Generative AI (GenAI) in Aviation Maintenance, Repair, and Overhaul (MRO)

MRO providers play a critical role in ensuring the safety, airworthiness, and longevity of aircraft. They are essential to efficient and cost-effective operations for the aviation industry writ large. More is being asked of today's MRO providers – their already wide range of services will need to meet growing demand as the aviation industry continues to scale to meet relentless passenger demand (already nearing/exceeding pre-COVID levels). Doing more with less has been the necessity of the post 911 aviation space, but MRO providers need novel approaches to overcome current challenges of skilled labor shortages, prolonged supply chain constraints, and greater demand for aircraft availability.

Aerospace & Defense has typically been a late adopter of emerging technologies. The attitude can be described as "wait and see until this buzzword means something for us" because the cost-benefit of impacting your production process is not yet clear. Safety and compliance considerations also hinder speed to adoption, forcing thoughtful evaluation and consideration by nature. Once that hurdle is overcome, however, the industry is quick to respond. Machine learning, for example, is now standard practice using data to guide predictive maintenance to prevent operational maintenance related delays and more accurate materials forecasting, reducing materials/inventory spend. With all the attention that GenAI has received, MRO leaders may think more work is needed before it is ready to be adopted. This is not the case: GenAI is more than a buzzword. It is already a game-changer. In the following sections, we break down use cases that can help MRO providers improve efficiency across every stakeholder (back-office, engineering, and maintenance technicians) and where to start to accelerate your path to adopting this technology.

1. Use Cases: How does GenAI help MRO providers?

GenAI offers opportunities to improve processes across the spectrum. Basic administrative tasks like daily operational reports and metrics, regulatory reporting can be addressed through tools today, while transformational capabilities require a strong data foundation few companies possess today. Below we detail different use cases MRO Providers and Operators should consider when identifying areas to improve with GenAI.

Exhibit 1

Four Stages of Transformation:
Implementing GenAI in your MRO Organization

Example Use Cases

Stage 1
Sales & Back-Office

Supply Chain
- Risk analysis & prediction
- Inventory & price optimization
- Supplier evaluation

Sales & Marketing
- RFP responses
- Marketing content generation
- Quote/pricing assistance

Stage 2
Legal, Analytics, Training

Legal
- Contract gen. & review
- Document summary

Analytics
- Data cleaning
- Metadata generation

Training & Knowledge
- Employee onboarding (inct. safety videos)
- Virtual recruiting
- Auto-generation of knowledge management

Stage 3
Front-line Enablement

Support Functions
- Technician Guidance
- Asset lifecycle management
- "Owners manual" & procedure generation

Operations
- Certification documentation support
- Logistics optimization
- Maintenance schedule
- Conversational interface

Stage 4
Engineering & OPS

Engineering
- Generative design/copilot (incl. options)
- Suitable material identification
- Testing scenatio creation

Operations (**level II**)
- Automated inspection & repair guidance
- Root cause analysis
- Ad-hoc parts design/manufacturing to complete repairs

Level of Difficulty

A.   Stage 1 - Sales & Back-Office

GenAI systems have improved back-office functions for several years, using algorithms to optimize administrative tasks like inventory management and schedule administration. With its ability to handle a significantly larger set of constraints and dynamic inputs, GenAI outperforms existing back-office tools, helping Operators and Providers better optimize based on the new status quo with stressed supply chains, labor shortages, and over stressed networks.

For organizations that consider themselves beginners, Sales & Back-Office functions are easier to begin with given existing approaches have likely already pushed companies to have the data foundation (from quality and organization) that would yield promising results. Additionally, changes to processes in these functions are low-risk, making them ideal starter candidates for a high-regulation industry like A&D. With "plug-and-play" solutions across these use cases, organizations should be able to rapidly implement these tools into employees' day-to-day and see quick wins in three broad forms:

1 Efficiency savings by reducing manual tasks (e.g., quarterly reports, PO generation, etc.)

2 Multiplier savings by allowing employees to generate content (e.g., RFP responses, contract reviews, training material, baseline analytics code etc.) quicker

3 Optimization savings by better tailoring inputs (inventory, supply chain, flex labor) to match needs through pattern recognition.

B.   Stage 2 – Legal, Analytics, and Training

The line between Stage 1 and Stage 2 may look different across companies – generally, moving from Stage 1 use cases towards Stage 2 implies an established data foundation that invites more risk-averse departments like Legal and Training, which can impact business and service delivery, to adopt GenAI. Extending the technology to these use cases will not only save significant time to ensure contracting is not an obstacle to new business, but also begin upskilling their newer workforce. Specific examples use cases include:

- Proactive contract revisions based on real-time business need – instead of waiting for demand signals to make their way through multiple departments, GenAI can communciate the need for additional purchase orders or revised volume quantities.

