SIEMENS

DIGITAL INDUSTRIES SOFTWARE

Four keys to modernizing A&D manufacturing execution

How smart manufacturing optimizes products and processes for the flexible, connected factory of the future

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SERIES INTRODUCTION

Reducing risk, cost and time-to-market with **smart manufacturing solutions**

If your aerospace and defense (A&D) company is like most, the goal of your manufacturing operations has not changed. But everything else has. You still want to achieve on-time, on-budget delivery of products that consistently meet certification. But today you're trying to reach this goal while managing the complexities of electrification, increased software integration and connected products, sustainable parts, labor shortages, supply chain interruptions and new processes to deliver on these innovations. Without a drastic change in your approach to product and process development, your target timelines or budgets are no longer attainable.

Yet forward-looking A&D companies have found a way to still realize these objectives. They have stopped performing linear, document-driven processes. They no longer have siloed teams working independently in each manufacturing discipline. Instead, through smart manufacturing solutions for digital transformation of their manufacturing processes, they are implementing concurrent, collaborative manufacturing development.

When we say "**intelligent manufacturing**" or "**smart manufacturing**," what do we really mean? And what does it mean to digitally transform manufacturing? It means leveraging an open, flexible ecosystem to help accelerate production ramp-up and deliver complex products faster with right first-time quality. It helps you achieve a seamless, consistent alignment of the as-built product with the as-designed product.

If this intelligent manufacturing concept has you picturing a "big bang" mega-project, we are glad to report that this is not the case. This series of ebooks will help you develop a road map and identify the best starting point to meet your business needs. The road map will set you on a path to realize significant benefits with each incremental step you take.

The solutions for intelligent manufacturing are built upon the unique, flexible and open Siemens Xcelerator business platform. They offer you the opportunity to deliver smart manufacturing efficiencies in three key areas of your business:

Developing a model-based plan
Uniting the virtual and real worlds to validate the plan
Optimizing products and processes

EXECUTIVE SUMMARY

A successful first launch of a rocket, deployment of your mission, or first flight of an aircraft is exhilarating for most if not all A&D professionals. But after product launch, you must quickly turn your attention back to making flawless products for subsequent missions. Competing in today's A&D marketplace requires continuous improvement in terms of quality, cost, process, sustainability and other critical aspects of your products and processes.

The final pillar of Siemens' comprehensive smart manufacturing solution for A&D manufacturing, and the subject of this third ebook in our three-part series, is to **optimize your products and processes** for the flexible, connected factory of the future. Bear in mind, if your manufacturing planning (ebook one) or manufacturing plant and processes (ebook two) presents the best opportunities for your company to reduce risk, cost and/or time-to-market, you will want to read either or both of these ebooks.

Smart solutions for manufacturing help to optimize your products and processes by increasing visibility into the manufacturing environment and providing an opportunity to leverage data in future iterations. In this way, smart manufacturing supports flexible, dynamic closed-loop production execution, optimization and traceability.

As you well know, to maintain your competitive edge there is no "resting on one's laurels" in A&D manufacturing. Through our smart solutions for manufacturing, you will have the digital connections and capabilities needed to keep moving forward and deliver complex, quality products with closed-loop manufacturing and closed-loop quality initiatives.

Optimizing products and processes through closed-loop initiatives

Is your manufacturing shop floor operating as a competitive advantage or an encumbrance? The collaborative, interconnected product and process development offered by smart solutions for manufacturing can provide your company a big competitive advantage – but only if you are able to execute your design intent on the manufacturing floor and be certain that every product you deliver consistently conforms to the customer's requirements. How can you keep your manufacturing operations humming as you build new, more complex products delivered at the accelerated pace demanded by today's A&D marketplace?

Siemens A&D customers tell us that **continually optimizing and modernizing their facilities** is essential to their competitive edge. Digital manufacturing solutions allow them to efficiently orchestrate production operations (closed-loop execution of systems and operations), realize continuous improvement (closed-loop optimization), and (document each product as built (closed-loop traceability).

Closed-loop execution of automated manufacturing systems connects design and engineering data to production automation and machinery on the actual manufacturing floor. This full connectivity enables the system to orchestrate shop floor operations based directly on the most current design and engineering data, even when engineering changes are made.

