa, using digital manufacturing allows you to simultaneously achieve both high quality and production efficiency

- Enabling you to attain ongoing business vitality in a globalized, increasingly competitive market, digital manufacturing enables you to orchestrate production excellence by continuously improving end-to-end manufacturing performance

To ensure success with digital manufacturing, the following are six key elements to look for in a solution, highlighting integrated manufacturing planning and validation. The following Siemens use cases illustrate how manufacturers are achieving new levels of innovation, efficiency, quality and cost.



Complex manufacturing process planning at BSH with Teamcenter Easy Plan.



Key #1: A robust digital thread streamlines accurate data sharing

“We now have a manufacturing structure managed by a single system and fully integrated with product engineering; as a result, 40 percent reduction in engineering time was achieved for the creation of work instructions.”

*Luiz Romanel
CNH Industrial*

An interconnected digital ecosystem streamlines cross-functional collaboration and accurate data flow. Disconnected systems often result in error-prone data duplication and cloning, multiple versions and other costly discontinuities. Conversely, a common digital backbone shared with product design, manufacturing planning and execution, improves collaboration across the entire product and production lifecycle.

The digital thread connects manufacturing engineering, manufacturing operations and the performance of plant resources with enterprise, design and automation systems. Speeding the dialogue and activities across design and production, the digital thread ensures continuity, accuracy and version control.

CNH Industrial, a global agricultural and construction equipment company, has reduced manufacturing engineering time by 40 percent by implementing Siemens digital manufacturing solutions to create a digital thread that runs from design engineering to manufacturing engineering. This enables streamlined, standardized work instruction authoring and collaborative, multiproduct line balancing across all their plants.

The Siemens digital manufacturing solution provides a digital thread that has been tuned to share manufacturing information. It integrates a rich set of digital tools to support the planning, optimization, simulation and validation of manufacturing processes and required production equipment.

Collaboration across the digital thread enhances manufacturing outcomes:

- Information defined and created by product designers is seamlessly communicated **downstream** to manufacturing engineers, quality personnel, shop floor technicians; anyone who needs it for their job functions
- Information generated on the shop floor is efficiently shared **upstream** with designers and manufacturing engineers, enabling documentation and analysis of the as-built product compared to the as-planned product
- When production personnel must **modify planned processes** to make them compatible with equipment and capabilities, the digital thread alerts designers and manufacturing engineers to these changes, enabling them to confirm the as-built product meets customer requirements
- Tighter **collaboration** between design engineering and manufacturing engineering enables you to reduce the time required to get new products to market. Design engineers can consider multiple scenarios for how a product can be manufactured before committing to a particular design. Manufacturing engineers may study designs early in the development cycle to ensure efficient manufacturability



Key #2: The comprehensive digital twin reduces risks and costs

Identifying issues before they occur on the shop floor is at the heart of manufacturing planning and validation. To do so, digital manufacturing solutions enable you to fully employ the virtual realm to simulate, predict and optimize products and manufacturing processes before investing in actual production.

The comprehensive digital twin supports manufacturing engineering efforts with a virtual representation that comprises all critical attributes and aspects of a product and its manufacturing process. Backed by the digital thread, the digital twin provides valuable insight prior to production as well as insights that drive continuous manufacturing improvements. This constant stream of accurate information makes manufacturing operations faster, more efficient and more reliable.

Guangzhou MINO Equipment Co. has leveraged the comprehensive digital twin to achieve a 30 percent reduction in project cycles and 98 percent accuracy in production line simulation, significantly reducing delivery time of its automotive production systems. Using Teamcenter enables MINO to design and plan its systems in 3D and virtually commission them well in advance of real production, eliminating trials on the factory floor and reducing on-site debug time through the digital twin.



“By simulation the whole production line, we can identify defects and problems in the design to make necessary corrections before real production.”

*He Wei
Production Director
Guangzhou MINO*

Siemens offers a highly realistic digital twin including production processes and systems, all connected tightly to our product lifecycle management (PLM) digital backbone. We provide the software tools needed to create a virtual model for every type of production process you may have.

