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By Jim Romeo

New-Age Avionics Maintenance

Avionics Testing and Repair Advances with New Tools and Technology

Avionics testing and repair are undergoing a rapid transformation as new technologies redefine how maintenance crews diagnose, service, and upgrade aircraft systems. From AI-assisted diagnostics to portable test platforms and augmented reality overlays, today's avionics maintenance is more precise, predictive, and efficient than ever before. As aircraft become increasingly software-defined, staying ahead in the hangar now means embracing tools once reserved for the lab.

A predominant theme in avionics testing and repair seems to be the role that technology and advances in science and engineering plays — be it artificial intelligence, software-centric solutions, more effective equipment, or new digital tools. All are contributing to advancements in avionics testing and repair.

Michael Miles is an avionics manager with Standard Aero in Springfield, Illinois.

"Computer-based troubleshooting continues to advance, modernizing avionics repair methodology. Hardware has given way to software and more and more systems from avionics manufacturers must be downloaded and sent to a repair center for each manufacturer," says Miles. "The days of an avionics mechanic being able to overhaul or replace small parts in instrument and computer systems are long gone. Most analog test equipment has gone by the wayside for bus readers and laptop connections. However, the one constant has been the multimeter. The multimeter has advanced from analog to digital over the years, but the basics remain the same. Troubleshooting wiring and components still comes down to power, ground, and continuity checks. If a component or system fails or gives an error message, the first manufacturer-directed step is to always to check the wiring to the system to ensure proper connection. While we have moved away from simpler diagnostic tools to the digital and software-based world, the multimeter is the one constant backbone of troubleshooting and provides us with the confidence in the source of issues to make the decision to repair or replace the failed system. However, with today's modernization in avionics, many advancements in component complexity have been offset by user-friendly systems and much better training for technicians."

In the past decade, there has been an ongoing emphasis on automated testing methods in avionics. This has enhanced productivity by providing hands-off testing with a wider depth of subsystem interrogation. Muirhead Avionics image/AMETEK MRO.

Dror Yahav, CEO Universal Avionics

Louis Mallette, President AJW Technique

Marlon Bustos, Accountable Manager Air Accessories and Avionics

Artificial Intelligence (AI) Offers New and Advanced Maintenance Methods

Artificial intelligence is also playing a role in new and more effective approaches to avionics testing and repair. Dror Yahav is the CEO at Universal Avionics in Tucson, Arizona.

"Avionics testing and repair have always been based on proven methods with strict standards that ensure reliability, such as bench testing and built-in diagnostics," says Yahav. "These essential practices are critical, but with the rise of AI and access to deeper operational insights, we're evolving our processes. We're now able to move from reactive maintenance to predictive, using AI data-driven strategies. AI helps us identify trends, streamline repair techniques, and optimize inventory, reducing both downtime and cost."

Yahav adds that they are feeding all their insights back into our AI models to train new design processes. Lessons learned in the field are directly shaping the next-generation product development and improvements we introduce to existing products.

Advancements in Test and Repair Are Incrementally Integrated

Louis Philippe Mallette is the president of AJW Technique in Montréal, Canada, a maintenance, repair and overhaul (MRO) facility for business and commercial aircraft and the global repair hub for AJW Group. Mallette says that primary testing of avionics components is performed using automated test equipment where a full functional test of the equipment is performed. This generally highlights any failures in specific areas of the component requiring attention. But there's an evolution to more sophisticated tools, technology, and techniques.

"Avionics components have evolved significantly over the years, progressing from principally analog electronics in the 1980s to the latest digital technologies today with increased use of microprocessors embedded in aeronautics," says Malette. "The testing of avionics components has become significantly more intensive, driven by new testing standards from the aircraft manufacturers and equipment OEMs to drive increased reliability and enhance safety on modern platforms. As an example, the number of test points performed during a typical avionics unit test is now easily 10 to 100 times what it would have been 20 years ago. The performance of the automated test equipment has clearly improved over the years and this, in conjunction with more efficient test software, has been accomplished without increasing the overall test time."

Mallette explains that once component failure is narrowed down to a specific circuit card, manual testing using an oscilloscope, for example, is used to verify the integrity of the circuit card assembly and to test individual devices on the card to identify the cause of failure.