Closed-loop execution of manual operations includes functionality like electronic work instruction (EWI) development and intuitive user interfaces. These enable you to increase workforce productivity, an important part of your response to the skilled labor shortages trending in the A&D industry. Operator feedback and data generated on the shop floor are used to develop manufacturing insights that spark process improvements.

Closed-loop optimization of manufacturing execution begins in real time, as smart manufacturing systems can instantly alert your production team to fix line or process problems during production. This brings nonconformance from the shop floor back to engineering, which improves predictability as it ties analysis of anomalies to quality and feeds predictive maintenance. Smart manufacturing further leverages data so that iterations of your product over time can be optimized.

Closed-loop traceability helps you more efficiently meet certification requirements and demonstrate compliance. The industrial internet of things (IIoT) and Industry 4.0 technologies have strengthened A&D companies' ability to trace and electronically document their production processes. Smart manufacturing systems automatically trace as-built data and populate reports. Production data can then be fed upstream to support continuous improvement.

Understanding limitations of the traditional approach and supporting systems

While the product design capabilities of product lifecycle management (PLM) systems are bedrock tools well established in nearly all A&D manufacturing enterprises, the traditional approach to A&D components and assemblies fails to fully leverage PLM manufacturing engineering and planning capabilities or the tools available in today's manufacturing operations management (MOM) solutions. As a result, companies relying on traditional approach and systems face detrimental limitations.

Nondigital communication to the shop floor: Paper-based solutions remain the norm in manufacturing operations for many A&D companies. The relatively low volumes of A&D production have allowed this practice to continue, but growing volumes as well as accelerated design and engineering changes and demand for faster ramp-ups make nondigital communications too risky for today's factory. Deriving manufacturing plans from multiple, disconnected systems and then converting them to paper schedules, work instructions and travelers is unacceptably tedious and prone to unchecked errors.

Siloed, tribal knowledge of equipment and operations: As experienced, skilled personnel leave the shop floor, they take their know-how with them. It is no longer viable to rely on these artisans and apprenticeships, so standardized and electronically documented guidance is needed. New technologies like augmented reality (AR) devices are also becoming must-haves in some operations, but older systems do not support them.

Poor visibility of process issues: When a critical performance parameter for a production machine drifts out of tolerance, traditional systems frequently do not detect this issue until a downstream quality check finds problems in the work-in-progress (WIP). By then, numerous additional WIPs may have been created with nonconformances, leading to expensive rework or scrapping. In some cases, the problem repeats but is not traceable, which leads to further delays.

Sparse manufacturing information: Operators on a traditional shop floor often simply stamp or initial a traveler to indicate completion of a process step. The resulting record only affirms that a task was performed, not how it was performed or any quantitative results of the task.

Difficult root-cause tracing: When a nonconformance occurs, it may be impossible to determine what process step introduced the defect, much less how it was introduced or what can be done to prevent more nonconformances from the same source.

Transitioning to a flexible, connected factory to overcome these challenges

When it comes to actually building and delivering your A&D products – quickly, cost-effectively and meeting all certification requirements in a fast-evolving industry landscape – digital manufacturing systems are essential. Smart solutions for manufacturing enable you to simultaneously optimize products and processes, reduce costs and ensure consistent product quality, all while automatically tracing and documenting everything.

Smart manufacturing solutions allow you to convert siloed, tribal knowledge of production equipment and processes to electronic work instructions, AR devices, automated processes and other means of accelerating accurate production. Standardized, role-based operator guidance and IoT sensors and smart devices allow you to monitor, predict and correct operational performance in real time, reducing downtime and increasing efficiency throughout production.

You will also reduce rework and scrap, since smart manufacturing solutions provide shop floor visibility that enables real-time adjustments and fixes to production equipment, processes and WIPs.

As you advance your operations beyond current capabilities, digitalized operational control lets you quickly implement legacy equipment updates as well as advanced manufacturing technologies like composites, additive manufacturing, AR and virtual reality (VR). You will maintain production accuracy and traceability while reducing risk.

