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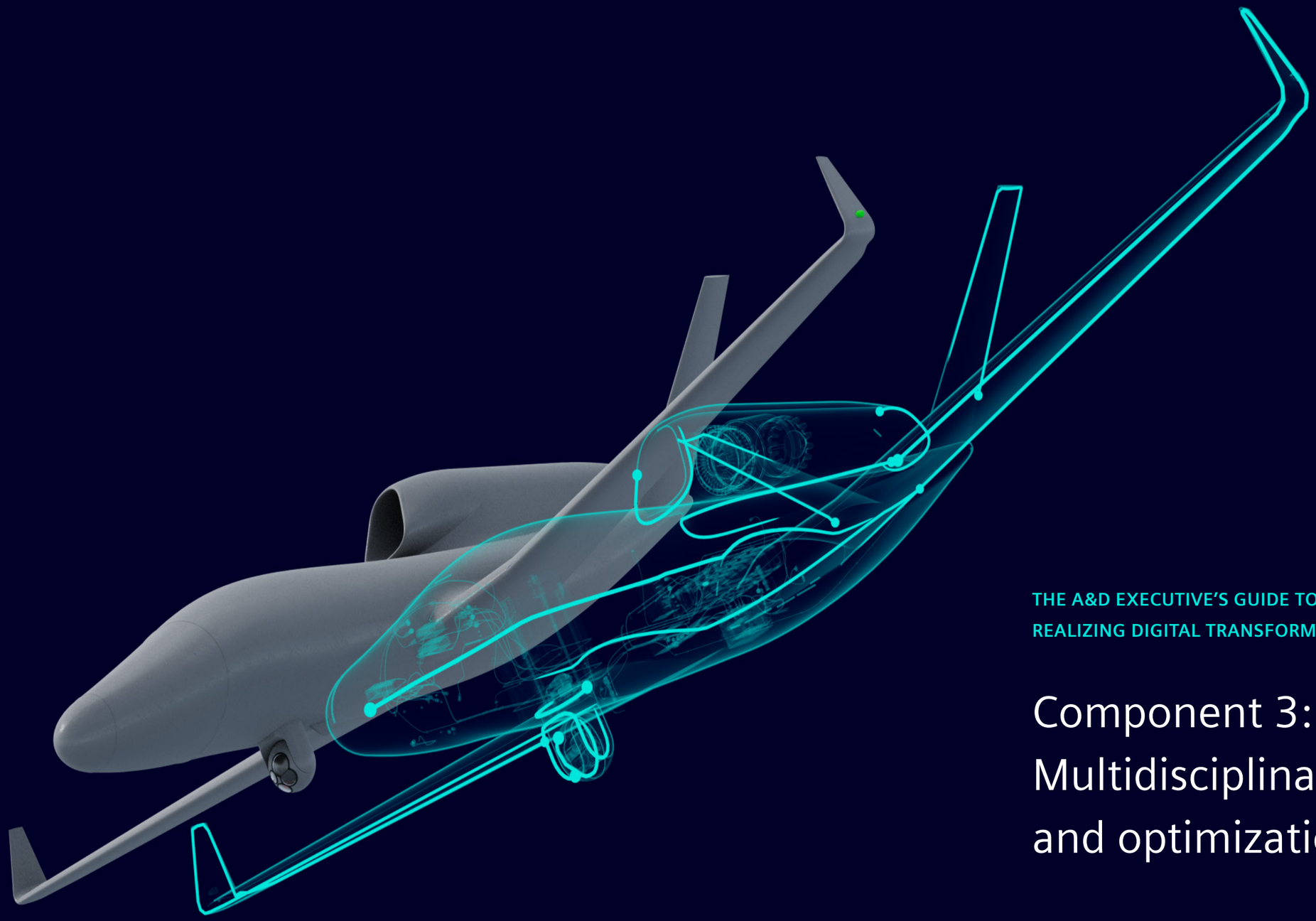


THE A&D EXECUTIVE'S GUIDE TO
REALIZING DIGITAL TRANSFORMATION

Component 3: Multidisciplinary design and optimization

Use dynamic design and iterative optimization to drive certifiable designs to market faster

siemens.com/aerospace-design

Executive summary

What is the biggest obstacle to rapid, optimized design of aircraft, spacecraft and defense systems? As Siemens works with manufacturers of next-generation military and sustainable aircraft, the recurring answer we hear is **silos**. Traditionally, aerospace and defense (A&D) design teams have worked in isolation within their mechanical, electronic, electrical and software design domains. These organizational silos have led to data silos. Cross-domain collaboration has relied on manual communication between teams, which results in delayed and error-prone data sharing, and ultimately, less than optimal aircraft designs.