- Empowering a newer workforce with reimagined trainings – instead of depending on seasoned veterans to take on new apprentices, MRO Providers and Operators can offer a stronger base of materials to accelerate their learning curve, including step-by-step generated repair procedures, troubleshooting tips and methods including video guided instructions

- As GenAI continues to permeate functions, the need for a streamlined approach to data capture, cleaning, and formatting to influence newer models becomes tablestakes. While initial forays may be more manual, companies will be unable to keep up without training GenAI to maintain data proactively.

C.   Stage 3 – Front-line Enablement

GenAI offers the biggest productivity improvement to front-line workers since lean practices became standard in the 1970s. With greater demand for services and a significantly newer workforce due to COVID-induced retirements, MRO Operators and Providers need to accelerate their typical learning curve, effectively taking new trainees and having them perform like 20-year SMEs in a short timeframe. Such a feat requires not only imparting a large amount of knowledge on these newbies, but also molding their instincts to reduce time to diagnose and complete repairs.

GenAI augments the front-line worker: through a combination of computer vision and documented repair protocols, the tool can help a worker diagnose their specific job and walk he or she through step-by-step until it is completed. Before – this type of attention would come at the expense of a veteran's own productivity, whereas now, every worker has a personalized coach guiding them through repairs. And as companies have data indentifying better approaches via improved reliability, lower TAT from other workers, etc., GenAI can automatically update procedures and repair techniques, vasting reducing time for reviews/ approvals, discussions, etc.

D.   Stage 4 – Engineering & OPS

Stage 4 brings companies to the edge of GenAI's current capabilities. Whereas software engineers today can ideate, prototype, and review code with the assistance of GenAI, our ability to translate these skills from bits to atoms remains a challenge. The first obstacle is the fact that GenAI has yet to be developed around engineering principles, while the second requires companies to intelligently clean, format, and structure their data into a form ingestible by the training engine to then offer usable recommendations around design and testing. Some firms, like Autodesk, have begun building a GenAI layer atop of their existing 3D modeling software to begin to test these waters, but we are still years away from being able to stretch this capability to more complex and tightly regulated structures like airplanes.

Early results from enabling software engineers and product designers with GenAI give us a preview of the power of GenAI to aerospace and industrial engineers. When trained on performance, maintenance, reliability, and other datasets engineers use daily to problem-solve, GenAI engines will be able to tackle the most labor-intensive activities for Operators' MRO groups. Today, improving reliability requires engineers to analyze numerous data sets, bring together dozens of groups touching parts from different angles (procurement, front-line, engineering, etc.) to understand failure modes and identify addressable root causes. This step alone can take weeks given the amount of follow-up and additional analysis required. Once identified, engineers with different disciplines will collaborate on corrective actions that address the root cause, while respecting constraints imposed by the FAA and cost targets. Instead, with a strong data foundation to support GenAI, much of the additional analysis can be done proactively by the analytics engine to identify probable root causes. Similarly, GenAI can proactively propose design recommendations that optimize on multiple constraints, e.g., "the most sustainable option," "speed to market", or "cheapest to implement". As such, Operators with these capabilities will be able to get more out of their fleet relative to a non-AI-assisted group.

2. Where to Start

Where as many novel technologies become easier to implement as they mature along the hype curve, this is not the case for GenAI. The most important rule for working with anything in AI is: "Garbage in. Garbage out." Companies that fail to invest in their data strategy (from capture to format) will never have successful experiences with AI; if you mis-train the engine, it will fail to generate any usable output.

Therefore, the first step towards implementing an AI is implementing a robust data strategy. Investing time now means more valuable data points to improve your future training models. Conversations at the C-Suite should help frame the goals, constraints, and timeline to drive progress and prioritization from the top down. As described above, quick wins by implementing GenAI in proven use cases should help finance larger investments needed to graduate to Stages 3 and 4. At minimum, however, leadership should discuss:

- Financing foundational IT investments to support a best-in-class data strategy as the legacy tech stacks may not be fully equipped to do so

- Adding data-minded talent (e.g., data scientists, AI engineers, program managers with data experience): buying the tech is not enough, MROs must also invest in the human capital to tailor and sustain GenAI in the organization

- Guardrails and Risk Mitigations: AI suffers from three flaws – Copyright infringement, response bias, and hallucinations. Given the amount of regulation associated with MROs, leadership must design checks to minimize risk as it expands GenAI throughout various business units

This will be the most important technology investment that the industry makes in the foreseeable future. Without it, MROs cannot overcome their labor and demand challenges. Any delay to starting now will only grow the obstacles to implementation down the line: those who fail to invest today may find it impossible to catch-up with GenAI-enabled competition within a few years.

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In summary, service providers in the MRO space should proactively adopt GenAI technologies. By embracing GenAI, MRO providers can significantly enhance their operations across various stages, from administrative efficiencies to frontline productivity and engineering innovations. The key to success lies in investing in a solid data foundation and adopting a strategic approach to integrating GenAI into daily operations by prioritizing non-safety/non-compliance-sensitive use cases, MROs can effectively assess the technology's viability, leveraging early successes as stepping stones for further implementation.

For further reading –
What is Generative AI and How Does it Impact Businesses? | BCG here

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