Accelerating Product Development Through Digital Transformation

AVIATION WEEK NETWORK
By Informa Markets

SIEMENS
Ingenuity for life

What do a startup air mobility company, a major aerospace and defense OEM, a space launch business and a shipbuilder have in common?

They must take complexity and make it simple — turn the lengthy design process into one of speed and agility.

These diverse businesses also share a need to expand what happens during the design and development process to include:

- Weighing design trade-offs
- Validating the manufacturing processes
- Examining and narrowing of alternatives to improve performance, reliability, safety and cost
- Assessing supply chain options
- Analyzing the impact of individual design decisions on the overarching lifecycle of the product
- Building in flexibility that allows a product or platform to adapt and morph as missions and customer demands shift throughout dynamic market and technology evolutions during the product lifecycle that jump across the serial steps of the past

From all-electric aircraft to 4.5-acre, 100,000-ton nuclear aircraft carriers, from spacecraft to fighter and trainer aircraft — the products of this decade require tools and enterprise-wide systems that support tweaking and refinement coupled with the ability to know within a degree of certainty how any one change could alter the outcomes of performance, reliability, readiness and cost.

The digital coding, algorithms and data that weave through today's aerospace and defense programs, then, are similar to the sinew, muscles and structure that connect any ecosystem, a living reflection of all that goes on between the earliest thought of creativity to monitoring system use and health.

Significantly, those using the digital thread and digital enterprise approach range from a historic space launch company, United Launch Alliance to newcomer SpaceX, from stalwarts Boeing, Northrop and Lockheed to rising star Bye Aerospace. The need for speed, precision and results remains the same.

Siemens Digital Industries Software and its Xcelerator portfolio have been at the forefront of developing and evolving the tools, processes and solutions required to advance the digital transformation beginning with model-based systems engineering (MBSE) and advanced program execution to design, engineer and manufacture the connected domains of today's modern digital enterprise.

The E-Advantage

The E prefix on U.S. Air Force programs carries significant fundamental change. It "marks" a platform to be designed, developed, tested, produced and sustained using digital engineering technologies.

U.S. Air Force secretary Barbara Barrett made the announcement, saying "The e-Series aircraft, satellites, weapons and more that are digitally engineered will receive an E prefix."

"Imagine iterating thousands of potential designs, developing composite materials without mixing chemicals, testing with countless sets of condition in air or space, and delivering the product for manufacturing as a digital file no larger than an email attachment," Barrett said.

The new designation begins with Boeing's eT-7A and extends through much of the other programs in the current funding portfolio.

Achieving Results

Complex systems rely on predictability, affordability, performance and adaptability. In looking at a digital environment, this means delivering results at every step of the program lifecycle.

As Boeing pursued the U.S. military's newest trainer aircraft contract T-X, rebranded as the eT-7A, it did so in a manner that aligned with how acquisition was changing within the U.S. Department of Defense. The company engaged in early development at its own cost, so that by the time a contract decision was made a manufacturing prototype had been flown and validated. The training and the support had gone through the troubleshooting. Boeing was ahead of the market with a solution at a price point no other OEM could match.

The digital capability was part of the mix, as was Boeing's extensive work on a new manufacturing environment, a novel business strategy, and a focus on providing a lifecycle service to the military — not just an aircraft, as program chief engineer Paul Niewald explained to Aviation Week's DefenseChain Conference audience. Boeing applied digital engineering tools on the eT-7A through an elaborate application of model-based systems engineering. In partnership with Saab, Boeing flew the first prototype within three years after launching the program in 2015. As the first test aircraft entered the production system, a final assembly process that previously took 24 hours, now takes 15 minutes, said Leanne Caret, president of Boeing Defense, Space and Security, in a report from Aviation Week & Space Technology.

For Bye Aerospace, a company targeting development of an all-new electric aircraft, the goal was to be among the first to market.

George E. Bye, CEO and founder, used a range of products from the Siemens Xcelerator portfolio to support this effort. These include Siemens NX, an advanced CAD/CAM/CAE software tool that engineers use for parametric design and direct solid/surface modeling and manufacturing to include machining modules for the latest materials. Simcenter is used for analysis (1D simulation, static, dynamic, electro-magnetic) and for thermal and fluid dynamics.

Bye also uses Siemens Fibersim, an end-to-end design and manufacturing tool for composite parts. Fibersim allows design teams to analyze and design within the context of the manufacturing process.

Photo courtesy of Boeing

As to the results Bye needed in the high-pressure game of aerospace startups — product development time was reduced, allowing the Bye Aerospace team to go through more iterations, not fewer, using a design team 66% smaller than the norm in aerospace. In addition, Bye was able to develop an all-composite, all-electric airplane with lower part count compared to a traditional aircraft of the same size.