But digital transformation technologies are ready to break down these silos. Supported by the Siemens Xcelerator open digital business platform and emerging capabilities using purposeful artificial intelligence (AI), **multidisciplinary design and optimization** technology integrates critical aspects of product development. This solution connects high-level architecture to design tools, and design tools to simulation and systems design. If your A&D organization is ready to drive certifiable designs to market faster, this ebook is for you.

Design complex, innovative A&D products – fast

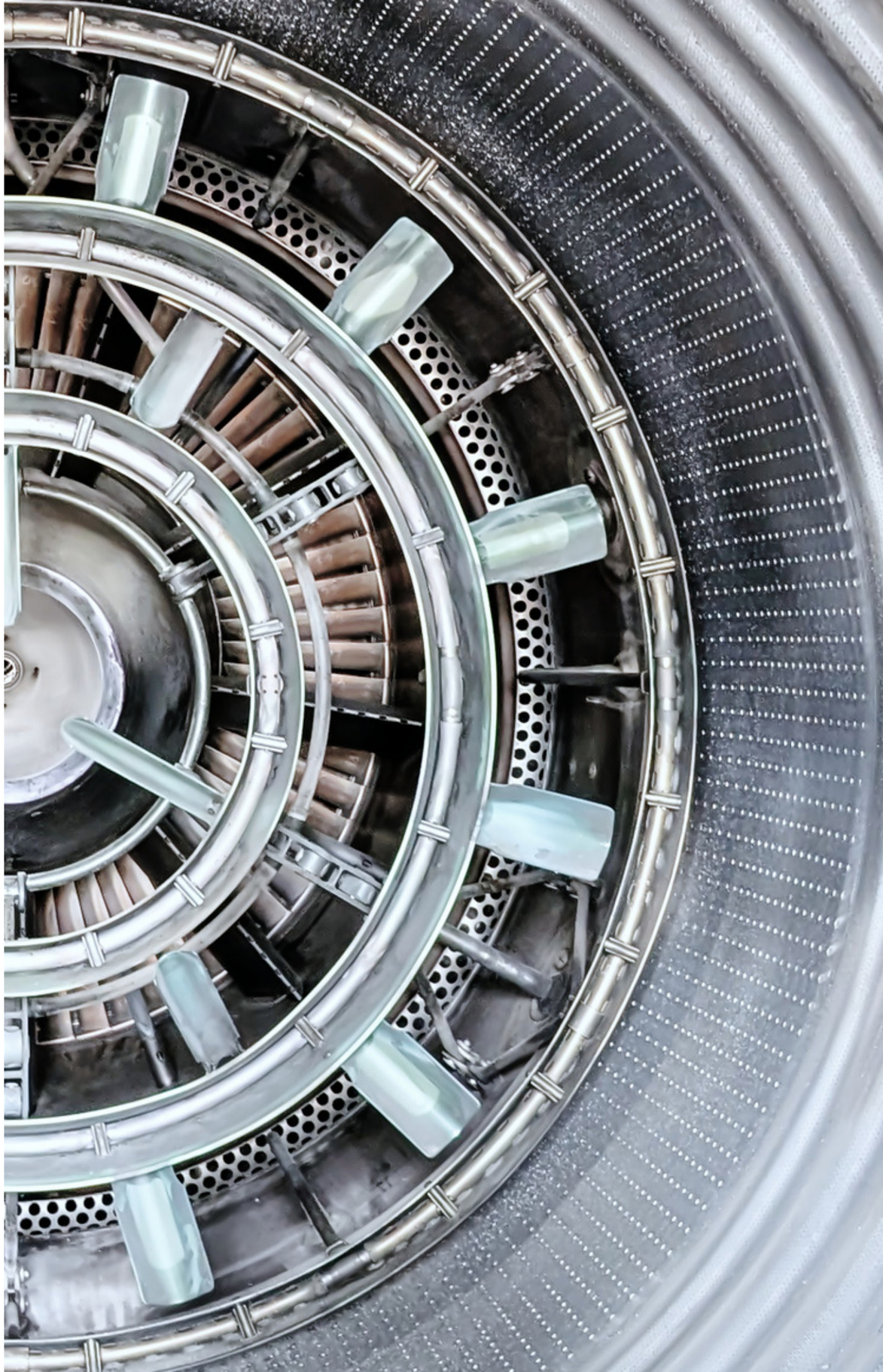
What will it take for your A&D organization to stay ahead of the competition? Perhaps more than ever before, a critical requirement for market leadership is innovation. Whether you are a military contractor, a start-up working on novel air transportation, or a commercial OEM or tier supplier, you must deliver new and highly differentiated products, faster. You have to attain design excellence even as complexity in aircraft, spacecraft and defense systems escalates. At the same time, your products and your production methods must be on a path to decarbonization as you comply with ever-increasing environmental regulations.

