

Pulling the plug on aging wiring problems

How a combination of new technologies and a changing of old habits can help avionics shops with wires past their prime

BY DALE SMITH

There are two types of avionics technicians: Those who have dealt with the problems of aging aircraft wiring and those who will deal with the problems of aging aircraft wiring. Which is no surprise when considering that today's fleet is flying much longer than designers and manufacturers expected. That longevity is especially evident on the business and general aviation side.

"By 2020, the average age of the general aviation fleet could approach 50 years," said Paul Werner, Ph.D., systems engineer at Sandia National Laboratories' FAA Airworthiness Assurance NDI Validation Center.

And that's just the "average" age. Many of the airplanes you are, and will be, working on are much older. While owners and shops can help keep their aircraft performing "like new" by upgrading avionics and changing engines and the like, there isn't much they can, or will, do about the wiring that ties all the components together. Chances are the wire the airplane was born with will be there when it's carted off to the junkyard.

"The wiring was originally designed with a 'fit-and-forget' operations and maintenance philosophy," Werner said.

So designers didn't take maintenance and inspection into consideration, which means access to wire bundles often is difficult, if not impossible.

While much of the attention to the problem of aging wiring has focused



Eclipse International Corp.'s ESP handheld unit tells the technician the distance to the fault from the point of the test leads.

on air transport category aircraft, business and general aviation aircraft have many of the same issues.

"One of the things we are finding out is, as the wires age, they become more brittle. They become hard to handle. And, one of the biggest things is maintenance seems to be playing the biggest role," said Michael Walz, FAA manager for Again Aircraft Systems at the William J. Hughes Technical Center.

"We see more of the instances of problems in the areas of highest maintenance traffic. Guys are getting in there and things happen," he said.

THE 'RODNEY DANGERFIELD' OF AIRCRAFT SYSTEMS

The real problem is wiring "can't get no respect" from avionics technicians.

"You have to get away from this feeling that wire is part of the structure," Walz said. "You have to treat it just like the rest of the avionics."

Which means no more using wiring as a handhold or a convenient place to hang your work light. Not that you ever do it, but you know those other guys in the shop.

Walz said the FAA, along with other industry groups, is trying hard to change technicians' attitudes toward wiring and bringing awareness to the fact that just because it may be strung along in the open and look plenty tough, a wiring bundle is not part of the structure. Wiring must be handled and cared for just like any other sophisticated aircraft system.

According to Walz, research has shown whenever an area of an aircraft is subject to frequent maintenance or

inspections, that same location also will be subject to higher instances of wire and connector problems.

“Typically, (these are) areas that may experience frequent or ‘intrusive’ maintenance,” Werner said. “Areas that allow the collection of debris, metal shavings, fluids or other contaminants.”

Keeping wiring bundles and connectors clean is critical, Werner said, especially with older wiring. As wire ages, the insulation becomes brittle and prone to cracking, which exposes the conductor and creates the potential for a hazardous electrical system malfunction, such as a short circuit or an arc. Condensation, fluid containments, metal shavings, dust and debris work their way into wire bundles and can bridge the gap between a wire conductor and an adjacent metal structure. These shorts potentially can overheat wires and create fire hazards — and you know what happens from here.

“If you are working up in an area that gets frequent inspections and there are wire bundles or connectors in the area, those are the things they should pay particular attention to and take care to protect,” Walz said. “The good thing is, guys are starting to take these things into consideration. I’m seeing a lot more clean-as-you-go.

“If structural guys are working in a difficult area, the avionics guys are there to put up plastic to keep SWARF and things out of there,” he said. “So you are starting to see it, but it is just the beginning. I can’t say how far that has gotten right now.”

Not only are technicians’ attitudes toward the care of wiring changing, Walz said he’s also seeing a change in the way wire is being viewed as an actual cause of a system problem.

“At least in the air transport world we can see by trouble reports that come back now, they are isolating it down to wiring issues,” Walz said. “No longer is it, ‘I just changed the box and

that was it.’ They are starting to look for arching and all the other things — guys are becoming more aware of these issues.

“It’s too broad to say there is one set of rules to this stuff,” he said. “Circuit breakers are tripping and nobody knows why. Then you get a wire bundle burning and everybody realizes then what happened. Those are the types of things that manifest themselves. Something is acting squirrely, (and you’re) not quite sure what is going on. A lot of it can be traced back to wiring problems — either wiring or EMI.”

