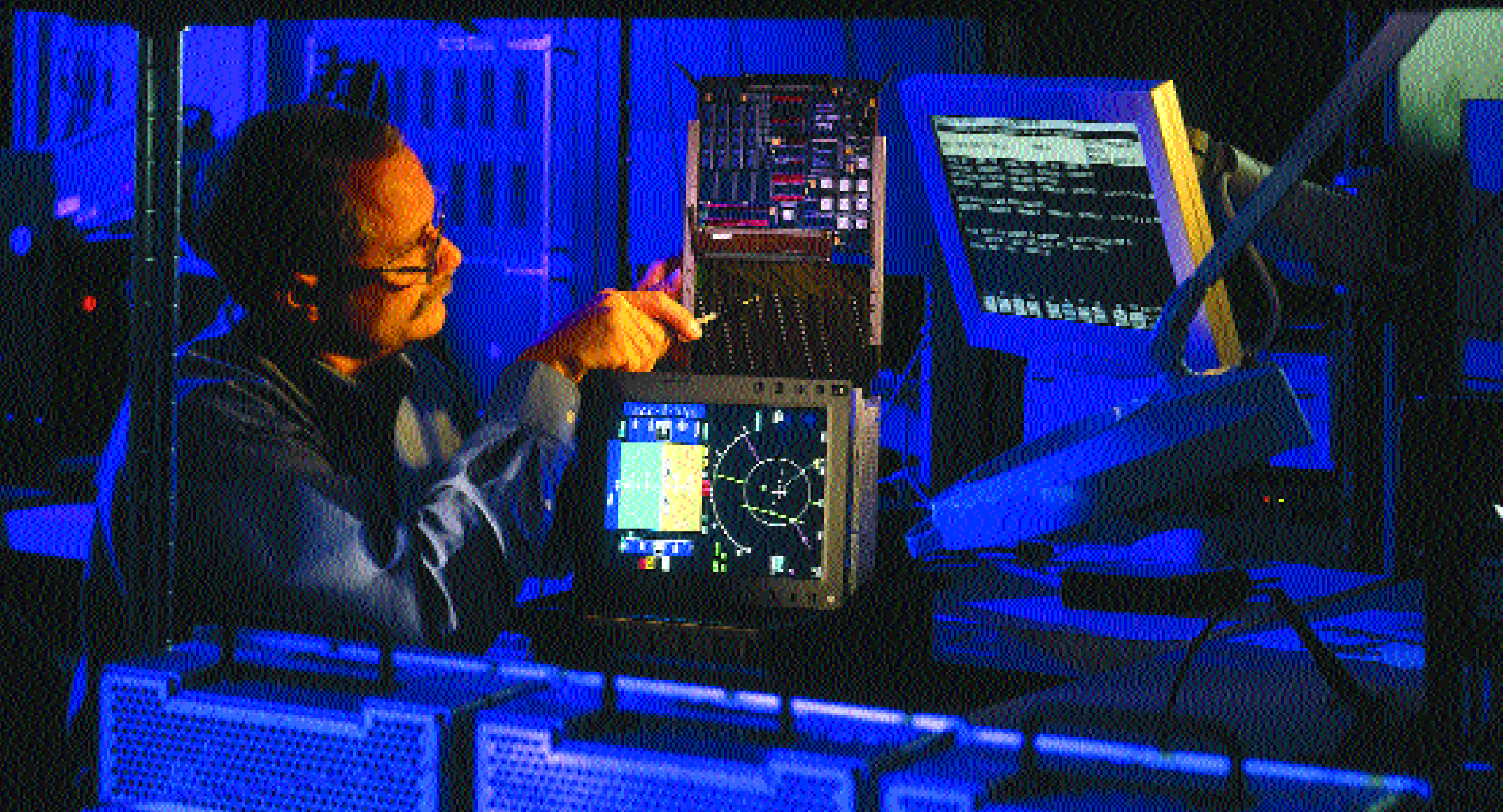
Built-In Diagnostics

BY DALE SMITH



Getting the most out of your avionics' built-in diagnostics capabilities.

Once viewed as the "cure-all" for avionics troubleshooting problems, technicians are finding that with the right knowledge and training, the built-in diagnostics in current generation systems are coming a lot closer to delivering on the promise.