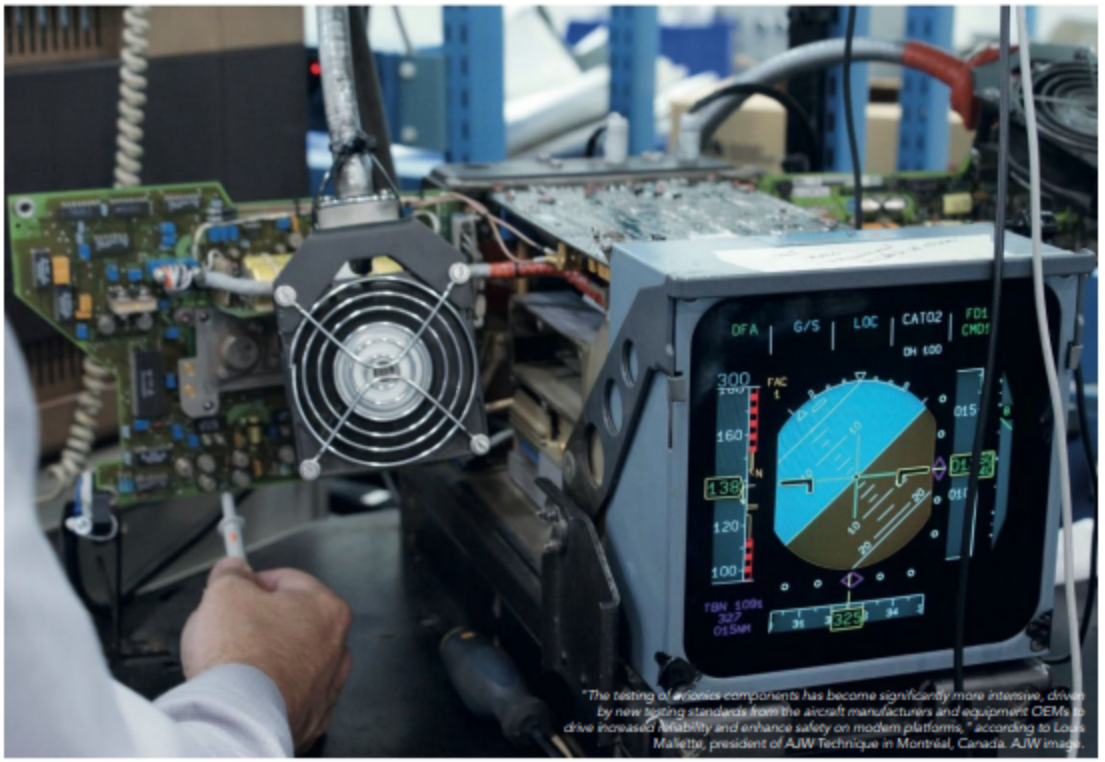
"It goes without saying that the workshop environment in which we are testing is more stable than the actual environment on the aircraft, so, if necessary, we also adopt stress testing techniques," he says. "In these instances, we heat and/or cool the component whilst testing, and subject it to vibration. This helps identify latent failures as simple as cold solder joints, which do not show up in regular testing."

Advancements in avionics are not taking place all at once but are incrementally finding their way into shops and depots. Sometimes this takes place as upgrades to existing equipment and procedures. Marlon Bustos is an accountable manager at Air Accessories and Avionics, a Broward Aviation Services Group Company, located in Florida.

Bustos says that the fundamental methodologies tend to remain quite consistent over time. "Most component maintenance manuals (CMMs) continue to specify the use of established test equipment," says Bustos. "However, at Air Accessories and Avionics we do observe incremental advancements. This often involves the integration of supplementary equipment, or the adoption of upgraded versions of existing testers. This evolution is partly driven by the fact that certain older test equipment models are no longer manufactured or supported for repairs, necessitating updates to our capabilities."

Concerning advancements or changes in how avionics are maintained, his observation is that many avionics components are typically not removed from the aircraft unless a failure has occurred.

"Unlike mechanical systems, avionics components generally lack parts susceptible to wear and tear," says Bustos. "As long as they receive the correct input power and are adequately cooled, their longevity is typically excellent. However, it's important to note that the repair and troubleshooting of individual processor boards within these components is generally not feasible due to insufficient information provided in the CMMs. This detailed knowledge is proprietary to the original board manufacturer. Consequently, in approximately 98% of cases, board-level failures result in component replacement rather than repair."



