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DIGITAL INDUSTRIES SOFTWARE

The A&D executive's guide to realizing digital transformation maturity

Equipping your organization to build complex integrated A&D products today and tomorrow

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Executive Summary

Today's aerospace and defense (A&D) executives are acutely aware that the future of A&D manufacturing is digital. Without accelerated digital transformation, your efforts to build complex integrated A&D products will continue to require too much time, too much money and too many engineers. These demands are compounded as you contend with new requirements and issues emerging from global initiatives to decrease aerospace-related carbon emissions.

How can you adopt and deploy advanced digital transformation technology faster to overcome these growing challenges? And how can you be sure that the technology you choose is fully equipped to support your end-to-end A&D product lifecycle, including design, manufacturing and sustainment, both now and into the future?

Siemens Digital Industries Software has studied these issues intently, relying on the breadth and depth of knowledge we have gained through our decades of service to the A&D industry. This eBook is designed to serve as a guidepost for A&D executives to learn more about accelerated digital transformation. We define the stages of digital transformation maturity and provide insights designed to help you craft your company's unique digital journey. By leveraging our insights with your knowledge of your A&D sector, you can seize this opportunity to propel your company to business leadership and market success.

The urgency of the digital transformation mission

The A&D industry has reached its inflection point. On one hand, funding is plentiful. Indications suggest greater revenue from an increased demand for passenger flights. Investments are growing in emerging markets, such as advanced air mobility (AAM). Sustainability initiatives are funding development of green components and systems. Investments are rising in sustainment as aircraft operational lives are extended. Geopolitical tensions and the need to modernize military systems are raising defense allocations. The drive for rapid innovation and advancements in the space sector is prompting new spending there.1 A&D experts estimate that over the next several years, A&D investments globally will equal trillions of U.S. dollars.

On the other hand, industry trends present obstacles that make it harder to deliver innovative, more sustainable A&D products for new programs and missions – on time and on budget. Chief among these, according to a National Association of Manufacturers 2023 survey, is a dwindling supply of high-skill talent. Other difficulties arise from ongoing supply chain volatility and the vast complexity of modern aircraft, spacecraft and defense systems. Outdated processes keep you from successfully managing these challenges.

To emerge as a market leader, you must make the most of your high-skill workforce by accelerating your execution of digital transformation. This will speed up design and manufacturing workflows while simultaneously freeing your team members from non-value-add, mundane tasks to focus on more sophisticated engineering activities and collaborative innovation.

Currently, most A&D companies rely to varying degrees on compartmentalized legacy systems. Simply communicating information between these systems – much less collaborating across departments – is time-consuming and error-prone.

Conventional product development proceeds one stage at a time through concept, design, engineering, certification, production, launch and sustainment. This linear and document-driven approach cannot meet today's time and cost schedules or efficiently manage multiple product configurations to meet the needs of various global customers.

In fact, programs that still rely on this linear, segmented approach typically spend half the development time and budget on the effort to get separately designed systems to work together.

If you are ready to build more optimized, safe and sustainable products faster, for less cost, with a smaller workforce, then this eBook will help you determine the best path for your company to achieve digital transformation maturity. You will assess where you are on this path, the value of taking the next step toward achieving digital transformation maturity and what your company needs to get there.

The foundation of digital transformation maturity

Digital transformation technology can drive an intentional and aggressive strategy that achieves on-time, on-budget delivery and sustainment of your A&D products. To do so, it leverages unprecedented interoperability, simulation and automated data traceability.

Effective digital transformation technology is built on three essentials:

Multidisciplinary interoperability and integration. More interoperability between systems as well as integration with external systems enables your development teams to exchange and use information more efficiently. Engineers are able to eliminate divergent requirements and create easy-to-use, cost-effective practices. This allows them to mitigate risks from the very beginning of the product lifecycle, quickly correcting mistakes and resolving conflicts between the specifications developed in different domains early, while cost and impact of change are low.

Flexible solutions on an open platform. To empower your team to fully leverage existing technologies while quickly incorporating new ones, digital transformation requires a platform that is as compatible with legacy applications as it is with new solutions. A flexible, open platform delivers full transparency of digital data across the complete product and lifecycle, including support for a closed loop approach that feeds actual performance data back into models for continuous refinement and optimization of products and processes.

