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DIGITAL INDUSTRIES SOFTWARE

Four keys to optimizing A&D production processes

How uniting the virtual and real worlds reduces
manufacturing costs and accelerates product delivery

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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

In this second ebook of our three-part series, we discuss how to take full advantage of the virtual realm as you modernize and optimize your entire factory and production process. Although this pillar of the comprehensive smart manufacturing solution comes second in our ebook series, for your operations it may come first. Ebook one focuses on manufacturing planning and this ebook focuses on manufacturing processes. If the prime opportunities to reduce risk, cost and/or time-to-market are found on your factory floor, then streamlining your production processes through smart manufacturing solutions may be the best next step for you.

The goal of this intelligent manufacturing pillar is to **achieve a smarter factory floor faster**. The means to this end are twofold: (1) leveraging integrated, modular manufacturing modeling and simulation services; and (2) gaining a competitive edge with advanced manufacturing technologies. Smart manufacturing solutions enable you to assess product design concepts virtually against the reality – and cost – of physically producing them. Collaboration between design and manufacturing engineers not only helps you to plan and optimize the manufacturing process but also allows you to adjust the design to manage manufacturing constraints and leverage untapped manufacturing capabilities.

Smart manufacturing solutions offer considerable business value, especially at the transition point between virtual product development and physical product realization. This ebook will help you explore how to realize this value for your A&D operations.

Achieving a **smarter** factory faster

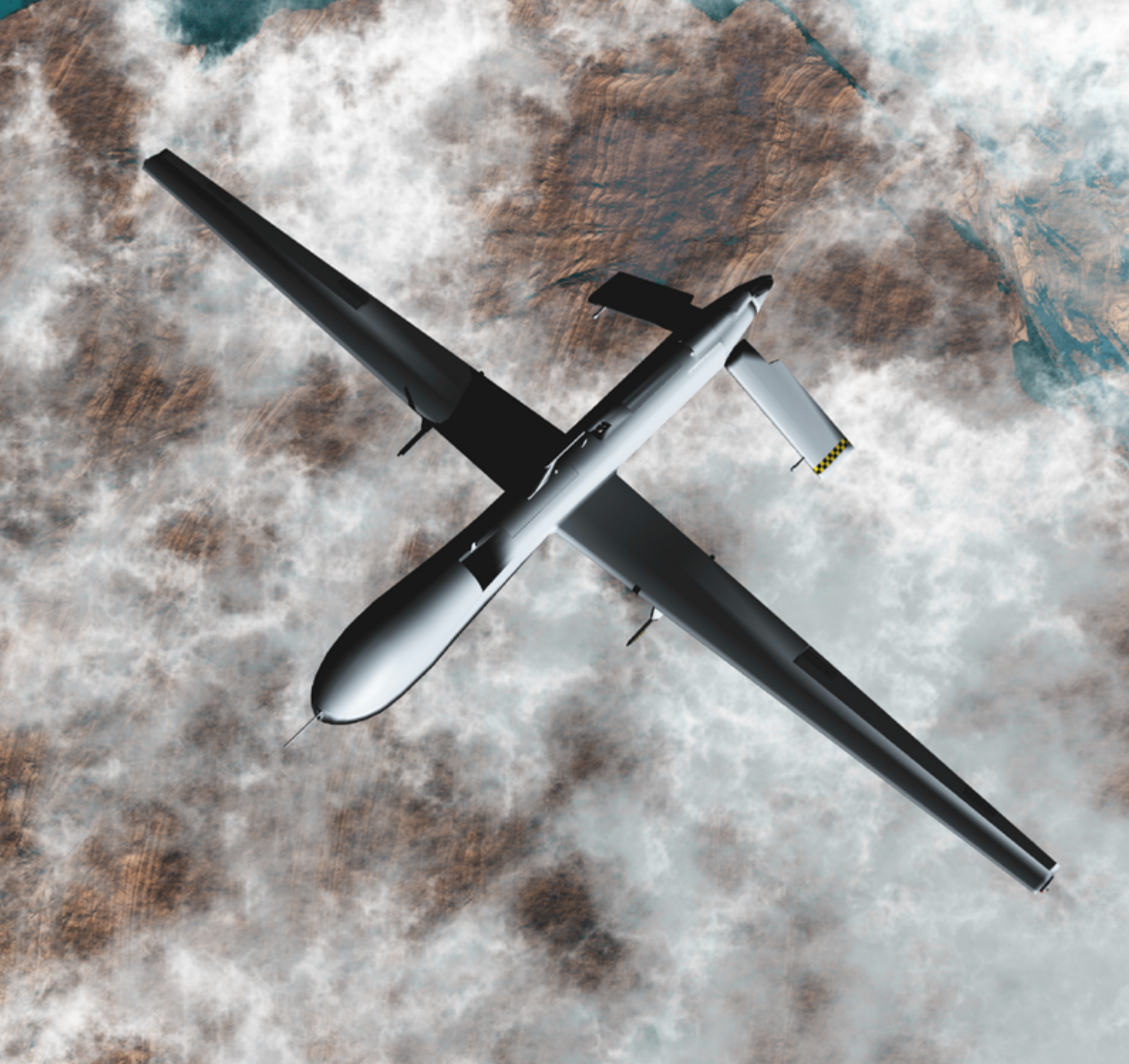
One primary goal of Industry 4.0 initiatives is to engineer flawless production. That is, A&D manufacturers want to anticipate each manufacturing issue and resolve it before the first production run, ensuring that quality and efficiency characterize their entire manufacturing operation. Accomplishing this lofty goal requires powerful capabilities, especially at the crucial point where virtual and real operations converge.

