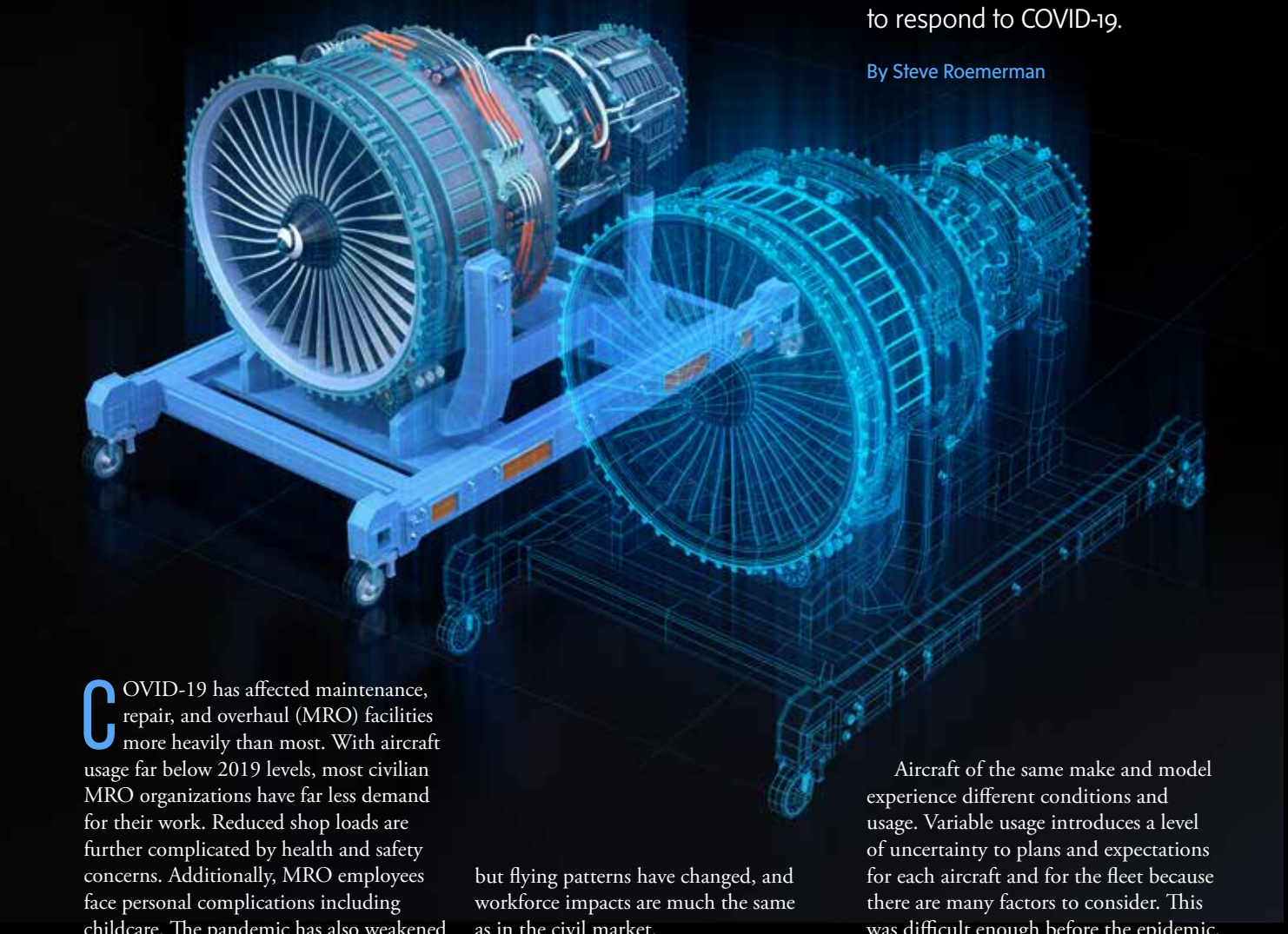
HISTORICAL TREND DATA CAN'T HELP MRO DURING UNPRECEDENTED TIMES

Long-standing practices must be reevaluated using condition-based maintenance, digital twins, and evolved artificial intelligence to respond to COVID-19.

By Steve Roemerman



COVID-19 has affected maintenance, repair, and overhaul (MRO) facilities more heavily than most. With aircraft usage far below 2019 levels, most civilian MRO organizations have far less demand for their work. Reduced shop loads are further complicated by health and safety concerns. Additionally, MRO employees face personal complications including childcare. The pandemic has also weakened MRO supply chains – original equipment manufacturer (OEM) part suppliers and refurbishers are struggling.

All of this wreaks havoc on MRO analytics. Most MRO analytics solutions rely on long-term historical averages or typical data patterns. Nothing about the current market is average or typical. Work processes, productivity, part lead times, and demand are all exhibiting unprecedented behavior. Military MRO faces fewer changes in aircraft usage, but flying patterns have changed, and workforce impacts are much the same as in the civil market.