The key to this transparency is comprehensive digital twin technology, which provides a single source of truth, cross-domain visibility and constant access to up-to-date information regarding every aspect of each product as well as the processes employed to manufacture it and the service activities that optimize its ongoing operational performance.

Combining the virtual and physical worlds. The combination of physics-based simulations with data analytics in a fully virtual environment makes it possible to realize innovations faster and more reliably. It also requires considerably fewer physical prototypes while multiplying the impact of your existing engineering workforce.

Siemens offers these essentials within the Siemens Xcelerator business platform. Siemens Xcelerator gives you an open, flexible, scalable platform that connects all domains and stakeholders in a collaborative ecosystem. It enables you to leverage a flexible portfolio of robust interoperability technology that can be seamlessly incorporated into existing processes and applied to new processes, allowing you to accelerate digital transformation maturity at your organization.

Siemens Xcelerator supports your digital transformation by adapting seamlessly to changing times and advancing technologies. Whether your company’s digital tools are tried and true, or comprise the most recent advancements, Siemens Xcelerator will support your journey to digital transformation maturity – now and far into the future.

The 5 levels of digital transformation maturity

Keeping up with industry demands and driving your organization’s growth require that you accelerate your A&D company’s digitalization journey. This process is uniquely enabled by the open, flexible, scalable Siemens Xcelerator platform.

Additionally, Siemens’ 5 Levels of Digital Transformation Maturity is a roadmap to building more optimized products faster and closing the workforce gap by multiplying the impact of existing engineers. It helps you assess where you are on the digitalization journey and then develop a strategy for maturing your digital transformation. As you execute the strategy, multiple solutions across various disciplines can be linked, and then used to accomplish much more.

The capabilities of each level are fully functional and indispensable to the operation of subsequent levels of digital transformation technologies. The next step cannot be fully achieved until all the previous steps are complete.

It should be noted that the levels of digital transformation maturity do not correspond one-to-one with particular software solutions. Instead, the software solutions fit within the digital transformation maturity framework.

As new digital functionality develops or fits into your plan, it can be incorporated into your digital ecosystem. For example, artificial intelligence (AI), augmented reality (AR) and other enabling technologies have advanced tremendously in recent years and are expected to continue advancing. The infrastructure provided by Siemens Xcelerator lets you leverage these toward your digital transformation maturity.

WHAT

Enterprise reference architecture:

Provides secure, traceable, well orchestrated data from requirements to industrial edge – capturing of all data along the lifecycle of assets and systems.

Enterprise interoperability:

Requirements, connected to design, leading to tests, commissioning and then feedback loop from the industrial edge – an authoritative source pulling from all enterprise federated data.

Automate the mundane:

Find mundane tasks that where you can remove the "human in the loop" and "free the human" to focus on the work that really matters.

Auto-generate multiple alternatives:

Generative design for assets, work packages and operations for continuous improvement and optimization studies that support decision making across the asset and system lifecycle.

Model-based financial optimization:

The full stack of data (federated and live feeds) is analyzed and optimized for sustainability (both profitable and ecological) with thousands of iterations and a trained AI environment providing competitive advantage.

Immature — **Digital transformation journey** — Mature

HOW

Create a physics informed digital twin along with a system of BOM, WBS or PBS structures that both internal and 3rd parties adhere to across the enterprise portfolio.

Create a digital backbone with agile APIs to create the needed "stack" that is foundational for the enterprise industrial metaverse.

Invest in AI/ML where confidence builds in the reliability of AI. Examples such as parts design, risk based inspection analysis, workforce management and other more routine, and repetitive tasks.

Invest in physics based analytics that allow for "tuning" of assets in the virtual world with numerous iterations leading to optimal physical world performance.

Create AI/ML that links markets, supply chain, equipment performance, and maintenance optimiza-tion along with nimble low code.

LEVEL 1

Configure

The first step of digital transformation is to implement technology that creates a digital space comparable to a very large file cabinet – a single virtual location to store assets that previously were kept on paper. This product data management (PDM) capability configures all product lifecycle information. It also tracks changes as they occur – a design innovation, use of a more sustainable raw material, implementation of a more energy-efficient production machine, or a component upgrade in an operational aircraft, for example. PDM gives your team ongoing access and search capabilities with these assets, making it a simple matter to locate information whenever it is needed.