A smart solution for manufacturing integrates PLM and enterprise resource planning (ERP) solutions with MOM software solutions, including production planning and scheduling, manufacturing execution, quality management and manufacturing intelligence/data analytics. This creates a manufacturing “golden triangle” that maximizes the flexibility of and visibility into your manufacturing environment.
To gain these benefits, the following four keys to our digital solutions for manufacturing help create a successful path to optimized products and production in your factory of the future.

USE CASE

Proform tubular parts

As Proform grew its business making complex tubular parts for aerospace and other industries, the Lyon, France-based company quickly outgrew its production scheduling approach that relied on Excel spreadsheets. From 30 work centers running eight hours a day, the company grew to 260 work centers running 24 hours a day. To gain visibility through as much as 18 months of planning and scheduling, Proform adopted smart manufacturing solutions that **increased administrative efficiency by 87 percent and raised on-time delivery to 96 percent**.

For more information read the case study.

KEY #1

Develop **flexible scheduling** and work orders

Leveraging simulation tools along with big data analytics and artificial intelligence (AI), smart solutions for manufacturing enable you to make better decisions faster as you execute production orders, operations sequencing and WIPs based on the manufacturing process plan.

Rather than relying on inflexible spreadsheet or homegrown siloed production planning systems, smart manufacturing solutions include connected capabilities tailored to both long- and mid-term planning and day-to-day scheduling of the sequence of production orders. Your planners can evaluate different what-if scenarios to optimize equipment utilization based on actual manufacturing data.

Supporting these production planning and scheduling tools, AI and data analytics feed on the vast quantities of data produced by sensors and inspection devices overseeing your complicated processes. They ferret out patterns and trends, which they use to predict risks and help you reduce them. As computing power has grown, AI now requires mere minutes to generate predictive models that might have taken weeks or months without it – if they could be generated at all.

With these powerful tools, your team can quickly determine the best way to increase production based on plant capacity, workforce capabilities and available resources and facilities. You can also easily manage various product configurations. Using the connected, intelligent and flexible approach offered by smart manufacturing, you can quickly adjust your lines to fit your configuration-specific or order-specific production needs.

KEY #2

Digitalize operational and quality control

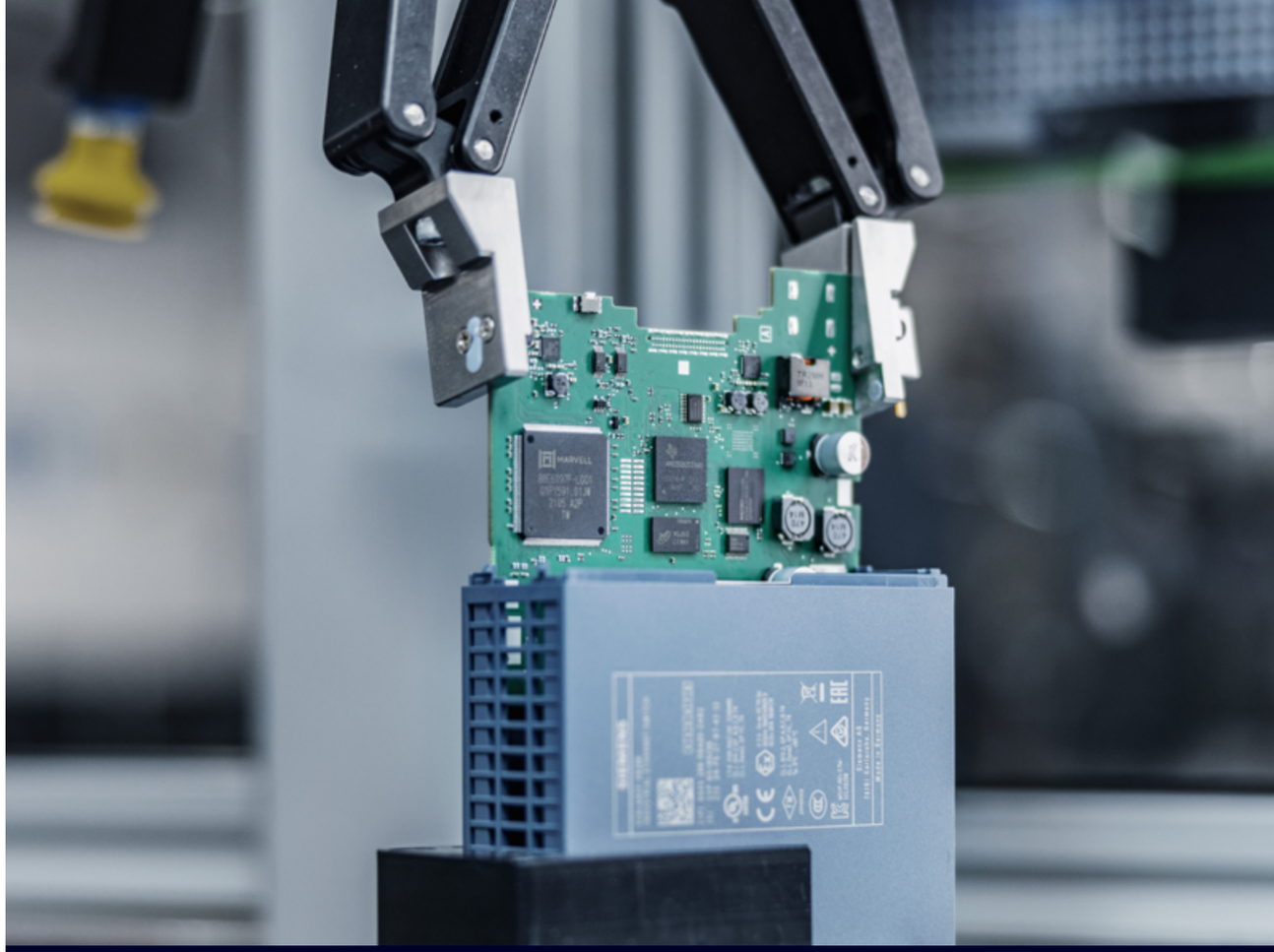
Smart solutions for manufacturing comprise the digital engine that coordinates product design and production engineering and planning with production execution. The cross-domain connections supported by these solutions take your operational and quality control capabilities far beyond what standalone manufacturing execution systems (MES) or quality management systems (QMS) offer.