Use the comprehensive digital twin to benefit your manufacturing engineering efforts:

- The digital twin enables you to design and simulate manufacturing processes, meet requirements and address constraints before you produce any physical prototypes
- Using the digital twin to plan, model and simulate manufacturing and assembly processes in the virtual realm results in safe, efficient facility operation, as well as the ability to quickly adapt to unanticipated events
- Using digital twin data from product and production, businesses can prevent costly equipment downtime. They can also make preventive maintenance more efficient, using digital twin data to transition from routine to condition-based maintenance scheduling



Key #3: Data-driven planning accelerates flawless production

The proverbial rubber meets the road for manufacturing engineers each time they receive design data for a new product or variant. To optimize manufacturing processes and efficiently produce high-quality products, today's marketplace requires more frequent, complex and faster manufacturing engineering work. Trials on the factory floor are no longer an option. How will you engineer a flawless manufacturing process faster than ever every time?

Dedicated manufacturing engineering software enables your manufacturing engineers to author, simulate and manage manufacturing data, collaboratively aligning plans with product design. Software functionality developed explicitly for manufacturing engineering includes:

1. Reconciliation of engineering and manufacturing bill-of-materials (eBOM and mBOM).
2. Bill-of-process (BOP) creation and update.
3. Production time analysis and line balancing.
4. Creation of shop floor electronic work instructions (EWIs)