Aircraft health, maintenance

Aircraft fleets require frequent health monitoring such as inspections and logbook reviews to ensure readiness. Normally, aircraft fleet monitoring includes how well each aircraft is performing and how long it will be until major maintenance takes the aircraft offline. Maintenance intervention is required if an aircraft fleet doesn't meet readiness goals.

Aircraft of the same make and model experience different conditions and usage. Variable usage introduces a level of uncertainty to plans and expectations for each aircraft and for the fleet because there are many factors to consider. This was difficult enough before the epidemic. Now it's very, very difficult.

There are several ways to trigger MRO events on an aircraft – traditional methods (event-based maintenance, usage based, time based), and predictive or condition-based MRO. Although a wide range of options are available, most approaches and software to manage MRO are now ineffective.

Preventative maintenance is usually driven by use and time, forecasting maintenance needs based on past data

and performance. A preventative system might follow a rule saying support personnel should perform a certain task after so many flight hours.

This practice sounds good in theory but can actually increase maintenance time and downtime even under normal circumstances. Now, some aircraft are in use, some are parked, and some are in storage.

While data inform MRO software, most solutions are deterministic. The analytics don't consider variable differences, and ignoring uncertainty is usually bad. COVID-19 has added greater uncertainty. Even worse, historical data tell a different story about maintenance needs during different fleet usage, making the numbers less reliable.

Event-based maintenance is driven by unplanned, unscheduled events. This method is dependent on something breaking before it's fixed. In theory, this saves time and resources because workers aren't performing unnecessary maintenance tasks. However, some fixes aren't quick or easy. Parts and skilled employees aren't always available when needed. Event-based MRO is challenged by COVID-19 disruptions to the labor force and changes to parts supply chains.

MRO the right way

Condition-based maintenance is the most practical choice for organizations seeking to improve their MRO program. This method accounts for the number of takeoff/landing cycles, weather (in use and while parked), exposure to salt spray and humid environments, and many other factors. If analytics are used to estimate the condition and remaining life of critical components, the condition of each item can be targeted for the best fleet readiness and lower MRO costs. These analytics consider each system's condition, not just flight hours, and maintenance isn't dependent on damaging events.

Organizations are probably already gathering most of the data needed for condition-based maintenance. Some impressive results have been demonstrated without digitally transforming aircraft fleets. Even more impressive results are expected when predictive health analytics operate embedded in the aircraft.

Whether embedded or off-line, condition-based analytics use a digital twin of each asset. The best strategy goes beyond detecting decreases in performance. The digital twin predicts the remaining life before problems arise. Properly implemented, these twins account for spans of uncertainty. Real-world data is noisy and has random variation on top of the noise. Condition-based MRO solutions should reflect native stochastic processes.

Traditional methods are inherently limited, and during the epidemic these limitations have become important flaws.

Cloud-based twins naturally integrate with existing fleet data and can be deployed quickly. Edge-based alternatives operate with limited computation. Applications can successfully use either approach, therefore, a twin can run in the cloud or run reliably on limited edge computing devices. The light footprint means the digital twin can easily move as the aircraft fleet evolves, migrating from the cloud to the edge, or from the edge to the cloud.

Another emerging MRO development is *evolved artificial intelligence* (AI). Most aviation and industrial analytics require a choice between deterministic cause-effect simulations, or data-only AI. Cause-effect simulations provide transparency but are usually limited to engineering applications. Purely data-driven AI can be powerful, but is rarely explainable, and lacks predictive power and the precision of cause-effect simulations. Evolved AI blends cause-effect relationships, including physics and business rules, with data-driven methods, while incorporating realistic spans of uncertainty. This approach blends and focuses AI learning on topics where data defines a twin, but within the constraints of reality imposed on cause-effect relationships.

Summary

Using accurately informed analytics, operators can better manage maintenance and upgrade planning, optimize fleet use, improve schedules, prioritize supply chain, enhance flows, and shorten MRO cycle times. Predictive analytics – especially condition-based MRO – offer great promise for these difficult times.

Although the entire MRO industry has experienced a downturn due to current global events, the lull isn't going to last forever. Once aircraft usage rises, organizations will need to be prepared for any necessary MRO actions because of the extended period of inactivity and daily wear. By using predictive analytics, fleet operators can ensure they avoid unnecessary, unplanned, or unscheduled downtime. Digital twins and advanced analytics reduce operating costs, a welcome result, now more than ever. A

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Lone Star's approach

Digital twin methods, performed and preferred by Lone Star Analysis, diverge from traditional. Maintainers at all levels receive prompt, on-demand insights tailored to their role. Alerts are also pushed when needed, even if on-demand queries don't occur. This helps the person who handles a single aircraft, the person who oversees local operations, and the manager of an entire fleet.

Condition-based maintenance approaches can be authored as either a cloud or edge solution. Existing platforms, such as Lone Star Analysis' AOS Edge, were created to generate solutions tailorable to nearly anything in the physical world. Differences in aircraft configuration, use history, and planned utilization are naturally managed for each individual asset.

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