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SEEING DOUBLE? HOW VIRTUAL TWINS ADVANCE INNOVATION IN AEROSPACE AND DEFENSE



INTRODUCTION

The aerospace and defense (A&D) industry stands at a critical juncture in 2025, shaped by a complex interplay of global pressures, technological breakthroughs, and shifting market demands. For heads of manufacturing, operations, and supply chain, this is not an entirely new landscape, but the stakes have never been higher. **Today's environment presents a dual-edged reality: unprecedented opportunities for innovation and equally profound challenges.** While the industry has shown remarkable resilience in the post-pandemic years, the path forward demands bold, forward-thinking strategies to navigate persistent disruptions and secure sustainable growth.

One of the most urgent concerns is **supply chain** fragility. According to Deloitte, resilience remains a top priority as global conflicts, material shortages, and labor gaps continue to destabilize production lines. Aircraft manufacturers, for instance, are contending with backlogs equivalent to more than 11 years of production capacity (Deloitte, 2024)¹. **These challenges underscore the growing need for advanced supply management tools, real-time digital tracking systems, and more localized supplier networks to mitigate risks and maintain continuity.**

At the same time, the sector faces mounting workforce pressures. Talent shortages, the urgent need for upskilling, and an aging workforce threaten to impede progress across the industry. Leaders must adopt strategies that not only attract and retain skilled talent but also compensate for the loss of experienced workers by empowering teams with the tools and training necessary to thrive in an increasingly digitalized environment. Digital manufacturing technologies are playing a key role in this effort by closing skill gaps and enhancing operational capability. **Automation and AI-powered systems** are relieving workers of repetitive tasks, allowing them to focus on higher-value responsibilities. Simultaneously, virtual and augmented reality are transforming workforce training, providing immersive, hands-on experiences that accelerate proficiency. These innovations are not just stopgaps, but foundational to building a resilient, future-ready workforce capable of adapting to evolving demands.

Technological integration represents yet another critical challenge. Many companies struggle to fully implement digital technologies across engineering and manufacturing domains, limiting the return on their digital investments



(Deloitte, 2024¹; Mobility Engineering Technology, 2025²). The expanding adoption of artificial intelligence (AI), autonomous systems, and digital twins is poised to reshape operations, but success depends on overcoming regulatory complexity, workforce readiness, and cybersecurity vulnerabilities. As emphasized by Harris Williams, these technologies are essential for boosting efficiency, streamlining supply chains, and enabling predictive maintenance (Harris Williams, 2025)³.

Digital manufacturing has emerged as a cornerstone of the industry's evolution, addressing some of its most pressing challenges in supply chain resilience and workforce development. By leveraging these technologies, A&D companies are not only navigating today's complexities but also laying the groundwork for long-term innovation and competitive advantage.

Additional factors, including growing regulatory scrutiny and geopolitical instability, add further pressure. Increased defense spending and evolving compliance standards demand agility, particularly in areas like cybersecurity and sustainability (Mather, 2025⁴; Mobility Engineering Technology, 2025³). Meanwhile, concerns about return on investment continue to surface, with many organizations struggling to realize the full value of their digital transformation efforts. This reinforces the need for deeper systems integration and a shift in organizational culture.

This whitepaper explores how virtual twin technology can help address these core challenges: supply chain resilience, workforce alignment, and technological integration, by showcasing tangible use cases and industry-proven success stories.

¹ Deloitte. (2024). 2024 aerospace and defense industry outlook. Deloitte Insights. <https://www2.deloitte.com/us/en/insights/industry/aerospace-defense/aerospace-and-defense-industry-outlook.html>

² Mobility Engineering Technology. (2025, January 9). The future of aerospace: Embracing digital transformation and emerging technologies. <https://www.mobilityengineeringtech.com/component/content/article/52372-the-future-of-aerospace-embracing-digital-transformation-and-emerging-technologies>

³ Harris Williams. (2025). Outlook 2025: Aerospace, defense & government services. <https://www.mobilityengineeringtech.com/component/content/article/52873-the-future-of-aerospace-embracing-digital-transformation-and-emerging-technologies>

⁴ Mather, R. (2025, January 26). Defense industrial outlook in 2025. Defense.info. <https://defense.info/re-shaping-defense-security/2025/01/defense-industrial-outlook-in-2025/>



WHAT KEEPS US UP AT NIGHT?