"We designed with change in mind," says Jim Forrester, director of design and engineering at Bye Aerospace. As the team transitions the initial design for the eFlyer 2 to the eFlyer 4, the aerodynamic shape morphs with the improved design characteristics. And rather than taking months, the transition is staged for one week. "In the end, that allowed us to get to market fast, with the right plane," adds Forrester.

As of October 2020, the company had 411 paid purchase deposits, split between the eFlyer 2 and eFlyer 4 — all within six years of the company's launch of the eFlyer program.

A similar experience was recorded by Newport News Shipbuilding when designing the "smart" shipyard for production of nuclear-powered aircraft carriers. Under an effort known internally as the Integrated Digital Shipbuilding initiative, the business transformed to a digitally enabled environment for a 25,000-person workplace that needed to operate in a synchronized dance combining technically complex tasks with the artistry of a master craftsperson, as well as new employees.

Unlike much of the aerospace and defense industry, shipbuilding is not assembly-line oriented, which makes integration of a digitally enabled environment important, but also unique in its focus not only on automation and robotics, but on people

and processes. As the team leading the digitalization initiative reported, “Standardizing the tools and processes we use to construct ships across our product lines has a propagating future benefit to ship alterations and overhauls, which is advantageous for maintaining an operational Navy fleet.”

However, translating a 130-year business and its processes to the digital environment created uncertainty. Leaders overcame that uncertainty with a belief that the smart shipyard was critical to remaining relevant in an era of shrinking shipbuilding capability. Just as important, it was critical for employees who needed to make decisions as close to the work as possible to also understand the implications of their decisions on a product that is as large as a small city.

Based on the availability of data, processes and people, Newport News was able to schedule aggressively, removing the time safety factor from every task and then harvest that time in a buffer to cover when more time was needed. The result was increased velocity of the overall work in progress, at times by 30%.

The Siemens Digital Transformation

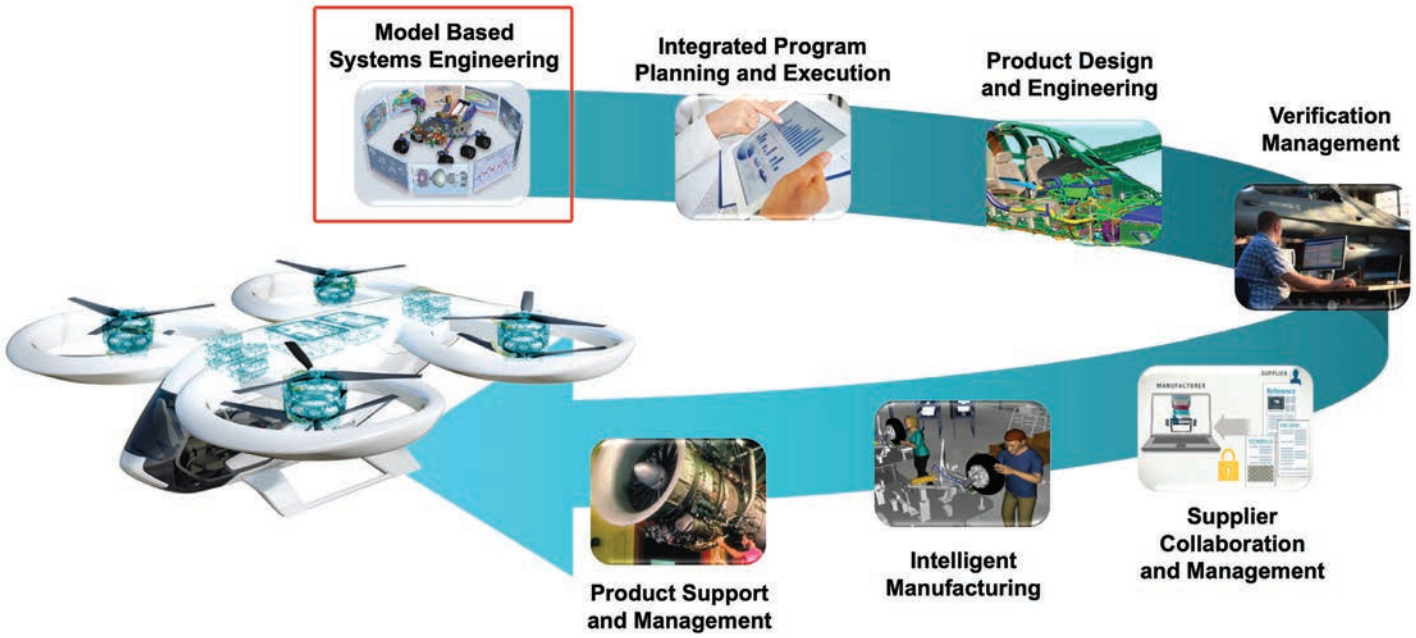
Siemens has been creating the digital ecosystem long before the universal demand for artificial intelligence, virtual reality or modeling came into play. The goal was to improve product performance while "bending the cost curve", cutting both product development schedules and cost, while allowing for increased iterations (in a shorter time) to reach the optimum design. More importantly, aerospace needed to reinvent itself in a software-intensive world that would allow new technologies and upgrades to be easily inserted into a platform with minimum downtime and little impact on the remainder of the system. And this new world would require that contractors compete for aftermarket contracts, rather than assume those long-lasting sustainment contracts as the benefit of designing the system.