To truly appreciate how far built-in diagnostics capabilities have come, we have to take a short trip in the ol' "wayback" machine to the early days of component self-monitoring and testing. "Diagnostics themselves go way back," explained Dave Smith, director of product management for Rockwell Collins' Business and Regional Systems Group. "Some of the first were called 'fault balls.' They used different colored balls that would flip over when a unit failed and they would stay that way until the box was tested and reset. Unfortunately, the biggest problem was that diagnostics circuit was probably the least accurate and reliable one in the box.

"That's the way it was with a lot of those early systems," he continued. "The older diagnostics tended to be very complicated, so if you had a fault, a lot of the times you didn't know if the problem was really in the box or with the diagnostics themselves."

"Back when each unit stood alone, troubleshooting was fairly easy," Pat Scott, technical manager for Honeywell Avionics' new Primus Epic system added. "If a flight director broke, that was your problem. You could just change that box and you'd probably get it right. But, when you move up to the days when you started to place multiple processor cards into an avionics cabinet and each processor began to serve several functions, troubleshooting suddenly became infinitely more difficult."

So, driven by the rapid growth in avionics sophistication and the corresponding need to provide ever-increasingly more reliable information to technicians, component manufacturers have consistently evolved and refilled their system's diagnostics capabilities.

That was then, this is now.

"The intent of today's diagnostics capabilities is to enable a technician to find a problem, fix the problem and get the airplane returned to service as quickly as possible," Smith said. "Our goal is to take all the 'adventure' out of troubleshooting."

To help achieve this high level of diagnostics capabilities and reliability, Honeywell and Rockwell Collins are introducing some revolutionary new capabilities into their new generation systems.

An example of the sophistication of the new self-diagnostics is the non-volatile memory built into Rockwell Collins' new Pro Line 21 CNS radios. The memory actually tracks the operation of the unit creating a historical file that technicians can use to identify the precise conditions that led to the display of a failure code. "When a technician gets one of these boxes on the bench all he has to do is plug it in to the test set and interrogate it to see if it lists any failures before he opens the box up," Smith explained. "A technician can run the whole test in a couple of minutes instead of a couple of hours. No more guessing or hunting around to find a problem."

On-board diagnostics for Honeywell Primus Epic integrated avionics system display unit showing present leg faults.

Smith also said that the non-volatile memory not only stores the failure, it also stores when during the flight it occurred and the temperature of the unit at the time. "If we can't duplicate the fault at room temperature, we can run it in the conditions to replicate the situation," he added. "With previous units you had to cycle it between the extremes of the TSO to try and make it fail. Now we can know exactly what circumstances we need to go to."

With the development of their new Primus Epic system, Honeywell has provided technicians with their most advanced system self-diagnostics and troubleshooting tools to date. For example, the system's Central Maintenance Function (CMF) automatically collects system operational information and stores any located failures in the Fault History Database, which can be interrogated by the user. The CMF offers the user the ability to view Flight Deck Effects (CAS messages), and correlated Maintenance Messages, view fault histories, perform file transfers, optionally view Aircraft Maintenance Manuals, per-

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form initiated tests, perform rigging procedures and view data the Member Systems transmit via the Avionics Standard Communications Bus (ASCB).

"Our new Primus Epic system truly introduces the most advanced integration that we've ever done on business aircraft," Scott explained. "And because of that, a technician has no chance of troubleshooting the system's distributed architecture without the help of a computer that can track the built-in test (BIT) and show them what's going on."

Just tell me where it hurts.

While the avionics manufacturers have continually evolved the built-in diagnostics capabilities of their products to provide technicians with more and better troubleshooting information, one area where they haven't been quite so successful in is creating a common "language" that the technicians and BITE computers can use to communicate.

"In earlier generation systems, when a technician would run the ground maintenance tests or integrated maintenance test sequences and if a fault was found, it would give you a set of what were basically hex-codes to help troubleshoot the problem," explained Dave Coleman, manager of customer services for Honeywell Avionics. "The only thing is, you needed a 'secret magic decoder ring' to decipher them."

Scott added that he has his own way of describing how the "language" of BITE has developed over the years: "The earlier maintenance systems were designed by BITE-heads for BITE-heads," he said. "Basically, everything was put in engineering language and we're still dealing with that problem today."

"Most technicians see a diagnostics display and say, 'What the #@!& is that supposed to mean?'," Scott continued. "We've kind of spring loaded most technicians into believing that there isn't very much value in what these things tell them because we haven't developed terminology they understand."