To achieve these objectives, it has become urgent for existing A&D organizations to accelerate their digital transformation and for start-up companies to invest early in data-driven operations powered by seamlessly integrated technologies. These measures will enable you to overcome **organizational silos** and the issues they create in product development.

When mechanical, electronic, electrical and software design teams work independently rather than collaboratively, they lack cross-domain visibility, suffer communication gaps and cannot provide the unified data sets needed for emerging AI-based simulation. Consequently, they experience delays, errors and slower decision-making in product development, and these drawbacks almost always spill over into the manufacturing phase. Unexpected changes and rework are virtually inevitable, as are higher costs due to product inefficiencies and missed deadlines due to late changes. It’s no wonder that 45 percent of A&D product launches are delayed, according to Gartner. Ultimately, silos can and have led to missed opportunities for innovation, increased program risk and reduced productivity.

Here’s the good news: integrated systems available today enable A&D organizations like yours to break down organizational silos, integrate all aspects of design within one digital ecosystem, and achieve better collaboration among teams. With a step-by-step implementation of a **multidisciplinary design and optimization solution**, your company will accelerate decision-making, deliver optimized designs faster, ensure product manufacturability, and integrate innovative design elements that deliver next-generation excellence in your products.

By transforming your design efforts into a multidisciplinary design and optimization approach, your A&D organization can better adapt to ever-changing requirements, explore innovative materials and technologies, and employ AI-supported dynamic design processes that ultimately enhance your competitiveness in the A&D marketplace.



Accelerate product design and optimization through digital transformation

What does a multidisciplinary design and optimization solution offer your A&D organization? Implemented through a step-by-step digital transformation of your design domains, this solution lets you create and optimize even the most complicated product designs efficiently.

The multidisciplinary design and optimization approach enables you to leverage today's integrated digital technologies – including advances like immersive engineering and AI-based deep-physics simulation – linked by a connected infrastructure. These technologies equip your mechanical, electrical and software design teams to work collaboratively, applying dynamic design and iterative optimization while streamlining all stages of design from concept to certification. You will confidently design aircraft, spacecraft and aerospace defense systems that meet efficiency, performance and cost requirements, while also meeting cost and delivery schedules and keeping business risk low.

This is critical to your competitive outlook given today's market conditions. The present and future complexity of aircraft, combined with more stringent regulatory standards and sustainability requirements as well as tighter time and cost schedules, make this new approach to product development an indispensable part of A&D business success.

Conversely, it is becoming more and more improbable that siloed legacy systems can deliver optimized, manufacturable designs in a timely fashion. Independent work by mechanical, electronic, electrical and software design teams is simply too inefficient to manage design complexity and the requirements put forth by today's A&D customers. As they focus exclusively on their own domain, the teams often use different tools and siloed data handling, leading to delayed and error-prone data sharing, and ultimately, less than optimal product designs. These legacy systems are also not built to resolve mounting workforce and supply chain challenges, resulting in even longer design phases and design-induced manufacturing challenges.

Hand in hand with this digital transformation, your design teams will need to embrace some cultural changes, which are necessary to gain all the advantages of a multidisciplinary design and optimization approach.