Historically, there has been a disconnect at this crucial point, and with good reason. Like most manufacturers in this sector, your company was probably an early adopter of design software to handle the complexity and flight-critical performance characteristics of your products. But the relatively low production volumes of aerospace vehicles and systems in the past allowed sufficient time for traditional paper communication of manufacturing information to and from the shop floor. Even as automated production processes have matured, the digital disconnection has remained.

In today's A&D marketplace, however, what was once acceptable and then tolerable has become unworkable. Faster time-to-market has become imperative, which means you must achieve certification quicker than ever before. You need a way to practice your manufacturing lines and adjust them so that you can predict and resolve problems before they happen. You can attain these objectives by eliminating the disconnect and bringing all disciplines together in a virtual environment. In other words, you must **unite the virtual and real worlds to validate the manufacturing plan**. This will enable you to plan, optimize and test your factory floor virtually before commissioning it physically so you can accelerate production start-up.

After we delineate the difficulties created by disconnected legacy systems, we will clarify what we mean by uniting the virtual and real worlds, then discuss four keys to successfully implementing this phase of smart manufacturing for your company.





Understanding limitations of the traditional approach and supporting systems

Ever-tightening certification, time and budget requirements in A&D manufacturing have necessitated urgent attention to the consequences of siloed disciplines and legacy software. Some of the most pressing consequences threaten your ability to meet the new requirements.

Unforeseen and repeating problems: With a traditional approach, you can't discover that anything is out of sync until you physically commission the line for the first time. These problems that can often repeat due to lack of visibility and nonconformance, must then be addressed on the shop floor. This leads to numerous to numerous manufacturing change requests that impact cost and schedule.

Unknown manufacturing performance: If you don't predict the performance and maintenance needs of manufacturing equipment before production commences, you must address unanticipated issues on the fly. This often forces you to halt production and leads to increased costs and missed delivery targets.

Unshared knowledge about legacy equipment: You can't build every line from the ground up (greenfield), so you must be able to leverage legacy equipment as much as possible. When information about each piece of equipment or workstation exists only in siloed systems or as tribal knowledge, it is not virtually accessible so you cannot use it to optimize manufacturing performance virtually.

Iterative physical commissioning: When the production line is not commissioned until it is assembled on the factory floor, then production trials and on-site debugging typically require multiple passes through the commissioning process at enormous cost and lost time.

Losing design intent on the shop floor: Differences between the as-planned and as-built product arise when a manufacturer is limited to disconnected engineering and manufacturing ecosystems. Issues such as losing design intent on the shop floor and engineering data that is not consumable compromise your ability to prove compliance and deliver your products on time and at cost. According to a Lifecycle Insights Report from 2023, a full 40 percent of A&D chief engineers surveyed report that the physical parts they make do not conform to the digital design.

