IMPO

Manufacturing Technology Innovations Advance MRO Capabilities

By Tom Hennessey

Smart manufacturing technologies, from Big Data analytics to robotics, are already transforming industries around the world — intensifying competition, increasing efficiency, and making products and services safer and more reliable. Manufacturing enterprises in the A&D sector are pioneering many leading edge applications, often combining several innovations into complex digital systems that integrate every phase of manufacturing, from initial design to obsolescence.

As conceptual technological advances break through into practical use on shop floors, we see the transformative potential for highly engineered products like airplanes. Maintenance, Repair, and Overhaul (MRO) operations are a critical aspect of the product lifecycle for multi-million dollar assets that take years to design and build. The safety and reliability of airplanes (and similar industrial products) are of paramount importance, and rely on incredibly intricate MRO procedures that are costly and time-intensive.

As competition grows amid a global surge in air travel and rapid development in Asian markets, MRO hubs must become more efficient, more precise, and more intelligent. In global air transport alone, worldwide MRO spending will increase 46 percent by 2026. There isn't much time to play catch-up: the world's aircraft fleet will grow 20 percent by 2020, just three years from now.

Six areas of innovation that are already driving real world progress toward model smart manufacturing approaches at leading MRO hangars: digital thread and digital twin; advanced analytics; IoT-enabled asset sensors and diagnostics; augmented reality; robotics and UAVs; and 3D printing.

MROs are implementing a model-based enterprise (MBE) approach to transform their operations, using engineering 3D models in conjunction with these innovations to optimize inspection, create spare parts on demand, practice predictive maintenance, and streamline repair work.

The Heart Of Smart Manufacturing: Digital Thread And Digital Twin

Two intertwined concepts lie at the center of the MBE vision and practice — digital thread and digital twin. The military aircraft industry spearheaded these practices, compelled by the need to improve the performance (and cost) of future programs by analyzing data captured digitally from end-to-end throughout a product's lifecycle.

The digital thread is a communication framework that enables connected data flow throughout the lifecycle and across traditionally segmented functions (design, engineering, production, maintenance), ensuring an integrated, authoritative, up-to-the-minute view of the asset's data that can be accessed at any point along the way.

The digital twin is the digital model of a particular asset (product) that includes design specifications and engineering models describing its geometry, materials, components and behavior. More importantly, it includes the as-built and operational data unique to that specific physical asset (for aircraft, the "tail number"). The digital twin includes engineering changes made during production and deviations from original design, as well as inspection, operation, and MRO data.

It's not hard to see how these comprehensive, harmonized digital records and models will help minimize downtime, streamline regulatory compliance, and ensure excellence in many industries.

Advanced Analytics And Big Data

IDC predicts major investments in big data and analytics initiatives over the next few years, leading to significant productivity benefits for early adopters. As capabilities advance, the synergy between human expertise and machine learning (AI) has the potential to vastly improve the functionality, safety, and sustainability of many highly engineered products.

The success of digital integration depends in large part on an enterprise's ability to collate, store, manage, and analyze data from all parts of the manufacturing enterprise, from business operations to production to MRO.

Making more complete and nuanced use of the data collected by sensors in manufacturing equipment and products (and by operational and business management systems) will increasingly drive progress toward the MBE vision. More specifically, predictive and prescriptive analytics could radically improve MRO planning. Today, most maintenance activities are planned based on a combination of elapsed time and asset usage frequency, which leads to both over- and under-servicing of assets.

Diagnostic Connectivity Via The IoT

Microcomputers (sensors) are now embedded in many devices and assets and able to connect to and exchange data with other systems and centralized data repositories (IoT). By analyzing exceptions and aggregate performance data against the asset's 3D model, engineers predict and diagnose issues as well as enhance future designs. By relying on sensor and usage statistics, repair and maintenance processes can be streamlined and performed with greater precision.

Industries like aviation have zero tolerance for safety and reliability issues. The ability to avoid disasters and expensive groundings by building performance-based models and predictive/prescriptive maintenance protocols becomes even more critical as the number of flights and aircraft continues to rise alongside consumer demands for affordable and convenient travel.

Augmented Reality In Advanced Guidance Systems For Work Execution

Augmented reality (AR) is the ability to layer digital 3D images and virtual objects on top of the real-world images with the aid of smart glasses or hand-held tablet computers. Many MRO shops are experimenting with this technology to support inspection and repair technicians. AR recognizes the asset a user is examining, overlays the points where service is needed, and provides the necessary instructions and diagrams via integrated tablet interface. In combination with automated inspection methods (e.g., UAVs, sensor data), augmented inspection results could also be projected directly onto the asset's physical surface.

As natural language capabilities mature, voice-driven interaction with smart glasses and tablets create a hands-free interface and the ability to "chat" with the device in a more natural manner. These advanced guidance systems have the potential to transform MRO tasks and outcomes: reduced time to repair (MTTR), fewer errors, and lower labor costs.

Inspection Automation With Robotics And UAVs

The rapidly expanding capabilities of autonomous equipment such as Unmanned Aerial Vehicles (UAVs) and robots are being leveraged in MRO shops. Automated inspection tasks are among the first applications. For example, UAVs fly around the aircraft, capture images, compare them against the respective 3D models (digital twins) and quickly report any damage requiring further inspection or repairs. Likewise, mobile robots with vacuum pad feet (e.g., LHT's Morfi) perform thermographic inspections of fuselages, identifying and recording cracks as shallow as one millimeter.

Inspections can be shortened by several hours, and work can be performed more accurately and safely (especially in hard to reach spaces).

3D Printing Of Spare Parts

3D printing is already revolutionizing prototyping and production in many industries, from consumer goods to medical devices. In the MRO enterprise, 3D printing has the potential to transform spare parts inventory practices. Manufacturers of spare parts and MRO hubs will store the digital data necessary to print parts and components in CAD software instead of storing physical parts on shelves, with obvious benefits to storage and distribution costs, inventory turnover, and MTTR. 3D printing can also be an efficient solution to procuring hard-to-find or discontinued spare parts. Considering that an unscheduled grounding (AOG) can cost as much as $200K, the ability to produce a needed spare part on demand protects an airlines' bottom line as well as its customer satisfaction ranking.

The digital transformation of commerce and communication has occurred in leaps and bounds over the past two decades. The manufacturing of highly engineered products requires a more deliberate pace and many obstacles remain, but the future fast approaches. Smart manufacturing implementations require experimentation, strategic investment, and skill development. Delaying initiatives now will make it difficult to catch high-flying competitors when these leading-edge innovations become standard practice.

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