While we're on the subject of things that technicians don't like about current-generation built-in diagnostics systems, we have to mention the "cascade" effect. What that is, is one box having a fault and because other boxes need that input they too display faults because their data is incomplete.

"Because of the downstream way boxes are tied together, one box can have a fault and the technician can end up with 20 or more fault messages on the display," he added. "The technician looks at the daunting list of 20-plus faults on it and he has to work his way through it one-by-one to turn the airplane—so most times, he turns to guessing. That's another thing we're working hard to make better."

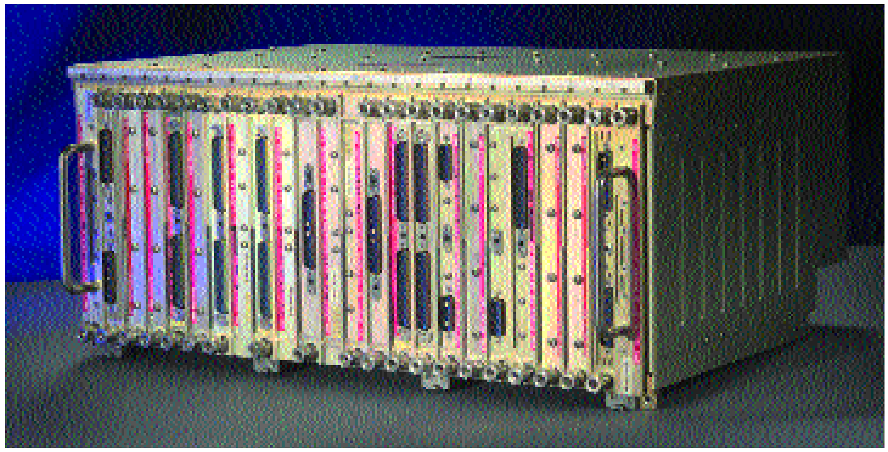
Knowledge is key.

While the availability of built-in diagnostics and system self-testing capabilities have led many people to think today's avionics are practically "self-maintaining" the truth is they're not. "A lot of operators are under the impression that you can have someone other than an experienced avionics technician troubleshoot these systems," Smith explained. "But the truth is you can't. You still need a technician who is trained on electronics and avionics because he is going to get a lot of information from the diagnostics displays that he's going to have to interpret. Remember, diagnostics can't give you the answers, they can only point you in a direction."

That was the sentiment shared by all of the people interviewed for this story by *Avionics News*—the more sophisticated the systems are, the more critical training and experience becomes to achieving timely and efficient troubleshooting.

"In fact, what we're finding out is that a lot of today's diagnostics are so complicated that if the technician doesn't know the system really well—better than he or she used to have to know it—they won't know how to sift through all the engineering-level language to understand what the diagnostics are really telling them," explained Craig Aldrich, maintenance training counselor for FlightSafety's Gulfstream Learning Center. "In fact, type specific training is probably more important now than ever."

"The principal of the diagnostics capabilities are to give the technicians the ability to quickly narrow down his search for a problem into a smaller



Honeywell Primus Epic modular avionics unit (MAU) including maintenance computer.

area," added Mike Ward, avionics instructor at FlightSafety's Citation Learning Center. "But you still need to thoroughly understand the system and all the different scenarios that can go along with a fault display."

To illustrate his thought, Ward gave the following example: Let's say you have a flight director which is the "brain" of the autoflight control system, and you have the autopilot, which is the "muscle" of the system. And the pilot comes in after a trip and gives a technician a squawk dealing with the autoflight system, saying no more than: "The autoflight system kicked-off after 15-minutes."

Now the technician really has to understand how the autoflight system works in order to ask the appropriate questions and run the right diagnostics. Is it a flight director problem or an autopilot problem? Do I go to the flight director portion of the diagnostics or the autopilot portion? "If you're not familiar enough with the system, you can run around in circles troubleshooting one area when the problem is actually somewhere else," he explained. "Autoflight systems are particularly troublesome because you can't duplicate their operation on the ground. You have to use the diagnostics, but more importantly, you have to rely on your own skills, knowledge and experience."

And like everything to do with maintaining any aircraft, consistent training is a major asset to helping technicians get the most out of what the airplanes can tell them. "From our perspective, we think training is very important," Coleman said. "But, many times we have to 'pull teeth' to get people to come in and spend time getting trained. Why? Well, in general a lot of users don't understand the value of training or want to invest in training. Somewhere along the line, they got the belief that these systems will do the troubleshooting for them."