Digital configuration offers a comprehensive picture and gives your team full access to each of your assets. However, the configuration step provides no functional connection between assets. So for example, at this level of maturity, the mechanical designer has to manually recreate a 3D representation of a systems-level design in the mechanical design tool. The next stage eliminates such manual tasks.

LEVEL 2

Connect

Once your information assets are digitalized and configured, making connections between data sets enables your team to perform in-depth analysis. If a mechanical design changes, the impact on electrical systems can be determined directly. Likewise, when a manufacturing modification is simulated and validated, the results are communicated directly to the manufacturing execution system (MES) for streamlined production floor changes. Or when an engineer issues a waiver for a design exception, this information is transmitted to the asset management software. In other words, the connection step of digital transformation maturity lets you put your data to work.

In this second stage, information designed at the systems level is automatically communicated to the design tool for each domain. Connection enables traceability from requirements, to design, to verification/certification, to manufacture, to service and finally to disposal of a product. A common data model enables cross-domain movement of product data. Product lifecycle management (PLM) software makes one department's changes available to be consumed by every stakeholder.

By automatically providing critical data communication, the connection stage relieves your team of manual data entry. Still, this step requires manual intervention by real human beings to find, collect, tag and move that data. Your workforce still spends valuable time looking for information, writing reports, creating tests and performing other mundane tasks.

LEVEL 3

Automate

In the next step of digital transformation maturity, automation reduces or eliminates the heavy lifting of manually setting up, maintaining, and moving data across domains, tools and databases. The system is smart enough to know how the information from various domains interrelates. With mundane tasks performed automatically in the background, your workforce is free to collaborate more efficiently and focus more fully on substantive design and engineering work.

At this stage, engineers make decisions at the requirements or design level. The system determines the impact of each decision and handles all updates. Reports, test results, procedures, process control and more now reside in an interconnected ecosystem, enabling immediacy in creating a complex aerospace product. For product manufacturing, these automated tasks can include movement of materials, build and assembly processes and inspection.

Digital tools first take over the mundane tasks that would otherwise consume highly skilled engineers' precious time and effort. With higher levels of automation, the tools automate tasks we previously thought only people could do. Required direct human interaction diminishes, freeing your staff to make only high-level decisions.

LEVEL 4

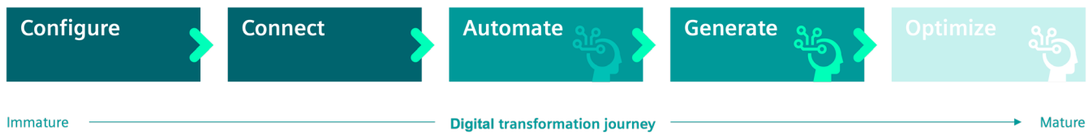
Generate

Just as AI is astounding the general public with its performance of personal, academic and business tasks, so too is it beginning to offer noteworthy capabilities to A&D manufacturers. The generative design stage of digital transformation maturity involves advanced AI, machine learning (ML) and “data lakes” – the proprietary knowledge your company has accumulated, often for decades. Generative design algorithms ingest and sort through all this knowledge.

An AI-powered multi-domain system creates one-to-many design alternatives. Instead of innovating individual designs and processes, the engineers’ time and effort is more effectively spent innovating at a systems level and establishing evaluation criteria. These can include cross-domain criteria, such as design-for-manufacture or design-for-service. The generative design system employs knowledge of all previous designs, including what worked and why it worked, to develop a few candidate designs and product manufacturing information (PMI) datasets.

Generative design can be performed at many levels, from individual parts, to systems, to entire products or factories. The designs are easily connected to simulation tools to perform virtual testing, measurements and performance analysis. Engineers use these tools to evaluate the candidate designs, select one and perform any needed modifications to take it across the finish line.

With generative design, you no longer simply multiply your time savings in product development — now they grow exponentially as you multiply the impact of your skilled workforce.