"The testing of avionics components has become significantly more intensive, driven by new testing standards from the aircraft manufacturers and equipment OEMs to drive increased reliability and enhance safety on modern platforms," according to Louis Mallette, president of AJW Technique in Montréal, Canada. AJW image.

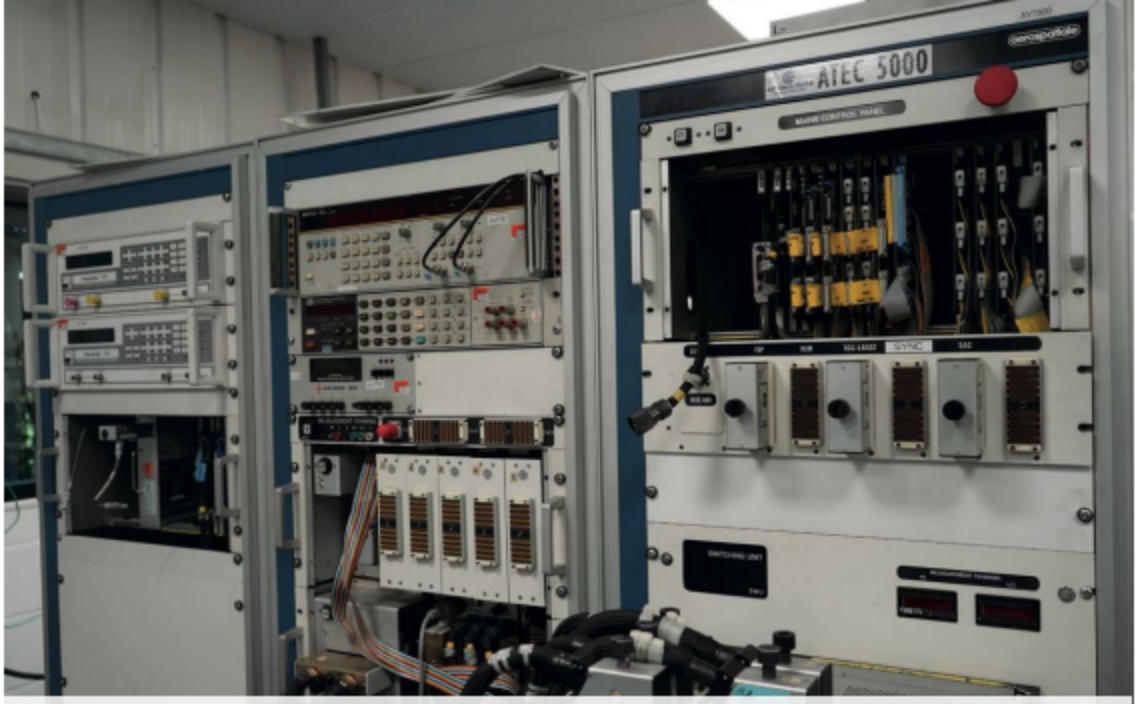
Ramey Jamil is the director of engineering at Muirhead Avionics/AMETEK MRO in London, U.K. He says that in the past decade, there has been an ongoing emphasis on moving towards automated testing methods, systematically enhancing productivity by providing hands-off testing with a wider depth of subsystem interrogation. This inherently allows engineers to gain greater insight into the root cause of problems, thereby enabling more effective and reliable resolutions.

"In some cases, at Muirhead Avionics/AMETEK MRO, we have seen LRU testing times cut down by more than 80%," says Jamil. "A test program that used to take two hours can now be reduced to mere minutes. With each passing year, these systems continue to improve their efficiency, leveraging advancements in the next generation of computing and sensors to provide greater productivity and further insight into our daily operations. Muirhead Avionics observes that these systems allow us to collate new data, detailing downtime and common failures, thereby fueling preventative maintenance routines. This enables us to predict potential issues before they arise and ensures we can secure our stock and supply chain. We are now looking at automating legacy avionics into automatic testing regimes, developing purpose-built rigs that mimic the manual operator-driven test programs through in-house developed sub-routines."