The aerospace and defense (A&D) industry's leaders in manufacturing, operations, and supply chain face a relentless pace of challenges that test their ability to deliver results in a high-stakes environment. The sheer complexity of managing global supply chains amidst material shortages, labor gaps, and geopolitical risks requires sharp focus and agile decision-making. Meeting delivery commitments, maintaining operational efficiency, and staying ahead of technological shifts are non-negotiable tasks that directly impact business performance.

1 Supply Chain Disruptions

Supply chain disruption dominates the agenda. Material delays or shortages can cascade into production backlogs lasting months, if not years. Real-time visibility is no longer a luxury; it's a business-critical necessity to anticipate and mitigate risks. Leaders must balance long-term supplier strategies with immediate tactical problem-solving to ensure continuity without compromising quality.

2 Workforce Pressures

Equally pressing are workforce challenges. The need to attract, retain, and upskill talent is vital to sustaining operations and driving innovation. Yet, competing for skilled talent in a challenging labor market can slow progress and strain existing teams. Finding ways to empower employees to adapt quickly to new systems and processes while delivering results creates constant pressure to perform.

3 Technological Integration

The rapid deployment of advanced technologies, such as artificial intelligence (AI), autonomous systems, and digital twins, is transforming A&D operations. While these technologies promise to streamline processes and reduce costs, their integration is hindered by regulatory complexities, cybersecurity concerns, and the persistent shortage of skilled talent to execute and manage these cutting-edge solutions.

Navigating this landscape means addressing the convergence of these issues with expertise, precision, and forward-thinking strategies. Leaders are not only tasked with resolving today's challenges but also positioning their organizations for sustainable growth in a rapidly evolving industry. The stakes are high, but so are the opportunities for those prepared to adapt and lead with clarity and intent.

FROM OVERWHELMED TO EMPOWERED: VIRTUAL TWINS SUPPORT SMARTER, FASTER LEADERSHIP IN A&D

Virtual twin technology goes beyond operational enhancements; it transforms how leaders in manufacturing, operations, and supply chain within the aerospace and defense (A&D) industry approach their most pressing challenges. By replicating physical systems in a digital environment, virtual twins deliver actionable insights that enable smarter decisions, greater efficiency, and more effective strategic planning. This technology empowers leaders to anticipate risks, optimize workflows, and confidently address critical issues like supply chain disruptions and workforce shortages. More than a short-term fix, virtual twins prepare organizations for long-term growth and innovation in an increasingly complex landscape.

Here's how this technology reshapes their professional lives, making their roles more efficient, impactful, and forward-looking.

1 Sharper Decision-Making with Data-Driven Insights

A&D leaders often face high-stakes decisions involving complex scenarios related to supply chain disruptions, resource allocation, or production planning. Virtual twins provide real-time, data-rich simulations that empower these leaders to make faster, more informed decisions backed by evidence.

Impact:

Scenario Planning: Leaders can simulate multiple outcomes (e.g., where to source materials or how to reroute supply chains) and choose the best course of action.

Reduced Risks: Testing decisions in a virtual environment reduces the likelihood of costly mistakes.

Proactive Problem-Solving: Access to predictive analytics allows leaders to anticipate potential risks (e.g., part shortages, equipment failures) and act proactively, instead of reacting to crises.

Example:

By using virtual twins to model inventory flow and supplier networks, a supply chain leader can reconfigure operations to meet deadlines even when disruptions arise, easing stress and maintaining operational flow.

2 Boosted Efficiency and Streamlined Operations

Heads of manufacturing and operations are often tasked with overseeing intricate systems and maintaining peak efficiency. Virtual twins simplify this by providing an end-to-end digital representation of facilities, equipment, and workflows.

Impact:

Operational Clarity: With virtual twins delivering real-time insights, leaders gain a centralized view of all operations, making it easier to detect inefficiencies and optimize processes.

Faster Troubleshooting: Equipment monitoring via digital twins enables leaders to detect and resolve production bottlenecks or potential downtimes before they escalate.

Optimized Resource Management: Leaders can effectively allocate resources, such as manpower and materials, based on insights into real-time demands and constraints from the virtual model.