Because you can optimize production schemes before expending shop floor time and equipment, you achieve faster and lower cost production that realizes consistently high quality in your finished products.

Siemens manufacturing planning tools are designed to advance your plans smoothly and transparently from eBOM, mBOM and BOP to EWIs and receive shop floor feedback that delivers constant process and quality improvement. Teamcenter Easy Plan, a task-based planning solution with an intuitive user (UX) experience, provides a single environment to capture all manufacturing data from different systems, helping you manage global production scenarios efficiently.



Key #4: Simulation and virtual validation deliver first-time-right production

Digital manufacturing reduces the time and costs that physical testing of a manufacturing system would incur. This fundamental benefit of digital manufacturing holds true if you can quickly, accurately and comprehensively interact with the planned manufacturing system in the virtual realm.

Manufacturing and assembly simulation is a key capability of digital manufacturing that ensures the planned process can be executed efficiently on the shop floor. It uses digital tools as part of the production digital twin to test manufacturing methods and procedures, including production, assembly, inventory and transportation. Robust 3D visualization capabilities, including virtual reality (VR), are an essential element for successfully validating manufacturability.

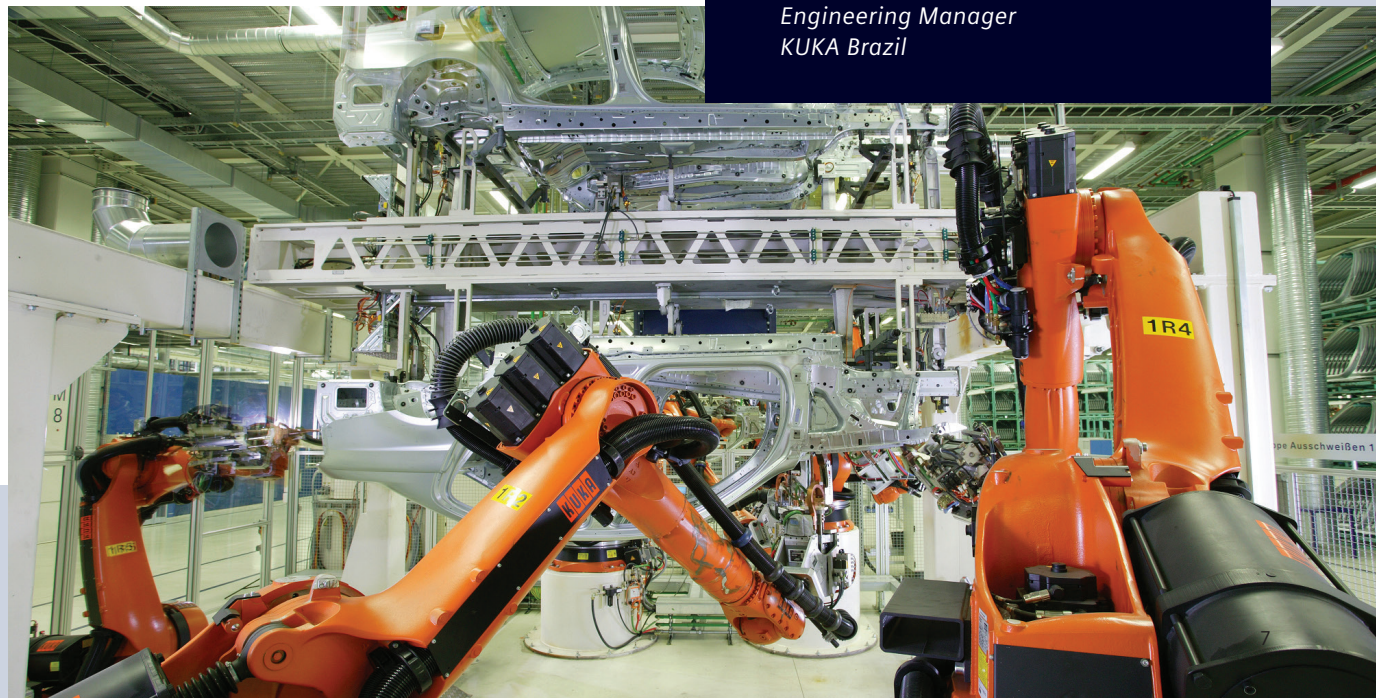
By simulating your process using a digital twin and analyzing why things are happening using the digital thread, you can create a production methodology that stays efficient in a variety of conditions. Timely collaboration between manufacturing engineering, manufacturing operations and business systems with virtual validation reduces risk and costly downstream issues.