In digital manufacturing, connected systems share the same data about your manufacturing mission through the comprehensive digital twin and a common digital backbone, which together maintain end-to-end digital manufacturing continuity. The smart manufacturing solution orchestrates manufacturing execution by communicating needed design and engineering information to the digital systems on the shop floor, including IIoT, automation supervision (SCADA) and edge devices that control automated equipment.

Human-machine interactions and user interfaces benefit from smart manufacturing intuitive task management. Operators perform the right task at the right time with the right materials and equipment, guaranteed by digital continuity. Up-to-date electronic work instructions guide operator activities with text, videos, 3D models and AR/VR devices as appropriate.

While the traditional A&D paradigm limits a quality program to controls during production and post-production checks, a smart solution for manufacturing treats quality management as an integral domain beginning with the early stages of product development. Quality management during production ensures that execution meets product design and customer/regulatory requirements. Digital manufacturing continuity makes nonconformance tracking and correction transparent and traceable.

The comprehensive digital twin of the factory floor also supports future engineering and market changes with simulation capabilities that direct quick adjustments. You can even replicate your manufacturing lines on-demand anywhere in the world because of the accuracy and integrity of the digital twin.



USE CASE

Egicon electronics

Producing aerospace electronic control units (ECUs), instrument clusters and human-machine interfaces (HMIs) in Modena, Italy, Egicon needed to raise the level of customer service and transparency, prevent costly recalls and reduce material waste to continue its business success. Smart manufacturing solutions fully automated the company's production processes and allowed Egicon to adopt a zero-defect approach using real-time root-cause analytics. These changes **reduced repair rate by 80 percent and scrap rate to zero percent** and increased end-customer confidence through improved traceability and reporting capabilities.

For more information read the case study.

USE CASE

NAVAIR fleet readiness centers

Siemens has been working with Naval Air Systems Command (NAVAIR), the air side of the U.S. Navy, to implement model-based definitions that directly support digital manufacturing at U.S. air depot fleet readiness centers. With the smart manufacturing solution's configuration management, reuse of data is enabled all the way down from engineering through simulations and through manufacturing planning then through manufacturing operations.