USING NEW TECHNOLOGY TO FIND AN OLD PROBLEM

Technicians and operators aren’t alone in their battle against aging wiring problems; manufacturers are continually trying to come up with new and better types of testing and diagnostics equipment. The team at Sandia National Laboratories has developed some effective testing scenarios to actually measure the effectiveness of these new units.

“A lot of these wire-checker manufacturers will make a lot of claims, but when they go out there, we get to really see what they can do,” Walz said.

When he says “out there,” Walz is referring to Sandia’s Airworthiness Assurance NDI Validation Center where the team has set up some interesting and accurate ways to “support the technical maturation of nondestructive inspection aircraft wiring system diagnostic technologies that are currently commercially available or under development.”

In short, Sandia has tests that test the testers. So, if a manufacturer develops a new tool they claim can find the proverbial electronic needle in a haystack, Sandia will give them a chance to put it to a real-world test.

The main resources at the laboratory are a test bed enclosure populated with

a combination of aged wiring harnesses taken from retired aircraft and newly fabricated harnesses with known defects — lots of defects. According to Werner, the facility has controlled gap fixtures for breached-insulation wiring defects, transmission lines with precision intermittence parameters, branched harnesses, feedback wire harness specimens with exposed defects and locations, electrically powered harnesses and a humidity-controlled wire harness environment, as well as other controlled testing capabilities.

Want more? Sandia also has a collection of “retired” aircraft on site with intact wiring systems that can be used for verification and validation testing. Many of these aircraft have electrical and hydraulic systems, which can be powered-up to create realistic testing environments.

The trick is, Sandia’s technicians already know where all the faults are in the wiring, therefore, they’ll be able to accurately evaluate how well any piece of automatic testing equipment does and if it does what it is supposed to do.

So, what have the folks at Sandia discovered with all their testing of the latest in wiring testing and diagnostic equipment?

“The state of the industry right now is they can find opens and shorts, and they can actually locate them with fairly good accuracy,” Walz said, “but wire breaches are still beyond the technology that we have right now. But we are working on it.”

FINDING FAULTS FASTER

Attempting to locate an open or fault problem in a complex bundle of wires or in a cable running behind an interior panel or under the floor is one of the most time-consuming, frustrating and costly tasks any avionics technician can tackle. And, as the avionics and electronics systems built into today’s

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aircraft become more complex, it's a challenge taken on with more frequency.

That's why leading manufacturers are creating newer and better types of automatic testing equipment (ATE). Properly used, these units can help technicians do inspections and locate problems in a fraction of the time. How fast?

"Our ESP handheld can tell you in about 4 seconds where the hit is at," said Chris Teal, marketing director at Eclipse International Corporation. "Sometimes, it can take a technician days to find the hit manually. What I mean by that is knowing where it is at down the line.

"Of course, you have to know which wire is bad first," Teal said. "Once you have an idea, the hard part is trying to find where the fault is and tracing it back down. Using a unit like ours keeps you from randomly poking a meter lead in the back of the insulation and such. That just leads to more wiring problems down the road."

In addition to finding faults faster, some of these new units also can help technicians hunt down wiring problems.

"One thing we've done is we have a feature called 'fault locator,'" said Charles Jennings, national sales manager for DIT-MCO. "In the past, if I were to test any type of wiring system, basically, I could tell you that there is a fault, but I couldn't tell you where it was. Fault locator actually gives you the location of the defect so it makes it much easier for the repair technician to troubleshoot the wire and system."

Eclipse's ESP unit also will tell the technician the distance to the fault from the point of the test leads, but Teal cautions that information should be tempered with a true understanding of what you are facing with that particular wiring system.

"Remember that all the same type aircraft are not the same. Even if you know (the fault) is 5-feet 6-inches from where you are testing, you don't know if it goes under the seats or over the overhead panel," Teal said. "You still have to understand the routing of the wiring in that particular aircraft."

No two technicians will route a wire the same way, especially when working with an older aircraft that has undergone extensive modifications to the cockpit and interior throughout its lifetime.

"It's just up to the artisans that installed the systems," Teal said. "That's why a technician's experience and knowledge is still their best tool. You can't get rid of your senses. These (ATEs) are just value-added tools to experienced technicians."

NO LOVE FOR THE ATE?