LEVEL 5

Optimize

The final step of the digital transformation maturity framework allows your engineering team not only to present the design requirements to the digital system but also to enter desired product and manufacturing performance outcomes, such as cost, weight, aerodynamic properties or service life, in the form of key performance indicators (KPIs). An AI-powered system can evaluate a generative design against those KPIs, adjust the design goals, and relaunch the generative design process. Closed loop optimization (CLO) enables autonomous generation of potentially thousands of iterations and presents your engineering team with the top designs most likely to meet all KPIs. CLO also generates virtual prototypes (digital twins) that are so realistic, they minimize the need for physical prototypes.

At this stage, engineers focus on thinking creatively about products that the connected digital systems could bring to fruition. Innovation is constrained only by physical and electromechanical principles rather than by human computational capacity. What's more, product development time may be slashed upwards of 90 percent even as you support this breadth of ingenuity.

How your organization grows through the transformation journey

One of the most important outcomes of accelerated digital transformation maturity is its impact on your limited engineering workforce. Team members will thrive in the less tedious, more creative environment brought about by digital transformation technologies as they innovate product designs, materials, manufacturing equipment and processes, and sustainment planning. In the process of building more optimized, safe and sustainable products, your high-skill workforce gets to focus on the kind of work they spent years of their lives preparing to do – work that they find fulfilling and will want to continue to do at your A&D company.

The digital transformation journey thus sets up a "cycle of virtue," in which you attract and retain a quality workforce, raise productivity and profits and invest in greater digital capabilities – which further attract and retain a quality workforce.

This cycle of virtue occurs no matter your current stage of digital transformation. As you invest in technology that enables better connectivity and collaboration, your employees spend less time looking for and using information from a massive ocean of data and manually communicating information across domains.

As you advance into the automation level, your digital tools automate tasks that previously only people could do. The automation, generative design and closed loop optimization stages multiply the freedom enjoyed by your high-skill people to focus on what they want to do – design, engineering, innovation – rather than on what they have to do. You improve workforce retention and human productivity. You gain a more predictable return on investment. Moreover, your burgeoning digital productivity accelerates the product development and production lifecycle quite remarkably.

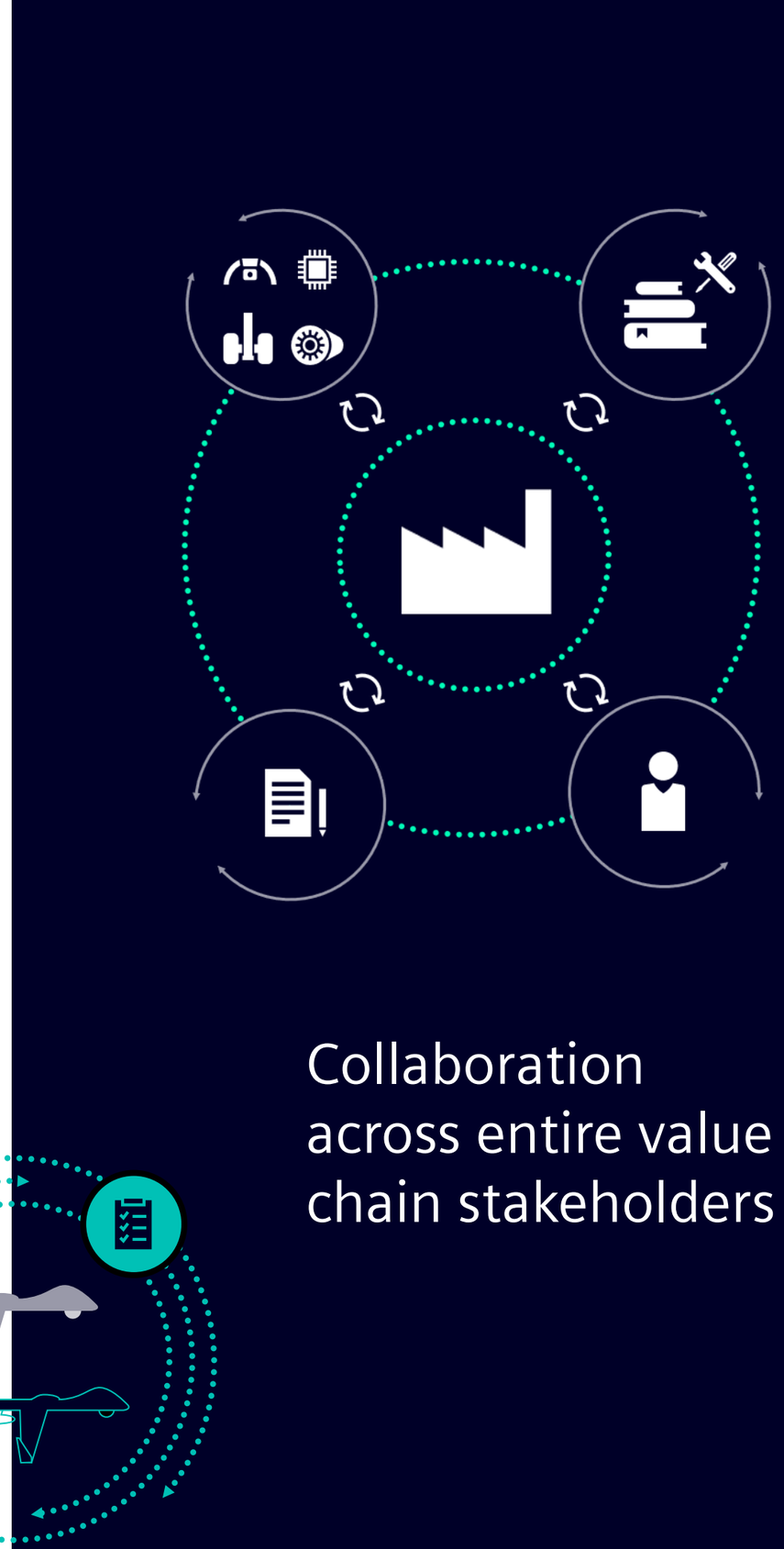
Each new investment in digital transformation maturity serves as an effective change agent for implementing your company vision. You equip your organization to optimize around the big-picture "system of systems" rather than around all the domains, disciplines and suppliers that contribute their small piece of the whole. It helps to bring about:

Speed-to-market – Build more optimized products faster, accelerating the product development lifecycle across all your business domains and supplier network

Workforce productivity and retention – Free high-skill workers from mundane tasks to bring their talent and skills to bear on product and process innovation

Increased margins – Fully employ multidisciplinary interoperability to replace slow physical prototyping and testing with rapid, cost-efficient virtual design, engineering, simulation and analysis

Industry leadership – Create innovation efficiencies and continuous optimization, meeting sustainability targets in your products and processes



Collaboration across entire value chain stakeholders

Equipping you for the journey – today and tomorrow

Where is your organization on its digital transformation maturity journey? If your A&D company is like most, an essential part of your executive mission is to develop a clear, practical and implementable plan for your digital transformation journey. One of the most direct ways to accelerate your planning is to ask your team members or departments to list three mundane tasks they perform regularly that they don't want to perform anymore. As you determine how each of these tasks affects human productivity and your product development lifecycle, you can prioritize technology investments likely to have the greatest impact on your business.

Our mission at Siemens Digital Industries Software is to drive each of our A&D customers' digital transformation forward, helping you identify and take the next step that will bring the most value. To this end, we have taken the lead in bringing end-to-end solutions together to deliver robust interoperability. This approach built upon an open, scalable, flexible ecosystem of technology simply does not exist anywhere else in the industry.

Our unique platform and capabilities empower you to leave the creative thinking, innovation and decision-making processes to your workforce talent and let your digital solution do the rest. Our portfolio equips every component of your end-to-end A&D product lifecycle. These components include:

Component 1: Mission driven systems engineering
Component 2: Connected verification and certification
Component 3: Multidisciplinary design and optimization
Component 4: Smart manufacturing
Component 5: Value chain collaboration and intelligence
Component 6: Optimized sustainment and availability
Component 7: Model-based acquisition and program pursuit

As you prioritize these disciplines according to your business strategy, Siemens is ready with the digital solutions that will enable faster, lower-cost, right first-time delivery of your innovative products. You will quickly secure your position as a market leader, successfully and safely executing the programs that are transforming air travel, space exploration and defense.

Click here to read more about our most recent advancements and customer success stories.

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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