“With Process Simulate Virtual Commissioning, we can get the robotics work cells 98 percent ready before ever going to the shop floor.”

*Gilmar Miranda
Engineering Manager
KUKA Brazil*



GKN Aerospace's Kongsberg plant production floor.

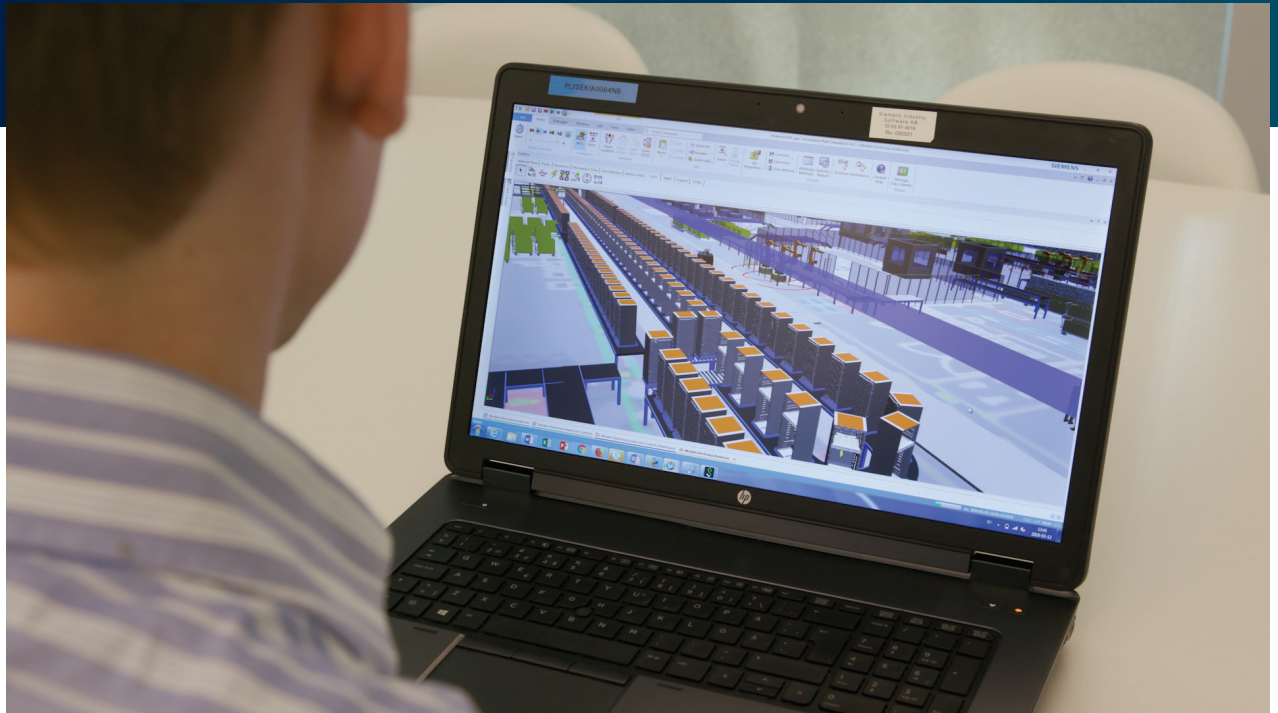


“We started to use Plant Simulation as we needed a better strategic planning tool to analyze and plan production capacity.”

*Alexander Hall
MOM-MES Architect
GKN Aerospace Engines
Business Line, TI-IS*

“The factory is too expensive to use as an experimental field. We must deliver better quality with less cost while eliminating production downtime.”

*Bernd Ebert
Senior Director Group Manufacturing Engineering
Food Preparation
Electrolux*



Tecnomatix Plant Simulation used at Electrolux.

Electrolux has already saved \$2 million in buffer space and associated investments as the company creates a digital twin of all its manufacturing sites, simulates and optimizes assembly processes using Plant Simulation in the Tecnomatix portfolio, and conducts robot simulations with Process Simulate in the Tecnomatix portfolio. The company is also implementing 3D factory planning using Line Designer with central libraries. In addition to cost savings, Electrolux has protected plant designs and investments and ramped up new plants without errors or delays.

Key #5: Closed-loop manufacturing ensures continuous improvement

Manufacturing agility in the digital era requires closed-loop collaboration across manufacturing engineering, manufacturing operations and beyond to enhance the performance of plant resources in concert with enterprise and automation systems. Such collaboration enables manufacturing engineers to perform virtual analysis of recurring issues and perform corrective actions and impact analysis to incorporate error-proof changes into production.

Closed-loop manufacturing (CLM) leverages your experiences in manufacturing performance using closed-loop feedback to improve product designs and manufacturing processes. A robust digital manufacturing solution achieves CLM by aggregating context-driven data intelligence from product, process, machine, people and business. It supports advanced data analytics, which leads to predictive and prescriptive manufacturing insights and a culture of effective data-driven decision-making.

Meccanotecnica Umbra (MTU) has reduced the time required for root-cause analysis by 90 percent in the company's production of mechanical seals in facilities across 10 countries worldwide. By implementing Siemens integrated manufacturing solutions, MTU was able to provide products of the highest quality regardless of production site. Along with MTU's enterprise resource planning (ERP) system, Teamcenter and Opcenter™ software systems were used to create a closed-loop quality management solution. MTU has also realized the paperless factory, improved production efficiency and traceability and reduced production costs.

