VIEW POINT

BACK TO THE FUTURE: TECHNOLOGY GUIDES SUSTAINABLE AEROSPACE OPERATIONS

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The aviation business is booming. The order book of leading manufacturers for small aircraft, drones, freighters, fighters, helicopters, business jets, military aircraft, and satellites continues to scale new heights. The backlog of flagship programs, like Boeing 777X, F-35 of Lockheed Martin, and Gulfstream Aerospace G700, among others, is also significant. Further, there is always steady demand from grounded defense and commercial airplanes awaiting routine inspection, preventive maintenance, repair, and overhaul services.

The current rate of production and rework should be reset for prompt delivery / return to service. In addition, regulations for airframe quality and engine safety demand an audit trail of component and action status, from installation to obsolescence. Moreover, the industry should implement policies of the Federal Aviation Administration (FAA) for clean and sustainable air transportation. The imperative for aircraft manufacturers: a robust ecosystem to streamline operations and augment the infrastructure and processes.

Technology transforms the value chain

Aerospace and defense (A&D) processes and workflows make this industry one of its kind. On the one hand, original equipment manufacturers (OEMs) need to collaborate with thousands of multi-tier suppliers in real time for delivery of critical parts. On the other hand, precision engineering and assembly demand highly skilled personnel.

Industry 4.0 frameworks connect the ecosystem, from discrete machinery, components and workstations to machine and plant-level communication architectures, with embedded sensors and cloud-based software. It empowers enterprises to leverage artificial intelligence (AI)-based smart tools, Internet of Things (IoT)-enabled monitoring systems, and robotic automation to enhance capabilities.

Take for instance, the fragile surfaces of airplane wings, which need to be drilled and bolted on. It demands the accuracy and reliability of CNC machines and sophisticated fixtures.

An IIoT ecosystem transforms cutting tools and CNC accessories by importing 4D / 3D models for verification of each parameter before and during machining. It also allows operators to customize settings for specific applications and tasks. Further, high-resolution simulation of machining processes and intuitive human machine interfaces (HMIs) boost the accuracy of drilling procedures.

In the factory of the future, intelligent software automatically collects and synthesizes real-time data to provide process transparency as well as actionable insights to eliminate production bottlenecks, inefficient workflows, and unplanned equipment downtime. Smart probing, integrated performance monitoring, and simulation-based validation enable informed decision making. At the same time, optimized processes improve efficiency and maximize resource utilization. Notably, Industry 4.0 infrastructure facilitates an outcome-based approach to engineering and business functions.

Smart tools drive innovation

The A&D industry has a sustainability imperative: boost fuel efficiency, reduce noise and emissions, optimize weight, maximize safety, and enhance the cabin experience. Advanced digital platforms integrate technology, processes and people across the product lifecycle, enabling innovation in aircraft building and aviation services. For instance, light airplanes fly longer distances with lesser fuel when conventional metals are replaced with ultralight materials and composites. They need to be tested for durability, fatigue and heat resistance, before replacement. However, trial and error is not an option. Digital twins, machine learning (ML), and predictive analytics provide a viable solution.

Digital platforms and analytical solutions allow designers and engineers to recreate computer-generated drawings and models. This approach provides design flexibility, while accelerating the development of flight-airworthy hardware. In a digital environment, manufacturers can evaluate the performance of carbon fiber reinforced polymers, ceramic composites, super alloys, and combinations of lightweight materials. AI / ML platforms analyze thermal and physical properties as well as resistance to corrosion and oxidation. The output can be integrated into the aircraft design to validate fitness for service in ultra-high temperatures and supersonic environments.

Modeling-based engineering frameworks redefine subsystems of aviation mobility. Simulation and analytical techniques can be applied at a conceptual level to enhance functionalities, without increasing the size or quantity of engines across aerospace programs and types of aircraft. Further, it allows manufacturers to modify engine architecture for alternative fuels, electric batteries or hybrid power.

3D / 4D visualization of design, reference specifications and production parts guides informed decision making. Significantly, insights into the impact of design modifications on specific machine dynamics and control systems streamline estimation and procurement.

Digitization drives supply chain resilience

Inventory management is mission-critical for OEMs assembling hundreds of aircraft valued in the billions of dollars. Notably, a significant portion of components and parts used in the wings, body and engines of aircraft are sourced from tier-1 and tier-2 suppliers. This dependence, combined with the moving parts of global operations, price fluctuations, and stringent quality requirements, add to the complexity of the aerospace supply chain.

Cloud enablement of the supply chain enables aircraft manufacturers and their suppliers to boost capacity and reliability by migrating siloed and linear systems to a connected network. The cloud ecosystem improves visibility, ensures timely delivery, and boosts quality by enabling real-time collaboration across locations. Further, it optimizes inventory by integrating engineering and production applications with supply chain platforms. This facilitates automated reordering, which mitigates risks and rationalizes costs. Moreover, virtual inspection using smart cameras minimizes inspection time for production supplies as well as spare parts.

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