Example:

A head of manufacturing can use a virtual twin to simulate adjustments to production workflows, saving time and resources by implementing changes confidently on the factory floor.

3 Enhanced Strategic Planning

Strategic foresight is key for leaders navigating the A&D industry's rapidly shifting demands. Virtual twins allow leaders to simulate long-term scenarios, testing how investments in sustainability, technology, or workforce training might affect overall productivity and growth.

Impact:

Innovation with Certainty: Simulating advanced technologies like hydrogen propulsion or AI-driven systems helps leaders understand ROI and obstacles before committing.

Sustainability Integration: Leaders can test and prioritize sustainability initiatives, such as implementing energy-efficient processes or switching materials to meet decarbonization goals without disrupting operations.

Long-Term Resilience: Analyzing supply chain scenarios ensures improved readiness for geopolitical, environmental, or market shifts, assuring business continuity.

Example:

Before approving a costly technology upgrade, operations heads can validate its impact on production timelines and workforce training needs through simulations, leading to smarter investments.

4 Empowered Workforce Management

A&D leaders are responsible not only for equipment and processes but for building strong, capable teams. Virtual twins make it easier to bridge the gap between complex systems and workforce proficiency.

Impact:

Simplified Training: Virtual environments offer immersive, hands-on training for workers, enabling teams to adapt quickly to new tools and processes without disrupting ongoing operations.

Reduced Human Error: Virtual twins provide step-by-step AR/VR guidance ensuring precision in assembly, inspections, and maintenance.

Improved Collaboration: Virtual twins align manufacturing, operations, and supply chain teams by providing a shared platform for collaboration and decision-making.

Example:

A head of operations can deploy virtual simulations to upskill technicians, ensuring they are confident in maintaining new, automated machinery before implementation, boosting morale and efficiency.

5 Reduced Stress Through Predictability and Control

The unpredictable nature of the A&D industry, from supply chain volatility to regulatory changes, can create high stress for leaders. Virtual twinning adds a layer of control and predictability, allowing leaders to focus on strategic priorities rather than firefighting daily problems.

Impact:

Confidence in Execution: Knowing that decisions have been validated in a virtual environment reduces second-guessing and builds confidence in day-to-day operations.

Proactive Crisis Management: Simulating crises in a controlled environment (e.g., factory shutdowns, raw material delays) allows leaders to design fail-safe protocols.

Time Savings: With faster troubleshooting and fewer manual interventions, leaders gain more bandwidth to focus on innovation and strategic growth.

Example:

With supply chain disruptions mapped and resolved in advance, a supply chain head can direct energy towards building supplier relationships and improving system resilience rather than putting out fires.

6 Stronger Customer and Stakeholder Confidence

Virtual twins provide a level of operational transparency that builds trust with stakeholders. Simulated testing, predictive modeling and data-backed insights offer assurances about quality, reliability and efficiency.

Impact:

Reliable Deliveries: Predicting and mitigating disruption ensures delivery commitments are met, protecting reputations with customers.

Stakeholder Buy-In: Visual simulations of supply chain improvements or sustainability initiatives make it easier to secure funding or approval from executives.

Improved Communication: Leaders can use virtual twins to clearly explain complex systems or changes to stakeholders, building credibility and alignment.

Example:

Presenting a virtual model of a proposed greener production facility allows heads of operations to more effectively communicate value to investors while maintaining trust in the company's vision.



BUILDING RESILIENCE, DRIVING SUSTAINABILITY, AND LEVERAGING TECHNOLOGY

Addressing key priorities like fortifying supply chains, advancing sustainability, and integrating cutting-edge technologies is essential to overcoming current challenges and unlocking future growth. This section highlights the top three strategic actions that can position your organization for success in 2025 and beyond, with examples of leaders in the A&D industry accomplishing those very things.

1. STRENGTHEN SUPPLY CHAIN RESILIENCE

Enhancing Supply Chain Resilience with Virtual Twin Technology

Virtual twin technology creates detailed digital replicas of physical systems, enabling A&D companies to simulate, monitor, and optimize operations in real time. This is especially critical for strengthening supply chain resilience, which has been rocked by global disruptions, material shortages, and rising geopolitical tensions.