Meet the success requirements of multidisciplinary design and optimization

Technology silos, created by disparate digital systems and disconnected data, and organizational silos that compartmentalize your design domains, together pose one of the greatest threats to the business success of your A&D venture. Removing organizational silos entails a cultural shift that brings your design teams together across all disciplines and promotes company-wide visibility and collaboration. It requires the following elements to succeed.

Collaborate across global teams. Encourage teams across domains to connect the requirements, goals and innovations of all design disciplines as well as the intersection of design and manufacturing objectives. Such a culture supports concurrent design with cross-disciplinary collaboration, so that each team considers how their aspect of product design might converge with others, and how these touchpoints could be leveraged to enhance performance outcomes for the finished aircraft.

Shift from static to dynamic design with iterative processes. As siloed disciplines come together, team members are able to understand, explore and optimize any aspect of product performance, from individual components to subsystems, to the full aircraft. Applying a dynamic design and optimization approach means gaining a big-picture perspective, then referencing that perspective as you work out the design details within your domain. Validation of design elements at a granular level during the dynamic design process keeps a comprehensive digital twin of the product fully visible and up-to-date for all stakeholders.

Investigate design alternatives and analyze and optimize as you design. The multidisciplinary approach frees aerospace designers to explore options and make design decisions that advance the state of the art for the aircraft they are creating. Designers can leverage the virtual realm to simulate and evaluate the performance of design variants. As they gain experience doing so, your team members will grow more confident that they can optimize performance of innovative components, subsystems and the entire aircraft in a timely manner without increasing risk.

A corporate culture defined by greater collaboration and dynamic innovation enables agile, timely aircraft design to take place. This environment's cultural shift works hand in hand with the technological shift of a multidisciplinary design and optimization solution. Next we explore the details of this technological shift: how to digitally transform aircraft design to meet present and future demands of the aerospace and defense industry.

Digitally transform aircraft design with an interdisciplinary, closed-loop solution

A multidisciplinary design and optimization solution provides the digital ecosystem and functionality needed to achieve certifiable designs that drive new products to market faster. It creates one collaborative environment that your teams use to explore, assess and optimize design alternatives. Benefits of implementing this solution as part of your digital transformation journey include new efficiencies, innovation and validation in the virtual realm of your designs and their manufacturability.

Key to this digital solution is the creation of a comprehensive digital twin, an always-current, centralized master model of the entire aircraft, which enables you to represent your real product virtually. A multidisciplinary design and optimization solution provides a fully integrated toolkit that makes each digital twin secure, visible and accessible to all stakeholders. It allows your teams to reuse and expand upon previously generated designs, in some cases applying purposeful AI tools to this wealth of data to accelerate performance prediction and optimization. The integrated solution connects all your design disciplines to this centralized model throughout every stage from initial design through validation and certification.

A multidisciplinary design and optimization solution also allows globally distributed teams to work with a common set of data, tools and processes. Any team member can incorporate design changes ‘live,’ as they happen. Because these capabilities let team members work more efficiently, the team gains confidence to experiment and explore alternatives to meet requirements.

Siemens multidisciplinary design and optimization solution relies on the power of the Siemens Xcelerator portfolio, which integrates mechanical, electrical/electronic and software design into a comprehensive view of your mission or program, its collaborators and requirements. It does so through integrated digital tools that facilitate well-informed decisions about every aspect of the design process. The Siemens Xcelerator portfolio covers integrated technologies, solutions and services, including mechanical, embedded software, collaboration, electronics, simulation, manufacturing, operations, an app development platform and the internet of things (IoT).

Three key capabilities anchor the digital transformation of multidisciplinary design and optimization:

- **Enable efficient collaboration** with an authoritative source of truth.
- **Leverage the comprehensive digital twin to achieve optimized design faster** through configuration-driven, multidisciplinary design.
- **Define and optimize in context** using best-in-class design and optimization tools including domain optimization.

KEY #1

Collaborate efficiently through an authoritative source of truth

A multidisciplinary design and optimization solution maintains a comprehensive, accurate and reliable multidomain product definition and allows the digital twin to serve as the repository for all product-related information.