40% of surveyed manufacturers experience design-to-product nonconformance

Uniting the virtual and physical to overcome these challenges

Smart digital solutions for manufacturing allow you to assess design concepts virtually against the reality of physically producing them and to develop a detailed quality control plan as you engineer your manufacturing operations. You gain visibility and traceability of changes and the ability to virtually verify change impact.

Virtual modeling of your manufacturing processes, equipment and lines is the fuel that feeds your smart manufacturing systems. The comprehensive digital twin captures and maintains this virtual modeling. A highly realistic virtual representation of the product, production processes and systems, the comprehensive digital twin, provides a centralized source of truth to ensure that all stakeholders are working on the same up-to-date models and data.

An important advantage of the comprehensive digital twin is that it empowers a flexible, modular approach to the factory floor. Your legacy equipment can be assigned or reassigned to a particular production line or floor location and the new configuration is easily assessed and managed in the virtual realm.

Intelligent manufacturing systems also leverage simulation services, which allow you to predict manufacturing performance and uncover problems before the line is configured on the shop floor. Much of the work of validation can also be completed virtually.

By predicting production line behavior, line planning software enables the production system to assess design concepts automatically against early visibility of product design as well as data from past production runs. As a result, the line automatically manages itself and precludes human error.

Implementing smart manufacturing systems to gain these advantages is simpler than many A&D manufacturers might anticipate. Allowing the four keys below to guide your implementation will help ensure maximum benefit.





KEY #1

Use the digital twin to model **integrated, modular manufacturing**

The starting point for uniting the virtual and real worlds in your manufacturing operations is building the digital twin of existing facilities. Digital tools within an intelligent manufacturing solution enable you to digitalize and review these assets virtually.

Applying smart manufacturing capabilities to this digital twin, your team will virtually evaluate existing facilities, equipment and tooling. If you are building products similar to existing ones, this evaluation will help you to make your manufacturing processes more efficient. For design changes or new products, the digital twin allows you to virtually reconfigure and assess your ability to realize the new design with existing assets. Because all this production information is maintained in a traceable chain of data, smart manufacturing also allows you to manage digital twins and configurations for individual tail numbers and custom products.

Designing jigs, fixtures, gages and other tooling to exact specifications can also be shifted left into the virtual realm, as can the development of software controls for machines and equipment. Completing these tasks well in advance of actual production leads to considerable reductions in risks, costs and time-to-market.

USE CASE

GKN Aerospace Engines

GKN Aerospace Engines needed a better tool to plan and optimize its production processes and equipment, a tool that would aid in strategic planning and handle real-life complexity to accurately predict lead times and consider variation. The company's goals were to identify production bottlenecks and test and evaluate different improvement approaches.

In its pilot project with smart manufacturing plant simulation software, GKN was able to test and evaluate production scenarios virtually and reduce production lead time for its turbine exhaust case/turbine rear frame (TEC/TRF) value streams at its plant in Kongsberg, Norway. The simulation software has enabled GKN to **increase the accuracy of its production capacity and utilization results by 30 percent.**

For more information read the [case study](#).

KEY #2

Leverage advanced manufacturing technologies

Remaining competitive in the A&D industry requires more than being highly efficient with existing production assets. It also requires you to modernize your operations with new manufacturing systems and technologies. The virtual tools of intelligent manufacturing provide a low-risk pathway for updating your facilities, equipment and systems.

Whenever you need to replace legacy equipment or update it with intelligent technologies, virtual planning of the manufacturing floor enables a strategic approach to selecting and incorporating new systems. You can research and explore equipment and technological options using the digital twin before investing in the actual equipment.

Smart manufacturing systems also enable a structured, systematic, virtual approach to adding advanced technologies to your manufacturing floor, such as augmented reality (AR), additive manufacturing, the internet of things (IoT), artificial intelligence (AI), including machine learning (ML) and advanced robotics. Establishing continuous monitoring, virtual verification of change impact, and improving user experience and system integration are additional opportunities with this approach. Virtual planning accelerates the integration of these new technologies with legacy equipment and helps you to quickly attain the competitive advantages of your investments.

One area in which updated technology saves considerable design time and reduces the potential for manually-induced errors is integrated wire harness design. To address the growing use of more complex electrical systems, with our wire harness design solutions electrical and mechanical designers can now collaborate. While the electrical designer masters the electrical content, the mechanical designer defines the harness geometry and fixtures, reserving physical space in the vehicle for the system. Visibility of electrical systems across the product development process helps reduce those problems that would otherwise be discovered later in the assembly process.