Twin sons of different mothers.

Another way training, or in particular, model specific training can be a great benefit to technicians are the vast differences found in the way avionics systems are engineered from manufacturer to manufacturer and model to model. They may look alike, but they're not created the same and those differences can be bewildering to an untrained technician.

"While there are just a few standard avionics manufacturers and they supply the same basic systems to all aircraft makers, there are a lot of differences between one installation and another and that makes a big difference in how you troubleshoot a system," added John Jordan, director of maintenance training at FlightSafety's Citation Learning Center. "You may see a Primus 2000 avionics package in a Citation X and you may see the 'same package' in a Falcon or Challenger. But even though they're the same avionics, they're different."

Jordan explained that this commonality leads to problems because the aircraft manufacturers use different sets of parameters to install their avionics. "Things that turn one thing on in the Citation may turn it off in the Falcon," he said. "There are many different ways of achieving inputs. One may use a logic module. Another may use a PC board somewhere to provide throttle data and the next may use some kind of digital-to-analog converter to get the same information."

So what's a technician to do? "Here's another situation where training is very important, Aldrich added. "Technicians see an unfamiliar airplane has an SPZ 8000 system and expect it to be the same as what they've seen before. It's not. System knowledge is critical to successful troubleshooting. It all goes back to training to know what's really causing what in each system. Without it you're just going to end up beating your head against the wall."

Another benefit to having a wealth of system knowledge is the ability to sense when the diagnostics may be sending you down the wrong path. And it does happen. Today's systems are very good but they're not foolproof and a technician needs to know when the readings they're getting are just wrong. It all goes back to training because a system's built-in test is not going to always be a tell-all solution.

Technicians also have to keep in mind that each avionics vendor only creates diagnostics capabilities for their avionics systems and today's aircraft have multiple types of systems in each installation. "Even though it's a Honeywell equipped airplane it probably also has a Universal, Garmin or Global FMS," added Ward. "No matter what system it has, the in-depth diagnostics will only support the primary supplier's products. It can look for inputs from the other components, but it can't support their diagnostics. So the technician still has to rely on experience to identify these situations and not just randomly pull a box because the diagnostics identify it as providing no data."

For example, Ward said, consider the Universal UNS-1D that's in the Citation Excel. It only has an ARINC 429 databus to the Primus 1000 avionics system. If that data isn't present, the system's display will just say, "Sorry, we don't get a bus from the Universal box" but it won't say why. "It could be a box failure, a connector failure or a bad wire," he said. "And there's no way of knowing until you get down inside the system and trace the bus. The diagnostics won't do it for you."

It's not my fault—really!

Providing advanced training for avionics technicians cannot only help operators cut troubleshooting times, it

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can also be a major contributor to cutting spares and replacement parts costs especially when you want to eliminate the costs of no-fault-found.

"As an OEM we get beat up by operators because of the high number of boxes that get sent in for repair but get diagnosed as 'no-fault-found,'" Coleman added. "But when we go back and analyze the actual data, we find that the majority of it's happening because the users haven't taken the time to train their people in the right way to troubleshoot their systems."

"I think entry-level technicians tend to rely too heavily on what the box is telling them and not enough on what experience should be telling them," Jordan said. "So instead of going through and doing the thorough troubleshooting program they will just go in and do what they call 'shotgunning' the system. They go in and replace all of the boxes that could possibly cause the problem." Then they send the boxes back to the OEM to let them figure it out—a big waste of everyone's time and money.

"But as long as the parts are covered by a warranty, the technicians don't have to worry about making the right decision," he continued. "But once the warranty is off, the pressure is on whether or not they spend 30- or 40-thousand dollars on a new box. This is where the experienced and well-trained technicians separate themselves from the box-changers."

FlightSafety's Ward went on to explain the lengths one avionics OEM has gone to, to force technicians to go beyond what the diagnostics may tell them and do more in-depth troubleshooting before a box is removed and sent back to the factory. "One OEM has put out, in their current documentation, the following statement: 'Under no circumstances do you replace one of the boxes in the aircraft because the diagnostics say that is the problem'," he said. "Because many times the problem is actually an input to the box and not the box itself. You don't want to go replacing a forty-thousand dollar box when the problem is really a twenty-dollar switch." q