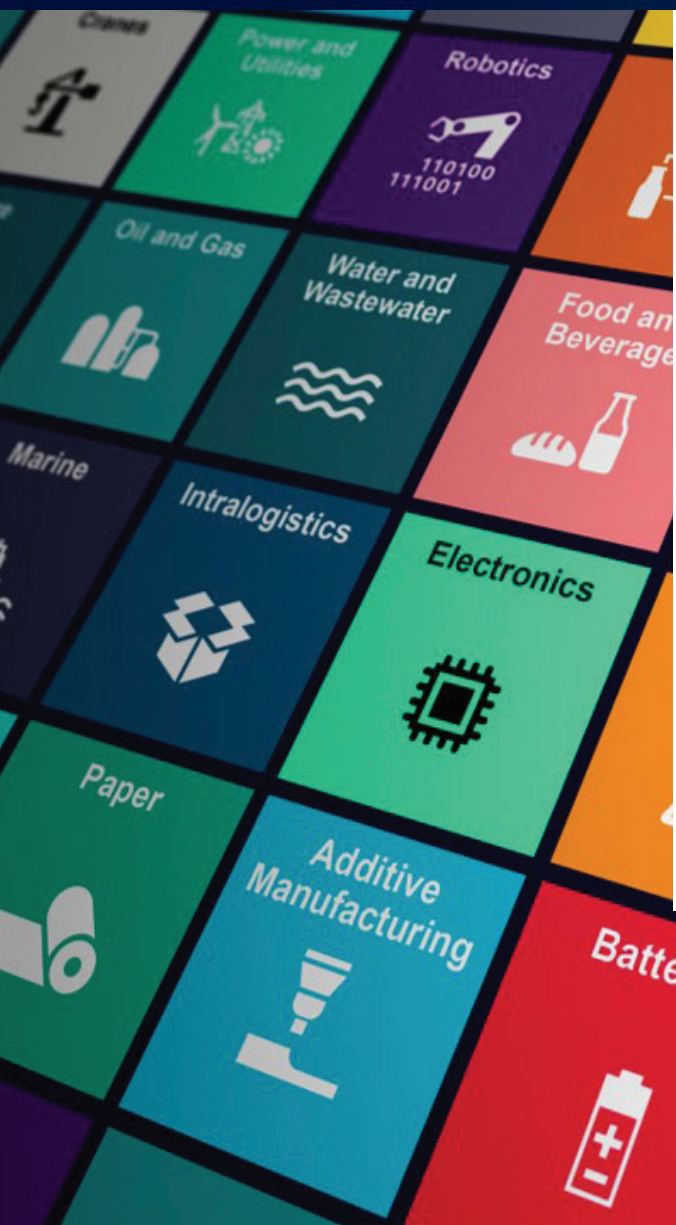
"MTU has been transformed over the years from a small company to a multinational company capable of withstanding the challenges of a global market thanks to an increasingly digital infrastructure."

*Gianluca Paoli
Corporate Head of Information and Communications
Technology
Meccanotecnica Umbra*

Teamcenter, Tecnomatix, Opcenter and Siemens digital manufacturing solutions are part of the Siemens Xcelerator portfolio, the comprehensive and integrated portfolio of software hardware and services. It is engineered to help you collect, analyze and visualize data, creating closed-loop analytics from development to manufacturing to real-world feedback – and then back again. By creating a collaborative, connected information loop, Siemens Xcelerator supports CLM to continuously improve the cost, time and quality of manufacturing efforts. It accelerates the delivery of products at optimal quality and cost.



Key #6: The right digital systems provider helps drive production excellence



The keys to success with digital manufacturing that we have described so far confirms our conviction that choosing the right digital industries software partner is vital. The digital tools you select today must be change agents that serve your strategic vision and manufacturing initiatives for the next decade or more. Your digital manufacturing partner must keep pace as you drive your business forward.

We have built our digital manufacturing solution and the entire Siemens Xcelerator portfolio by listening to and learning from our customers, then innovating and capturing best practices for every digital task across industries. Your user experience with our products has contributed to a rich and deep knowledge base and an extensive set of integrated product capabilities. We use this best practice to accelerate time-to-value of our software. Our robotics, assembly and machining simulation and plant design and optimization deliver a validated and optimized production process to the shop floor.

By leveraging the appropriate solutions within our portfolio, you can modernize your products and production processes to keep pace with innovation and disruptive market pressures.



Bringing process and product innovations to life

What is the value of a modern digital manufacturing solution for you? From our customer experiences, we can confidently say that digital manufacturing raises new product introduction (NPI) rates, decreases cost of change and quality and establishes a digitally connected process for recommending continuous improvements. It allows your manufacturing engineers to proactively consider engineering or supply chain changes to better plan the required process updates supported by associated production-ready feasibility studies and impact analysis.

Connecting traditionally disconnected departments and processes will bring your product and process innovations to life with speed and excellence. A digitally connected manufacturing enterprise delivers streamlined product development innovations with a virtually validated process that is optimally executable with closed-loop actionable data intelligence at scale, from a single location to global sites in collaboration with the supply chain.



About Siemens Digital Industries Software

Siemens Digital Industries Software helps organizations of all sizes digitally transform using software, hardware and services from the Siemens Xcelerator business platform. Siemens' software and the comprehensive digital twin enable companies to optimize their design, engineering and manufacturing processes to turn today's ideas into the sustainable products of the future. From chips to entire systems, from product to process, across all industries, Siemens Digital Industries Software is where today meets tomorrow.

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