

Fault Monitoring and Detection for Lower Aircraft Cabling Repair Costs

As an essential component to the modern aircraft, electrical wiring is required for ensuring data is communicated, electrical systems function properly, and so on. Their safe operation and reliability is paramount, and yet aircraft cabling can experience significant faults. Not only can these cost airlines in down time, the repair and maintenance costs can be high. As such, the industry is searching for better systems for maintaining, monitoring, and repairing cabling in order to keep operational costs as low as possible.

Diagnosing and Locating System Faults in Aircraft Wiring

The complexity of aircraft cabling systems has increased dramatically in recent years, to the point where electrical wiring systems in aircraft are now considered stand-alone systems in terms of regulation from the Federal Aviation Administration (FAA) and European Aviation Safety Agency (EASA). Their regulation now falls under the Electrical Wiring Interconnection System or EWIS. Within the EWIS are systems for detecting and locating defects at the system level. This is an essential requirement in order to improve safety and reduce maintenance costs. With over 40 km of cabling in a modern A380 aircraft, there are many parts to bring together and many potential points of failure.

One of the challenges is locating and replicating the failures. While ground maintenance can establish and locate some defects through classical continuity tests, transient defects which are more likely to occur during flight are hard to reproduce, making them difficult to nail down. A whole category of problems termed “no fault found” (NFF) or “cannot duplicate” (CND used by the US military), have sprung up to capture these issues. According to one estimate, NFF problems are the reason behind 35 to 60 percent of all incoming aircraft component repairs.¹

Replacing a single line replacement unit (LRU) can be extremely costly. These problems are so prevalent that they end up costing the aerospace industry significant amounts of money in unnecessary labour and parts replacements and reduce readiness. What often happens in the case of NFFs is that the offending part is quarantined after repeated repair attempts and labeled as rogue. All of this amounts to millions or even billions of dollars in NFF problems. In fact, the US Department of Defense estimated that they spend more than \$2 billion every year on intermittent avionics faults inside weapons replacement

assemblies alone.ⁱⁱ It's no wonder there's a race on to find the best solutions for wire fault detection and repair.

Better Training and Systems for Fewer Aircraft Wiring Faults



Image via Flickr: [chimothy27](#)

One of the main problems with NFFs within an aircraft's wiring system is aging cabling that has been affected by vibration, corrosion, and temperature swings, causing newer equipment connected to the old wiring to fault. As a result, when new parts are installed, it often takes place without accurate knowledge of how they will interact with other components.ⁱⁱⁱ

As such, many companies are looking to provide additional holistic training to solve NFF problems. Honeywell, for instance, is providing technicians the ability to test units in a singular fashion with a bench that provides system interaction simulation. Testing from a system level rather than a component level allows them to see how the LRU communicates with other integrated architecture.^{iv}

Another way for companies to combat NFF is to follow guidelines set out for reduction of such problems. The [672 Guidelines for The Reduction of No Fault Found \(NFF\)](#) is one such system. It provides a structured process for identifying, analyzing and resolving NFF issues, with guidance for decision making and how to act in the early stages of component repair. Many companies have implemented such systems in order to reduce maintenance costs by cutting down on the removal of parts unnecessarily, developing better maintenance practices, and so on.

Innovations in Wiring Architecture for Reductions in Maintenance and Repairs

Another way to reduce costs associated with NFFs is to develop architecture that can better detect and analyze when faults occur. One method of doing so are harnesses. They are the essential part for ensuring that all of the primary and secondary systems do as they are supposed to do in the modern fly by wire machines, carrying communication signals and electrical power to different parts of the aircraft. In a sense, they are the central nervous system for the plane, enabling smooth operation.

By scanning in real time, a harness can determine the cables impacted by a fault without affecting the operational modes of the aircraft. Given the challenging conditions a conventional aircraft faces day in and day out, harnessing systems for plane's wiring need to be resilient and able to withstand extremes. Universal Wiring Systems, a harnessing manufacturer, has a unique mechanical over-braiding solution in

order to provide EMC screening or harness protection. This system allows them to braid directly into the harness, with hoses and conduits that are flexible. They use materials ranging from tinned copper wire to PTFE to Nomex to PEEK. Braiding allows the company to bundle diameters up to 33 mm. In addition to this harness design, the company has created the DIT-MCO 9000 point analyzer in order to provide comprehensive testing for continuity, resistance, and insulation.^v

Honeywell has developed their own technology for reducing the occurrence of NFFs when it comes to integration of their parts into the whole system. Their Enhanced Ground Proximity Warning System (EGPWS) provides a detailed history of alerts to help evaluate performance in real-world operation. These mini flight data recorders store data in a specific area of non-volatile memory that can be downloaded in an encrypted fashion. This allows them to log failures or exceedances which require maintenance, map trends and analyze them over a period of time, and troubleshoot a particular event that has occurred.^{vi}