As you incorporate new technologies, smart manufacturing software also allows you to virtually trace manufacturing requirements down to the granular level. The ability to continuously optimize for efficiency and quality are critical capabilities that manufacturers urgently need.



USE CASE

Digital Manufacturing Centre

Digital Manufacturing Centre (DMC) is applying smart solutions for manufacturing to its end-to-end additive manufacturing services. To deliver end-use-ready components to A&D customers, the company set out to deliver the highest-quality components and reduce production time for both prototypes and serial production. To achieve this, DMC uses Siemens' smart manufacturing solutions to provide all the capabilities required to support additive manufacturing in creating and optimizing parts, including those with highly complex geometry. Designing and engineering one particular part for **additive manufacturing reduced the weight of that part by 50 percent.**

For more information read the [case study](#).



KEY #3

Simulate to **optimize** the manufacturing process

The simulation capabilities of smart manufacturing systems are undeniably one of the most important advantages of uniting the virtual and real worlds. Simulation brings plants, production lines, processes and advanced manufacturing systems to life in the industrial metaverse, well before the physical factory is readied for production.

With simulation tools, you can optimize, test and adjust your processes, tooling and production lines and gain actionable insights, all in the virtual realm before physical commissioning. You can also virtually assess the plan against emergency scenarios. These capabilities allow you to rapidly modernize your production line. Simulation can be used to evaluate and implement advanced manufacturing techniques, equipment and operations. It enables your team to improve the ergonomics, safety and efficiency of your workplace environments using virtual humans, task-based simulation and ergonomics analysis. It also supports offline robotics programming.

By employing the simulation capabilities of a smart manufacturing solution, manufacturers not only accelerate the development cycle but also dramatically reduce the time and costs associated with physical prototyping, first runs and engineering change orders.

USE CASE

Global military aircraft manufacturer

A major A&D manufacturer has been particularly successful in using Siemens' simulation tools. The company can design hundreds of model variants in the digital realm and test them virtually for thousands of hours before any actual parts are manufactured or assembled. Using this approach on a specific military aircraft program, the company and its partners reached first flight in just 36 months. Siemens smart solutions helped the manufacturer to **reduce assembly hours by 80 percent**.

