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The Digital Twin in Space: NASA's Next Spaceplane's Sophisticated Design Approach

Tony Hemmelgarn, President and CEO, Siemens Digital Industries Software
Jeff Babione, Chief Operating Officer, Sierra Space

KEY TAKEAWAYS

- With product lifecycle management tools now accessible in the cloud, teams can move quickly and make decisions with confidence.

- As digital twin technologies have evolved, the gap between the virtual and real world has become smaller.

- Looking ahead, digital twins will support the "industrial metaverse."

- The Siemens Xcelerator business platform offers software, hardware, and services to scale digital transformation across industries.

- Thanks to Siemens technology, Sierra Space is developing a vehicle that will enable humans to live and work in space.

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OVERVIEW

Although every industrial company is at a different stage of its digital transformation, one principle applies to all of them. Digital transformation depends on a core capability: **combining the physical and digital worlds**. This requires organizations to think differently. Companies must abandon legacy siloed tools and turn to a single source of truth.

Sierra Space, a company at the forefront of space transportation, is using the Siemens Xcelerator platform and its digital twin technology to support its Dream Chaser® spaceplane next-generation digital engineering program. To deliver space-worthy performance, the team is leveraging digital twins that incorporate structural, thermal, mechanical, and software designs, as well as advanced manufacturing environments.

CONTEXT

Tony Hemmelgarn and Jeff Babione discussed the evolution of digital twin technology and how Sierra Space is using software from the Siemens Xcelerator platform to efficiently design and manufacture the Dream Chaser spaceplane.

KEY TAKEAWAYS

With product lifecycle management tools now accessible in the cloud, teams can move quickly and make decisions with confidence.

Digital transformation isn't a new concept. Attitudes toward it, however, have changed. Looking back 10 to 15 years ago, ERP systems were a common boardroom topic. On the other hand, C-suite executives rarely discussed product lifecycle management or operational technology, even though these systems had a greater impact on organizational success.

This thinking has changed over time. In particular, COVID-19 forced companies to think and work differently. During the pandemic, companies who had begun to digitally transform and had digital processes were able to easily collaborate worldwide and move quickly, while those without struggled.

Looking ahead, other disruptions are inevitable, from future pandemics or the emergence of new business models. In organizations that sell their product as a service, for instance, a digital backbone is critically important for ensuring uptime and quality. Today, the boardroom has recognized the importance of product lifecycle management (PLM) technology and the digital backbone it provides, due to its comprehensive functionality and its ability to support better business decision making.

As digital twin technologies have evolved, the gap between the virtual and real world has become smaller.

The term "digital twin" has been around for a long time, but its meaning has changed over the years. Early digital twins were based primarily on 3D CAD models that focused on assembly and fit rather than on function.

Over the last five to 10 years, digital twin functionality has become more comprehensive. Today, digital twins have become exact digital replicas of their physical counterparts — a link between the virtual and real world, so the closer that linkage is, the more valuable a digital twin becomes.

Siemens delivers the ability to create the comprehensive digital twin with Siemens Xcelerator, which delivers significant value to organizations like Sierra Space. For example, it can simulate how a product's mechanical components, software, and electronics work together. Digital twins can also simulate how manufacturing processes will run in the factory environment.

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Looking ahead, digital twins will support the "industrial metaverse."

Within the next decade, digital twins will become even more useful than they are today. By embedding a digital twin into product or manufacturing processes, teams can simulate and validate everything in a virtual way. After interacting with the model, they can make changes and see how the model operates.

"Executable digital twins" simulate the operational aspects of products. For instance, companies responsible for undersea piping might run an executable digital twin on an edge device to optimize the flow of fluids using computational fluid dynamics software.

More work needs to be done to advance digital twins and support the "industrial metaverse," so Siemens is partnering with NVIDIA to bring digital twins to photorealistic life in the Nvidia Omniverse. For example, users will be able to immerse themselves in factory simulations that are linked to digital twin capabilities. If a change is made in the simulation, it will immediately appear in the digital twin.

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>
> *Tony Hemmelgarn, Siemens Digital Industries Software*

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In addition to comprehensive digital twin functionality, Sierra Space benefitted from other key elements of the Siemens Xcelerator platform.

1. **Agile and personalized software.** Siemens believes software will become increasingly tailored to each individual's needs. Thanks to low-code capabilities, users can personalize the way they work with Xcelerator without the need for software development skills.