Ramey Jamil Director, Muirhead Avionics/ AMETEK MRO

There are many digital tools as well as new skills available that enable avionics testing and repair to be more expedient and effective. With such tools and technologies, tribal knowledge and reliance on specific personnel experience is less than in the past.

"Historically, many avionics technicians were referred to as 'sparkys' or other informal monikers, in relation to their work with the instrument and autopilot systems," says Michael Miles. "This is more prevalent in today's software-based systems. Bendix/King Sandia and some of the older analog systems have given way to Garmin, Collins, and Honeywell smart digital systems. The use of laptop computers has become a way of life for maintaining and updating the modern systems. Troubleshooting skills are now based on component diagnostics through the systems themselves and computer-based downloads that will point to likely root causes of the affected systems. I have seen technician skill levels with computer and diagnostic skills rise significantly over the years due to many more learning opportunities for the early career technician. Each manufacturer has its own classes and schools nowadays and they are invaluable tools for the line technician. AEA and FAA classes can also help teach the basics of avionics wiring and general repair for someone just beginning. This has been a great help in getting technicians qualified at a quicker rate than years past. The complexity of the systems has increased, but thankfully the training and OJT programs have kept up with the



Muirhead Avionics says it has seen some LRU testing times cut down by more than 80%. "A test program that used to take two hours can now be reduced to mere minutes," says Ramey Jamil, director, Muirhead Avionics/AMETEK MRO. "With each passing year, these systems continue to improve their efficiency." Shown here, is the ATEC 5000. Muirhead Avionics/AMETEK MRO image.

advances in technology. No longer is 'tribal knowledge' needed as much today because of the many digital tools at our disposal."

Yahav says that avionics maintenance is moving from traditional scheduled maintenance toward a more intelligent, predictive model. Data is continuously gathered across the entire lifecycle of the system. This creates a real-time digital profile of the equipment's health and usage.

"With Universal Avionics, this proactive maintenance is enabled using UA FlightPartner and FlightReview iPad apps, recording data across connected systems (such as flight management systems and flight data recorders) for extensive aircraft and fleet reporting after every flight," says Yahoo. "This cloud connectivity streamlines maintenance workflows, helping technicians save 45 minutes on aircraft database updates each month. Predictive maintenance algorithms run in the background, analyzing this data to detect early signs of degradation. Instead of waiting for a fault or relying solely on routine intervals, we can now recommend preemptive actions before any equipment fails. This enhances safety, reduces unscheduled downtime, and optimizes lifecycle costs."

Software-Centric Test and Repair

Muirhead's Jamil says that along with other industries, aerospace has continued its trend towards more software-centric development. In the past, specific functions were developed using hardware alone, that is in the form of logic circuits, made up from resistors, diodes, breakers, etc., and spread across several different boards.

"Now avionics development has shifted most of these functions to a single IC, utilizing advanced software logic and control laws instead," he says. "In essence avionics have become smaller and smarter, fundamentally impacting the way we maintain them at Muirhead Avionics. This approach demands currency and competency in software development as well as requiring a whole new set of specialized tools. However, this trend does come with a major set of benefits; it has now become easier to execute modifications which rely on software updates, as opposed to a board replacement or complete overhaul. We can also interrogate them further, giving us the ability to explicitly analyze the root cause of the issue. When coupled with automatic testing methods this process is dramatically improved in both efficiency and reliability."

Ismael Fadili, VP of sales, AMETEK MRO, Europe

Jamil adds that now, more than ever, avionic MRO specialists like Muirhead Avionics are becoming a key focus point of the aerospace industry, housing critical and cross sectoral data. Hence, with the advancements in data analytics and AI, this data can be used to drive the development of the next generation of avionics, making them cheaper, more reliable, and easier to maintain.

"Over the next few decades, we expect to see a shift in the way the aerospace industry operates," he says. "OEMs will seek to establish long-term partnerships with MROs earlier in the development cycle, leveraging their data, knowledge base, and experience to ensure a smoother deployment and go-to-market strategy."

Ismael Fadili is vice president of sales for AMETEK MRO Europe. He concludes by saying that one of the key things impacting the industry is formal FAA rulemaking on the 25-hour CVR mandate which is forthcoming.