Supporting advanced manufacturing at one fleet readiness center, NAVAIR is now not only creating a build process and manufacturing machine code but also connecting data directly down to three-axis and five-axis machines. The solution allows reuse of data multiple times, resulting in a **touch time being reduced by 25 percent for first article passes and 98 percent for repeat jobs**.

For more information read the white paper.

KEY #3

Optimize end-to-end operations with closed-loop systems

Until recently, the vast amounts of data generated in a digital factory were used only for their initial purpose. A sensor that monitors the ramp-up, hold and ramp-down temperatures and pressures of an autoclave, for example, generates data throughout this process. But this data can do much more than ensure correct performance of that autoclave. Data analytics could uncover an opportunity to reduce the energy expended in that autoclave.

Beginning with real time data analysis as your WIPs become finished products and extending through continuous product and process improvements, closed-loop manufacturing and quality programs complete the loop of manufacturing communication and provide your teams with valuable insights. Fewer nonconformances and minimized production disruption are just two of the outcomes achieved with smart solutions for manufacturing.

In real time, sensors and smart devices on the production line monitor performance and predict near-term operational issues, predicting and preventing problems before they occur. To help you achieve new line speed and throughput targets, smart manufacturing software also monitors machine performance and predicts broader operational issues, using them to drive continuous improvement.

A closed-loop manufacturing system leverages insights from real production to optimize processes. Continuous optimization takes place as you aggregate manufacturing data from IoT and production systems to enrich production simulations.

Closing the loop back to design and engineering, smart manufacturing employs the comprehensive digital twin to ensure that data from actual performance of the factory in operation and the product in use is fed back into models that are continuously refined.

KEY #4

Digitally collaborate across the value chain

Industry-wide, a growing reliance on suppliers means that the success of an OEMs finished A&D product may be heavily dependent on supplied parts or subsystems. OEMs and higher tiers need a systematic approach to ensuring the quality, cost-efficiency and timely delivery of supplied parts and assemblies.

The good news is that the actionable insights and informed decisions supported by a smart solution for manufacturing are by no means limited to an individual company's facilities and operations. The comprehensive digital twin enables you to create closed-loop connections between the virtual and physical worlds across the entire value chain.

Recent and ongoing supply chain bottlenecks have made headlines in public media and created urgent concerns along the A&D supply chain. When these bottlenecks cascade into production delays and missed delivery dates, the whole industry and our customers suffer as financial and safety risks escalate. But closed-loop manufacturing gives your procurement and planning teams full visibility and immediate access to all relevant data. Better, faster responses to supply chain issues help to minimize schedule and cost impacts.