Managing the complete design in one single collaborative environment with a holistic digital twin creates a transparent, authoritative source of truth and breaks down the traditional organizational barriers between various disciplines such as electrical, mechanical and software. This approach eliminates silos, ensuring that all teams have visibility so they can work together to facilitate more effective communication and decision-making early in the design process.

When an authoritative source of truth provides a place where team members, regardless of function or location, can find the latest design data and information, this environment helps your design teams build trust and foster collaboration. In this way, the technology behind the comprehensive digital twin facilitates the cultural shift of breaking down the organizational silos that hinder progress. Relying on an authoritative source of truth also streamlines the management of your product's overall lifecycle.

USE CASE

GKN Fokker

Two major challenges confronted the design team at GKN Fokker, producer of structures, landing gear and electrical systems for the A&D industry. First, the company's most recent customer base includes many smaller companies that need to get their aircraft flying in a much shorter timeframe than the aircraft of GKN Fokker's historical customers, like major OEMs. Second, the novel aircraft of these newer customers are incorporating numerous innovations, such as vertical takeoff and landing (VTOL) and alternative fuel propulsion systems.

Key to meeting these challenges is bridging the gap between design and analysis teams – a capability at the heart of multidisciplinary design and optimization technology. By implementing an integrated solution compatible with a range of finite element (FE) tools, GKN Fokker has significantly increased the number of configurations that can be tested and analyzed within a given timeframe. The technology allows GKN Fokker to reuse simulation files whenever an FE model is updated or an aerostructure's geometry changes. The company has **reduced FE model creation time from weeks to days**.

For more information read the case study.

USE CASE

Natilus

The need for a multidisciplinary design and optimization solution was self-evident for startup Natilus as soon as the company set the aggressive goal of reducing airfreight cost by 50 percent. The design team is developing remotely controlled planes that maximize cargo volume through a blended-wing-body configuration.

Engineering creativity and innovation have been essential to this effort, and Siemens solutions have enabled the Natilus team to re-think airfreight solutions. Siemens NX Immersive Designer is a key digital tool. “Siemens’ immersive technology is revolutionizing how we develop our next-generation aircraft,” says Natilus CEO Aleksey Matyushev. “It’s not just about seeing the design; it’s about experiencing it in a way that enhances our engineering decisions and accelerates innovation.”

Natilus reports that use of Siemens software has **reduced the development time to build its first prototype aircraft by 50 percent**.

For more information read the case study.

KEY #2

Leverage the comprehensive digital twin to **optimize design faster**

When a multidisciplinary design and optimization solution manages the complete product design-in-progress in a single collaborative environment with a holistic digital twin, it enables your designers to quickly and easily iterate and evolve dynamic designs. This capability allows your teams to explore the design more thoroughly across domains with better context of the surrounding subsystems and components.

Additionally, powerful 3D simulation solutions enable you to efficiently verify designs virtually, maximizing their physical performance. You can now experience high-fidelity 3D visualization of your digital twin with game-changing Siemens NX Immersive Designer. Using this software with traditional mouse and keyboard inputs, you can design in-context with a fully immersive infinite canvas. And you can experience 3D CAD design in the industrial metaverse thanks to our exclusive partnership with Sony to create the Sony XR head-mounted display (HMD). It’s the most precise and natural way to experience, interact and collaborate in 3D.

The multidisciplinary design and optimization approach is nothing short of transformative. You will create mechanical structures and systems; define and optimize electrical systems and harness designs; develop multi-board printed circuit boards (PCBs) using co-design across electrical CAD (ECAD) and mechanical CAD (MCAD) to avoid connectivity issues; and integrate software design to drive early verification.

The multidisciplinary digital twin ensures that all aspects of designs are considered and balanced. It prevents miscommunication and errors and minimizes the risks of late-stage changes when on the manufacturing floor. In fact, it helps confirm the manufacturability of designs, keeping costs and delays within limits.

KEY #3

Define and optimize in context with best-in-class digital tools

A multidisciplinary design and optimization solution combines all aspects of product design, including electronics, mechanical, electrical and software, to streamline the entire product development process – from product inception to manufacturing. Embedded electronic design automation (EDA) solutions and industry-leading software design solutions seamlessly integrate electrical/electronics, PCB and software design with the overall product design. This ensures that when requirements change, all aspects of the design can adapt simultaneously, significantly accelerating design changes while reducing their impact.