"Airlines will likely need to retrofit their existing fleets by 2030 at the latest but can accelerate the safety benefits by adopting the 25-hour CVR earlier through a simple box swap. This will be a challenge for many avionics shops over the next few years and Muirhead Avionics is well positioned to prepare this transition. We anticipate that the digital transformation will be another challenge with AI integration, especially to support predictive maintenance." MM

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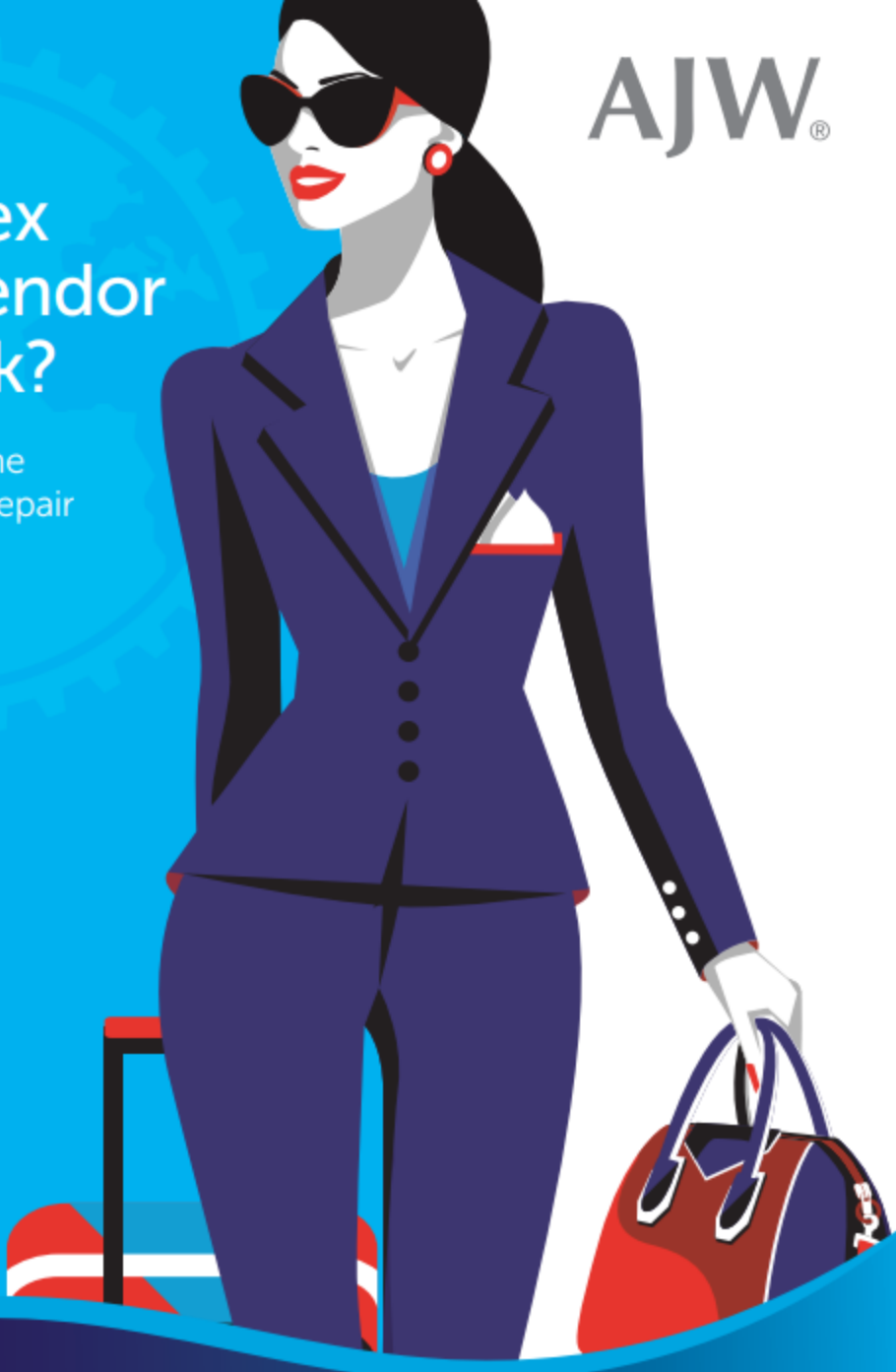

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