2. **An open ecosystem.** Siemens offers Xcelerator as a service. It is interoperable with Siemens' other businesses including building technology and mobility. The ecosystem also supports integration with competitor products and legacy systems.

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Sierra Space's mission is to build platforms in space that improve life on earth. By dramatically reducing the cost to reach low-Earth orbit, Sierra Space's Dream Chaser vehicle will allow humans to live and work in space. This will unlock a real state change for human civilization.

The Dream Chaser is currently being designed to transport supplies to and from the International Space Station. The reusable spaceplane is about one fourth the size of the Space Shuttle. It will be able to land at any compatible commercial runway in the world and will support turnaround times similar to an airline.

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We are entering a profound time in human history that we call the Orbital Age. We will pivot from having a few astronauts on a government space station to thousands of people traveling to commercial space destinations on a fleet of spaceplanes. The Dream Chaser is the first element to achieving that vision.

Jeff Babione, Sierra Space

Tools from the portfolio of solutions in the Siemens Xcelerator platform have enabled the Sierra Space team to simulate conditions that the Dream Chaser will encounter during its missions, like thermal and mechanical loads. The digital twin is used to simulate and analyze scenarios such as the turn time required to replace a tile or an oxygen tank. Although CAD technology has been around for decades, it is only recently that Sierra Space has adopted PLM and other solutions that are part of Siemens Xcelerator that provide a single source of truth to all stakeholders. This has been a game changer for the company.

At its core, Xcelerator shortens the design evolution. If the Sierra Space team changes the Dream Chaser assembly or the sequencing, those changes are pulled back automatically into other systems in the design process. For instance, structural analyses are automatically updated to reflect new geometries and that information becomes part of the single source of truth. Teams work much faster because they don't have to export data, conduct structural analyses, and then import information back into systems.

The use of Siemens Teamcenter as a single source of truth has enabled Sierra Space to unlock an incredible amount of innovation because engineers focus on what the Dream Chaser should look like and how it should work, rather than the administrative aspects of moving data from one system to another. Design cycles have accelerated dramatically, but so have production cycles. Sierra Space has experienced between a one-half to two-thirds reduction in assembly time. Parts go together faster and teams encounter fewer challenges.

At Sierra Space, Siemens' Xcelerator toolset and digital thread are key for developing, building, and using technology to change life on earth. You can't move a spaceplanes from concept to reality in a short period of time without these technologies. Siemens Xcelerator is unlocking innovation in a way that I've never seen in almost 40 years.

Jeff Babione, Sierra Space

By 2030, hundreds of people will live or work in low-Earth orbit. People will be able to drive to Florida to the Sierra Space space port, hop on a Dream Chaser, hang out in low-Earth orbit for a week or two, and then come back and land at any airport. The low-Earth orbit environment will support many technological breakthroughs, such as printing 3D organs in space and other innovations to eliminate diseases that have plagued the human race for hundreds of years.

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BIOGRAPHIES

Tony Hemmelgarn
President and CEO, Siemens Digital Industries Software

Tony Hemmelgarn is president and CEO of Siemens Digital Industries Software, a business unit of Siemens Digital Industries. Prior to this appointment, he served as the company's executive vice president of Global Sales, Marketing and Services. In that role, he worked in partnership with Siemens Digital Industries Software's zone sales leaders to aggressively target geographic, industry and strategic corporate opportunities. Prior to that, Hemmelgarn was senior vice president and managing director for Europe, the Middle East, and Africa (EMEA). He has also held the United States country management position as well as serving as senior vice president of the Industry Vertical Organization.

Previously, he spent eight years with Intergraph Corporation, an international software firm. At Intergraph, Hemmelgarn assumed increasing levels of responsibility, progressing from technical management to regional technical director and director of Sales and Marketing. He moved to Intergraph from Cad Cam Incorporated where he headed up the services division.

Hemmelgarn earned a Bachelor of Science degree in Mechanical Engineering Technology from the University of Dayton.

Jeff Babione
Chief Operating Officer, Sierra Space

Jeff Babione is the chief operating officer (COO) for Sierra Space, having joined the executive team in spring of 2022. Jeff joined Sierra Space from Lockheed Martin, where he enjoyed a distinguished 30-year career, serving most recently as vice president and general manager of Skunk Works®, leading the famed division that developed some of the most iconic aircraft in aviation history including the U-2, SR-71, F-117, F-22 and the F-35.