"We provide ATE to companies such as Boeing, Airbus, Cessna, Bombardier, Gulfstream, and their many suppliers. The testers are used to test electrical products from simple cables to complex equipment racks," Jennings said. "With few exceptions, the commercial aircraft maintainers don't use ATE at their maintenance facilities to verify the integrity of their wiring systems. I guess they still use flashlights and mirrors."

So, with all that new ATE units can do, why aren't they "standard equipment" in every avionics shop?

"That's a loaded question," said Brent Sorenson, president of Universal Synapitics. "I can't answer to everybody, but I'd say that they have been doing business for a long time using continuity testers, Ohm meters and stuff like that to find these types of problems. It's just become so engrained that I think it's hard for them to feel comfortable with some new technologies.

"In some instances, these tests tend to work better than what some auto-

matic test equipment will do," Sorenson said. "Some ATE will go through and test an entire airplane one test-point at a time and it's probably going to miss an intermittent problem now and then. So, technicians kind of want to go back to what they've used to find problems in the past."

On top of breaking of old habits, there's also the problem of management being reluctant to pay thousands of dollars to buy test equipment when they have trained and experienced technicians who can do the job — and they're already paying for them.

"It's the initial purchase cost versus the time it will take to make that back," Teal said. "Or better, the shop's perception of the time it will take to pay it back."

Is this a valid concern or just a smokescreen to keep from spending money?

"It is valid if they don't have a plan on how to use the new unit and integrate it into their testing ... how they'll make money from having it," Teal said. "You can buy technology all day, but if you don't have the workload to use it ... Remember, with this technology, you can cook through testing rather quickly, so you need the workload to justify it."

Teal said groups using new technology like Eclipse's ESP handheld are reporting unbelievable return on investment (ROI) numbers.

"Some of the ROI we get from people is over 1,600 percent," he said.

WHAT'S NEW IN AUTOMATIC TESTING EQUIPMENT?

DIT-MCO International Corporation

DIT-MCO's model 2135 is a low-cost 1,000-volt circuit analyzer that provides performance and fault location in a lightweight configuration. Configured with up to 300 points of switching, the 2135 tests wiring and components for leakage, resistance and

capacitance at programmable voltages of 0.225 to 1000VDC and 2 amps. The optional fault locator gives technicians a clear indication of where along the circuit path an error likely exists. The 2135 features an easy-to-use text editor that allows dual display of UUT names and test programs. TestEdit can open multiple programs simultaneously for quick and easy data sharing.

For more information, contact DIT-MCO at 1-800-821-3487 or visit www.ditmco.com.

Eclipse International Corporation

The ESP is Eclipse's first handheld fault location unit. Manufactured under exclusive licensing from NASA, the ESP utilizes standing wave reflectometry to accurately locate opens and shorts in a wide variety of cable and wire types. It features a simple menu-driven interface; English and Metric display modes; locates faults up to 1,000 feet from the test point with accuracy within 1 inch; stores up to 99 wire and cable types with user-defined names; and has an RS-232 data port for optional link to PCs.

For more information, contact Eclipse International at 951-371-8008 or visit www.eclipse.org.

3M

3M's new advanced systems tester, the 900AST, is a handheld, integrated test set designed to locate opens, shorts and intermittents in aircraft wiring systems. Using resistive fault loca-

tion and a time domain reflectometer, technicians can locate faults and verify repairs on various conductor types. In addition, the 900AST supports a full range of individual tests to categorize and sectionalize potential problems. The unit can display the distance to a fault in inches. The unit also measures AC and DC voltage, conductor and insulation resistance with foreign voltage compensation, capability and capacitance, and can be used to conduct soak test measurements.

For more information, visit 3M at http://solutions.3m.com/en_US/.

Universal Synaptics Corporation

Universal Synaptics' IFD-2000 was created specifically to locate age-related failures and faults in wiring, many of which first appear randomly or intermittently as brief, low-level opens or shorts and seldom repeat with the same intensity. The IFD-2000 is radically different. It uses a super sensitive, electronic, bio-sensing neural network to monitor each and every circuit simultaneously. Even when testing simple wiring systems, the effectiveness of the IFD-2000 in finding age-related defects is much greater than many other measurement technologies. The unit can be installed onboard an aircraft to do automated testing before or after each operation.

For information, contact Universal Synaptics at 801-731-8508 or visit www.usynaptics.com. □



DIT-MCO International Model 2135 wiring analyzer is configured with up to 300 points of switching.