Applications in Supply Chain Resilience:

1. Real-Time Visibility

Virtual twins provide end-to-end supply chain visibility by integrating data from every stage of operations. These systems allow leaders to identify bottlenecks, predict risks and respond quickly to disruptions. For instance, a virtual twin can simulate the impact of a delayed shipment and recommend alternative sourcing strategies to avoid production downtime.

2. Predictive Analytics

Using historical and real-time data, virtual twins can forecast demand, material availability and potential disruptions. For example, a manufacturer could simulate scenarios like raw material shortages or equipment failures to adjust procurement and scheduling strategies.

3. Supplier Network Optimization

Virtual twins can model supply chain networks, help organizations evaluate supplier performance, optimize geographical diversification, and assess the resilience of critical supply routes.

Who's doing it now?

For companies like **Aciturri**, a leading supplier of complex aerostructures, the need for innovative solutions to streamline operations and enhance performance is more critical than ever. Aciturri has revolutionized its supply chain processes by adopting virtual twin technology, unlocking new levels of efficiency, precision, and value delivery.

By implementing Dassault Systèmes' **3DEXPERIENCE** platform, the company has achieved faster project delivery, optimized resource allocation, and built stronger relationships with its clients. These advancements not only solidify Aciturri's position as a trusted leader in aerospace manufacturing but also exemplify how modern digital tools can be leveraged to drive meaningful progress in competitive, complex industries.

Organizations striving for similar breakthroughs can look to Aciturri's success as a beacon of what's possible when vision meets technology. This is the future of supply chain management, redefined.

“ We can create a 3D representation of a production facility, not only adding the parts, the machines and the manpower to account for space, but connecting all of these resources to estimate timings so that we can accurately work out how many components we can deliver in a given time.”

“ Thanks to DELMIA, we can make better, faster and more accurate decisions. As a result, we have been able to reduce the typical time it takes to deliver a project to one year!” –

Eduardo Cid, Industrialization Manager, Aciturri



2. WORKFORCE AND TALENT SHORTAGES

Building a skilled, adaptable workforce remains one of the most significant challenges for the aerospace and defense (A&D) industry. With an aging employee base, shortages in specialized skills, and ongoing shifts toward automation and digitalization, organizations are under immense pressure to ensure their teams are prepared to meet both current demands and future innovations. Virtual twin technology emerges as a key enabler in overcoming these obstacles by transforming workforce management and equipping teams with the skills and tools they need to excel.

Applications in Workforce Development

1. Immersive Skill-Building and Training

Virtual twins create realistic, hands-on training environments where workers can practice tasks in a digital setting before applying them to live operations. This capability significantly reduces the learning curve for new employees while giving experienced workers opportunities to upskill. For example, a manufacturing technician can simulate assembling a complex component using virtual overlays, ensuring precision and familiarity before moving to the production floor.

2. Enhanced Collaboration Across Teams

Virtual twins act as a unifying platform, bridging gaps between various functions like manufacturing, engineering, and supply chain management. These digital ecosystems provide a shared view of processes, enabling seamless collaboration and improving communication. Cross-functional teams can work together more effectively to solve problems, identify improvements, and ensure alignment across operations.

3. Optimized Workforce Allocation Using Data

Through real-time monitoring and predictive analytics, virtual twins provide insights into workforce efficiency and resource utilization. Leaders can identify areas where additional support or training is required, ensuring that employees are matched to roles where they can perform at their best. For instance, predictive capabilities might highlight an overburdened team or pinpoint processes that require automation, enabling decision-makers to allocate resources more effectively.

Who's doing it now?

Spirit AeroSystems has successfully leveraged virtual twin technology to address workforce challenges in its advanced manufacturing facilities. By integrating augmented reality (AR) tools powered by virtual twins, the company has revolutionized its training programs, providing technicians with step-by-step visual guides for tasks like assembly and inspections. This approach has not only improved worker accuracy and efficiency but also accelerated the adoption of advanced manufacturing techniques.

Meanwhile, Bell Textron has used virtual twins to simulate human-machine interactions, identifying opportunities to streamline processes and design ergonomic work environments. By digitally testing workflows, Bell has reduced the strain on workers while ensuring that new technologies are seamlessly integrated into daily operations.