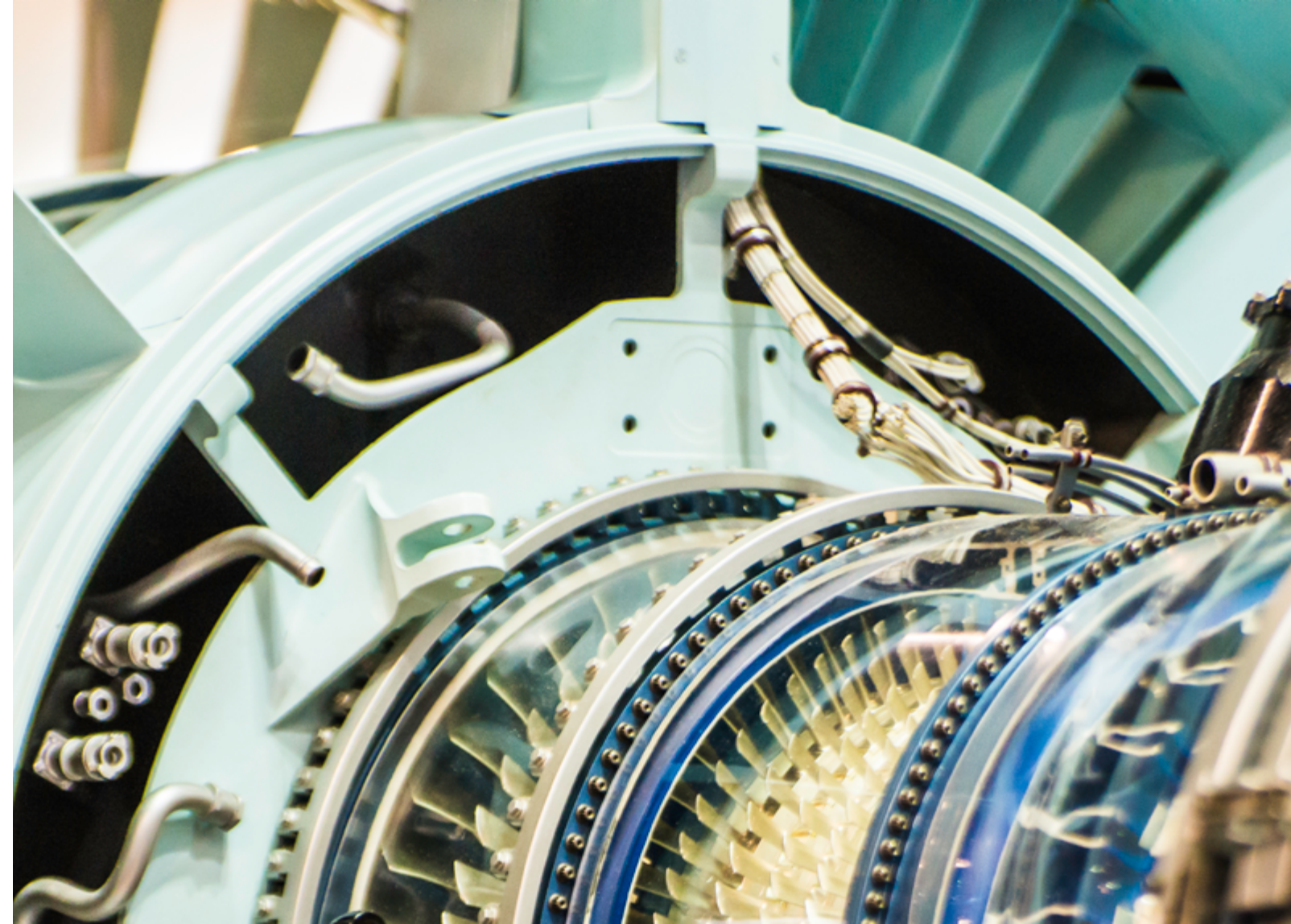
KEY #4

Virtually validate and commission the manufacturing environment

The automated and flexible manufacturing systems of today's A&D environment include sophisticated tooling, robots, transfer lines and safety equipment. Using smart solutions for manufacturing, you can execute line planning and validation and perform machine validation virtually. As part of this process, you can leverage quality planning and management functionality to validate processes and products, integrating nonconformance management and rework processes into the workflow. Smart manufacturing helps you ensure that execution meets product design specifications as well as customer and regulatory requirements.

Much of modern production automation is controlled by programmable logic controllers (PLCs). Smart solutions for manufacturing also let you virtually commission this automation, debugging PLC code in a virtual environment before downloading it to real equipment. Confirming in the virtual realm that these automated systems will work as expected significantly reduces system startup time. Manufacturers that have used the virtual validation and commissioning capabilities of an intelligent manufacturing solution have reported **reductions in engineering time by as much as 30 percent**.

In addition to reducing engineering time, virtual validation and commissioning also reduce shop floor errors, safety failures, waste and time for production ramp-up.



USE CASE

General Atomics Aeronautical Systems

General Atomics Aeronautical Systems, Inc. (GA-ASI), global aeronautics company and Siemens customer, was looking to accelerate their design process using advanced model-based design capabilities that could digitally and directly flow into the manufacturing process. This would eliminate time consuming manual steps, especially related to composite airframe structures. After looking at several tools, GA-ASI selected Siemens' design, simulation and composites solutions to **reduce by 25 percent** the number of hours it took them to perform detailed structural design and create the technical data package required for manufacturing.

For more information read the [case study](#).



Mastering the virtual/physical inflection point

For companies that manufacture parts and products for the A&D industry, one of the riskiest and most stressful times is when you advance your operations from the virtual “drawing board” to the physical reality of the factory floor. An intelligent solution for manufacturing unites the virtual and real worlds in a way that streamlines this transition while building in opportunities to continuously increase efficiency and improve quality.

Uniting the virtual and real worlds to validate your manufacturing plans ensures that you can efficiently manufacture consistent products that conform to regulatory-approved design. You will lower risks, achieve production validation and commissioning with confidence and ramp up to full production more quickly. This pillar of a smart manufacturing solution will help you attain the critical objective of building quality, complex products faster.

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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