Each designer and collaborative team is empowered by multidisciplinary design and optimization technology to explore innovations. Best-in-class simulation and optimization software enables them to shift from static to dynamic design and embrace iterative processes. They can analyze, understand and perfect every aspect of design, then validate design performance and manufacturability in the virtual realm with powerful simulation tools. In this way, innovations can be incorporated into product design quickly and then be manufactured right first-time for more cost-effective production.

Siemens Xcelerator also enables you to leverage operational data from simulations or even from the production floor to drive design modifications and improve asset utilization. With the vast quantities of design data generated in support of today's highly complex A&D products, multidisciplinary design and optimization also serves as a prime proving ground for emerging AI technologies. AI's ability to train itself on these data lakes will enhance performance prediction and optimize solutions. Integrating AI in this manner has the potential to change the way products are designed and engineered.

USE CASE

Northrop Grumman

Designing the Habitation and Logistics Outpost (HALO) and its Lunar Gateway for the U.S. National Aeronautics and Space Administration (NASA) has required Northrop Grumman to manage next-level project complexity and vast amounts of data among hundreds of partners and suppliers. Digital transformation using Siemens Xcelerator has supported Northrop Grumman in its efforts to streamline the work between design analysis, testing and manufacturing teams.

With a mission of sustained lunar surface exploration, HALO must meet stringent requirements to perform in the harshest of environments. Northrop Grumman has leveraged multidisciplinary design and optimization technology and other Siemens Xcelerator tools to simulate and analyze non-terrestrial performance in extreme thermal, mechanical, dynamic and vibroacoustic environments during spacecraft handling, launch and separation as well as mission operations.

Automating the design space exploration process on the Siemens Xcelerator platform is expected to **reduce analysis time by 30 to 50 percent**.

For more information read the case study.

Advance digital transformation maturity through multidisciplinary design and optimization

For many aerospace and defense organizations, the time for breaking down silos has clearly arrived. A multidisciplinary design and optimization solution allows you to streamline product development while enhancing collaboration and optimizing overall design – seizing a competitive edge.

With some strategic planning, the transition from independent mechanical, electronic, electrical and software design to multidisciplinary design and optimization does not need to be abrupt or disruptive. Instead, as with most aspects of modern digital transformation journeys, a stepwise implementation will allow smooth, incremental progress to faster delivery of innovative, optimized, certifiable designs.

The conventional approach to design, albeit siloed, has nevertheless propelled your design efforts along the path to greater digitalization, with its many advantages. Digital tools created for individual domains represent the lowest level of digital transformation maturity, **configuration** control with product data management (PDM). At this level, information from each discipline is digitally stored, with changes tracked and ongoing access and search capabilities provided. Data sharing between stakeholders at the configuration level is available but limited. Performance of cross-database functions is primarily a manual undertaking.

Siemens multidisciplinary design and optimization solution offers data **connection** among disciplines and domains, the second level of digital transformation maturity. It supports the capabilities described in this ebook, allowing you to execute a collaborative design process, manage complex A&D designs, innovate and optimize while controlling risk – and remain competitive in the ever-changing A&D marketplace.

Requirements for human intervention begin to decrease at the connection level of digital transformation maturity, with the work of finding, collecting, tagging and moving data still being manual activities. Siemens multidisciplinary design and optimization solution has started automating these manual tasks, advancing into the **automation** level. The solution enables continuous optimization of aircraft design across all stakeholders and across the entire product lifecycle.

The Siemens solution is also deliberately designed for the future. It enables you to advance within the automation level and eventually into the final two levels of digital transformation maturity, called **generative design** and **closed-loop optimization**. These final levels are becoming fully available as new artificial intelligence (AI) capabilities reach commercialization.

Siemens digital transformation solution for multidisciplinary design and optimization provides a rich set of adaptable capabilities to help maximize the efficiency of your design teams, accelerating delivery of designs that satisfy customer and regulatory requirements. As your A&D design capabilities progress, you will also lay a foundation to leverage future AI capabilities for even greater efficiencies into tomorrow.

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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