An alternative approach taken by Universal Synaptics is their hardware-focused neural network approach using advanced intermittence diagnostic and prognostic solutions. Their patented hardware monitors potential failure points in parallel using neural sensing to ensure the right circuit is being measured at the right time. By doing so, they are attempting to address the problem of intermittent problems that last nanoseconds that are extremely hard to detect and analyze.^{vii}

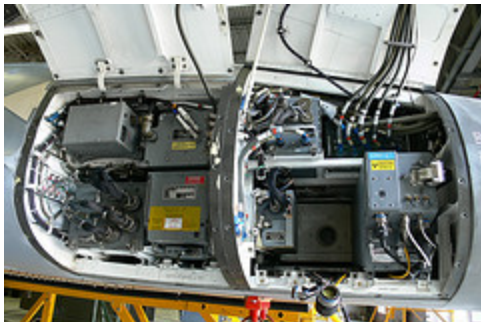


Image via Flickr: [archangel 12](#)

By mimicking the actual operational environment, their system is able to directly identify the cause of an intermittent failure. They combine their detection system with back-end digital processing that simultaneously packages and reports data. Their tester can detect intermittent discontinuities to 50 nanoseconds while simultaneously and continuously testing thousands of lines. As a result, they're able to detect aging-related problems before they become costly failures.^{viii}

One example of this is their the use of their system for the US Air Force's F-16 fighter aircraft Modular Low Power Radio Frequency unit, which saved \$62 million by detecting several problems include that the coaxial cable lines, cracked solder joints, broken wires, loose crimps, and unsoldered pins were the problem. As a result, 138 parts that had previously been called unrepairable were returned ot service.^{ix}

Aircraft Maintenance and Repair Industry Continues to Grow with Wiring a Major Focus

Growth within the aircraft maintenance, repair, and overhaul industry has been steady in the last few years, especially with the aging of fleets and the increase in outsourcing to maintenance, repair, and overhaul (MRO) companies. That said, labor costs worldwide are rising, with a recent IBISWorld estimate placing the MRO labour costs to rise 0.9 percent between now and 2018. As such, much of the emphasis in the industry is on reducing costs in order to minimize repair and maintenance requirements.^x As the MRO industry grows, no doubt repair and maintenance of wiring systems will continue to be a focus as planes become more, not less electric.

Maryruth Belsey Priebe



Maryruth can't help but seek out the keys to environmental sustainability - it's the fire that gets her leaping out of bed every day. With green writing interests that range from sustainable business practices to net-zero building designs, environmental health to cleantech, and green lifestyle choices to social entrepreneurship, Maryruth has been exploring and writing about earth-matters and ethics for over a decade. You can learn more about Maryruth's work on JadeCreative.com.

Sources

ⁱ Ramsey, J. W. (2005, August 1). *Special Report: Avoiding NFF*. Retrieved March 30, 2014, from Avionics Today: http://www.aviationtoday.com/av/commercial/Special-Report-Avoiding-NFF_1046.html#.UziL86hdWSU

ⁱⁱ *No Fault Found (NFF) – Aviation Maintenance*. (2014, March 6). Retrieved March 30, 2014, from Southeast Aerospace: <http://seaerospace-blog.com/2014/03/06/no-fault-found/>

ⁱⁱⁱ *No Fault Found (NFF) – Aviation Maintenance*. (2014, March 6). Retrieved March 30, 2014, from Southeast Aerospace: <http://seaerospace-blog.com/2014/03/06/no-fault-found/>

^{iv} *No Fault Found (NFF) – Aviation Maintenance*. (2014, March 6). Retrieved March 30, 2014, from Southeast Aerospace: <http://seaerospace-blog.com/2014/03/06/no-fault-found/>

^v Richardson, M. (2014, January 24). *Merlin's magical miles of wiring*. Retrieved March 30, 2014, from Aerospace Manufacturing: <http://www.aero-mag.com/features/24/20141/2286/>

^{vi} Mulkins, J. (2012, August 27). *Honeywell Electronics - Enhanced Ground Proximity Warning System (EGPWS): Flight History Data*. Retrieved March 30, 2014, from NTSB.gov: http://www.nts.gov/news/events/2012/ISASI_Conference/2012_ISASI_Honeywell_Presentations.pdf

^{vii} *Advanced Intermittance Diagnostic / Prognostic Solutions*. (n.d.). Retrieved March 30, 2014, from Universal Synaptics: <http://www.usynaptics.com/index.php/technical/neural-analog-technology>

^{viii} *Advanced Intermittance Diagnostic / Prognostic Solutions*. (n.d.). Retrieved March 30, 2014, from Universal Synaptics: <http://www.usynaptics.com/index.php/technical/neural-analog-technology>

^{ix} *No Fault Found (NFF) – Aviation Maintenance*. (2014, March 6). Retrieved March 30, 2014, from Southeast Aerospace: <http://seaerospace-blog.com/2014/03/06/no-fault-found/>

^x *Aircraft Maintenance, Repair & Overhaul in the US Industry Market Research Report from IBISWorld Has Been Updated*. (2013, December 21). Retrieved March 30, 2014, from PRWeb:

<http://www.prweb.com/releases/2013/12/prweb11442346.htm>