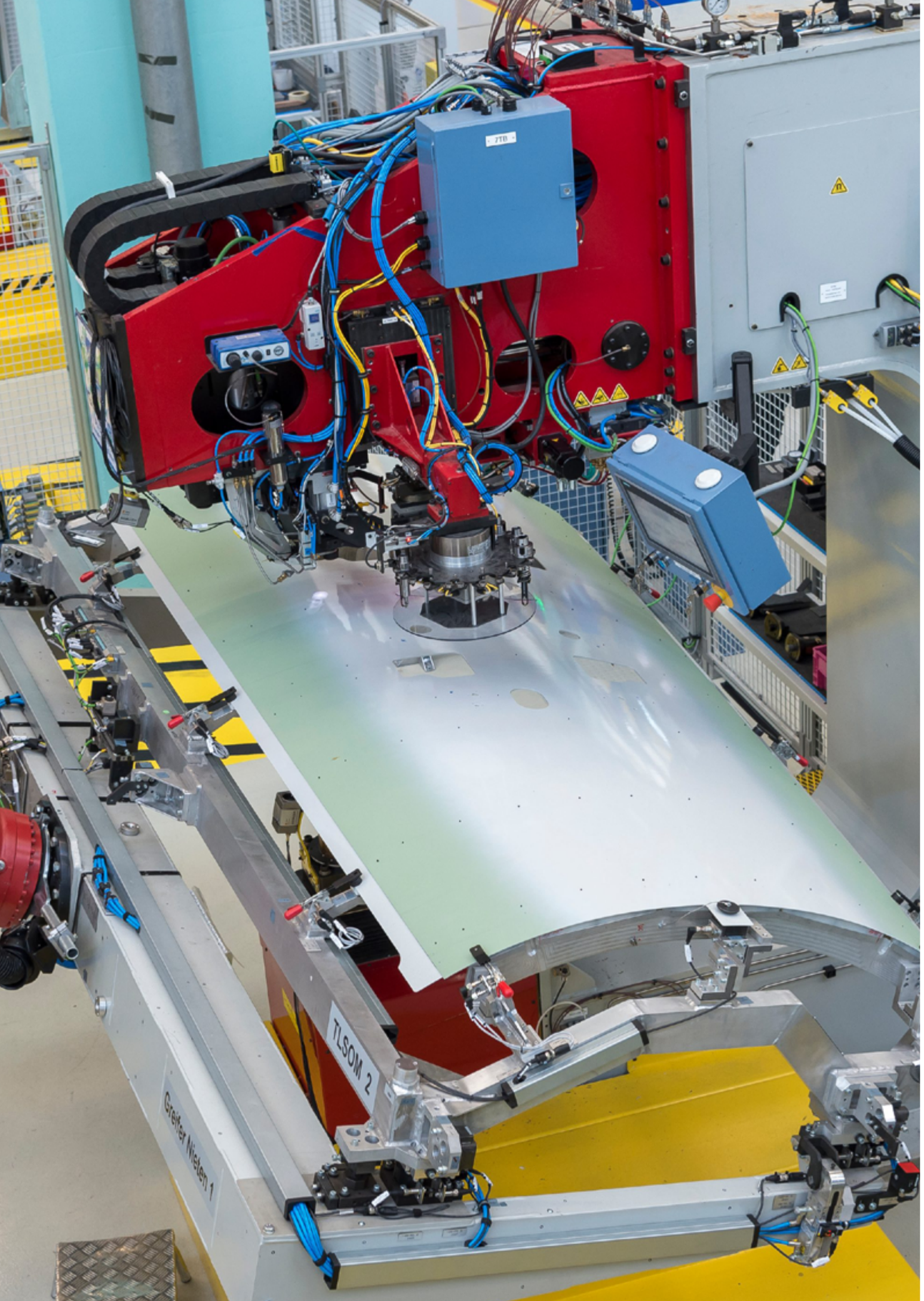
Procurement and planning are just two of the domains that benefit from smart solutions for manufacturing and the connected ecosystem of partners, suppliers and developers that they support. Leveraging interoperable technologies through this ecosystem enhances productivity, efficiency, cost savings and measurable business outcomes.

USE CASE

Armor Meca precision machining and assembly

From its facilities in Brittany, France, Armor Meca has been supplying precision machined aeronautical components and subassemblies to major A&D OEMs for more than 50 years. The company recently expanded their business by producing more complex parts with higher added value and expanding its portfolio to include new metals such as titanium. By using Siemens' solutions to modernize production processes and methods, Armor Meca transitioned from a 5-axis machine shop to a digital factory. Digitalization has **reduced NC programming and machining times and improved surface finish, precision and quality**.

For more information read the case study.



Advancing **toward the flexible, connected factory** of the future

By accelerating digital transformation with Siemens' smart manufacturing solution, you optimize your factory floor. What does this mean to your business success? With a connected digital ecosystem, you can accelerate production start-up; build quality, complex parts faster; meet production throughput targets; and increase competitive advantages across your manufacturing processes.

As you digitally transform your production processes and achieve this flexible, connected factory of the future, your continuous improvement initiatives become easier to implement and more effective. And you gain great confidence in your product and process plans, that they will consistently meet customer and regulatory requirements. Likewise, your connected, digital ecosystem will help ensure the requirements, costs and schedules you have for your suppliers are traceable and accessible.

With closed-loop manufacturing and digital transformation of your manufacturing processes uniquely delivered with Siemens Xcelerator, your A&D company can do much more than survive these challenging times. You can transform and elevate your manufacturing enterprise to attain an exceptional competitive edge.

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 – Accelerating transformation.

For more information on Siemens Digital Industries Software for A&D, visit our website or follow us on LinkedIn and Twitter.

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