The digital thread and digital twin became synonymous with this reform. However, a digital environment goes beyond either of these key elements.

And, as the examples provided in Bye Aerospace and Huntington Ingalls’ Newport News Shipbuilding illustrate, customizing the digital thread to meet the unique characteristics of any advanced technology is essential.

Siemens views the digital thread as a composite of interwoven and connected digital strands, creating an ecosystem for program execution excellence. The Xcelerator portfolio of software and services, which provides the industry’s most comprehensive digital twin is why Siemens is trusted by aerospace manufacturers and government agencies to enable productivity and innovations for the next generation of design, manufacturing and maintenance through increased automation and collaboration.

Siemens digital threads focused on program execution excellence



The Siemens model-based systems engineering (MBSE) digital thread is at the core of creating a digital enterprise that brings together all elements of the Siemens collaboration platform with systems engineering, mechanical, electrical/electronics, software design, multi-domain modeling and simulation. Most companies use some form of systems modeling (SysML) within their development processes. However, this approach alone is not sustainable in the current context as product complexity is increasing exponentially. Companies need to move from system modeling alone to a digital thread approach, leveraging an open ecosystem that enables the usage of any system modeling tool, and connects it to the entire lifecycle of data and information needed to certify, deliver and maintain new products. Aerospace and defense companies can now optimize the performance of their technical program and transition seamlessly from an antiquated systems modeling approach to the Siemens MBSE digital thread for orchestration and integration across the entire product lifecycle.

Through the tight integration of this MBSE digital thread, teams can test and push the boundaries, all while monitoring how this affects down-stream work, from ease of manufacture to ease of access for maintenance.

With an overarching integrated program planning and execution digital thread solution, **program teams can plan for cost, schedule, assess and monitor risks and opportunities**, and — as with Newport News — remove the built-in safety net that tends to fill a schedule at every distinct step of the process.

And, as with Bye Aerospace, the Boeing eT-7A and many of today's key military autonomous and advanced aircraft, hypersonic propulsion, missiles, and space programs of record that are increasingly being awarded as fixed price, the modern era "pencil" — the product design and engineering digital thread brings together all the varied disciplines with an integrated set of CAD/CAM/CAE development tools. **These are the essential elements to "agile" development that pushes through iterations of creativity and design in weeks or months rather than the multiple years of the past**. Most important, these smart systems bring to bear the rich legacy of breakthroughs from the organization, stored in the digital archive of work already completed.

Verification management is the next piece of the ecosystem where **the digital thread enables underlying capabilities, including verification and validation** — one of the unique facets in aerospace that leads to regulatory certification. All the design, analysis, virtual and physical test artifacts are synchronized with one another. And while this is critical to gaining regulatory approvals, it also supports corporate-wide standards and re-use of proven processes and techniques.

In other words, this digital thread goes to work for the program or project team, providing alternatives and existing artifacts to increase the velocity of innovation breakthrough and design/development.

Complexity has many forms, from the very nature of the technology, to the layers of suppliers who come to bear on the final platform or product. And that's where Siemens' solution for supplier collaboration and management comes in. The digital thread manages data interactions across this value chain, using a model-based process, providing the embedded data that aid in identifying risk and opportunity. Through the collaborative tools provided by Siemens, users coordinate, manage and secure information across all stages of the product lifecycle, protecting the data rights of everyone involved.

While Siemens Digital Industries Software assists organizations across all industry sectors, Siemens as a corporation has a long-heralded reputation in manufacturing and innovation. And in the second decade of the 21st century, this comes to bear in **creating intelligent manufacturing capabilities**. The digital thread moves a company towards a fully integrated factory, seamlessly transitioning engineering design to manufacturing planning. Companies are able to optimize factory layout, to evaluate new processes and apply automation — all before a single wall goes up. When connected to other Siemens digital threads, users can "see" before they "do", resulting in cost savings, time savings, and overall production savings.

Finally, with a digital thread weaving through design, development, planning and manufacturing, the attention focuses on after-delivery service to support complex products — the heavy lift when it comes to total cost of ownership. Using a configuration-driven environment, the maintainer can access the data that paints a picture of what the product has done, where it has been, what it has endured. **In other words, the information needed to keep that asset in use, at prime performance — the product support and management digital thread**.

Imagine a decade from now — as traffic in space grows, as advanced air mobility takes hold and as sixth generation aircraft take to the skies — one thing is certain. Creativity, innovation and technological advances will move forward ever faster, as Siemens brings the promise of tomorrow's technology to the industry today in very real and meaningful ways.