3. ACCELERATE TECHNOLOGICAL INTEGRATION

Integrating advanced technologies like AI, IoT, and robotics requires streamlined processes, robust testing, and improved workforce capabilities. Virtual twins greatly enhance these efforts by serving as a collaborative digital environment that aligns design, engineering, and manufacturing disciplines.

Applications in Technological Integration

1. Simulated Technology Adoption

Virtual twins offer a risk-free environment to prototype new technologies and operational changes. Organizations can evaluate the impact of IoT-connected systems, AI-driven workflows, and robotics integration without risking costly disruptions.

2. Predictive Maintenance

By monitoring digital twins of manufacturing equipment, companies can predict faults, plan maintenance schedules, and reduce equipment downtime. This optimizes productivity and extends the lifespan of critical assets.

3. Workforce Upskilling

Virtual twins enable immersive training programs by replicating real-world manufacturing environments. Workers can gain proficiency in using advanced tools and systems, accelerating technology adoption across teams.

detailed insights into safety, resource allocation, and strategic investments.

This transformation brought measurable results. Bell improved operational efficiency by identifying and resolving issues through virtual testing and reducing production delays. Predictive simulations enhanced risk mitigation, equipping them to handle disruptions more effectively. Resource investments were optimized with data-driven decision-making, ensuring funds were allocated wisely. The technology also prepared Bell's workforce for future needs by analyzing human-machine interactions and training requirements.

By integrating virtual twin technology, Bell has driven agility, precision, and resilience throughout its manufacturing operations, securing its position as a leader in aerospace innovation.



REFLECTIONS IN THE FUTURE

Virtual twin technology turns operational complexity into actionable clarity. For heads of manufacturing, operations, and supply chain in the A&D sector, it does more than streamline processes; it redefines how they lead. By enabling data-driven decisions, enhancing efficiency, and supporting visionary planning, virtual twins empower these leaders to thrive in otherwise volatile conditions.

Ultimately, this tool transforms leadership roles from reactive problem-solving to proactive innovation, making a lasting impact on their professional lives and the success of their organizations. With virtual twinning, A&D leaders don't just survive disruption; they leverage it to build a brighter, more sustainable future.

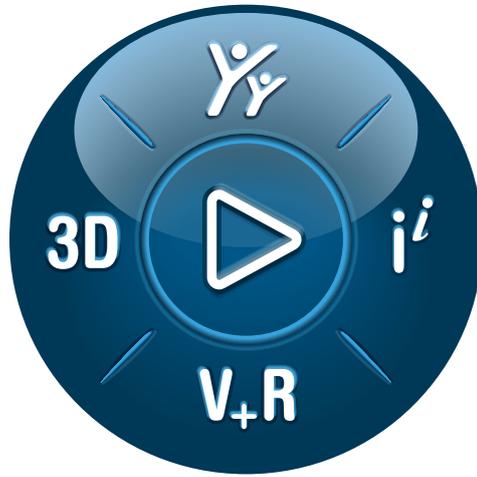
Yet, this transformation isn't simply about survival. It's about seizing the opportunity to lead. Aerospace and defense leaders can set the stage for a new era of industrial excellence by adopting bold, future-focused strategies and investing in innovation today. Organizations that prioritize agility, collaboration, and sustainable progress will emerge not just as participants in the industry's future but as its architects.

Now is the time to act decisively. By leveraging technology to its fullest potential, shaping a dynamic, adaptive workforce, and embedding sustainability into every facet of operations, your organization can thrive amidst disruption and secure its place as a pioneer in aerospace and defense. **The future is here, waiting to be built. Will you be ready?**

Who's doing it now?

Bell Textron faced challenges in managing complex manufacturing operations, particularly ensuring precision in flight-critical components like gear cases and composite blades. Outdated validation methods struggled to meet the demands of their processes, and new programs brought additional risks like equipment failures and material shortages. To address these issues, Bell adopted virtual twin technology, enabling them to digitally simulate manufacturing environments, workflows, and changes without real-world risks.

Key applications of virtual twin technology include virtual facility design, where digital replicas allow teams to optimize layouts and processes before committing physical resources. Advanced simulations helped Bell anticipate disruptions like machine downtimes, refining systems for resilience while boosting adaptability. Virtual commissioning of machining processes minimized errors and optimized alignment, improving workflow efficiency. The technology also provided



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