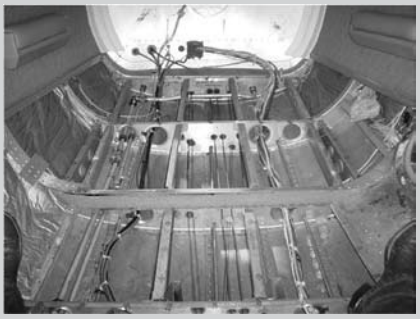
TAKE THE TROUBLE OUT OF TROUBLESHOOTING AUTOPILOTS

BY DALE SMITH



Beechcraft Duke, under floor. Autopilot harness routed with strobe harnesses. AP disconnected when strobes flashed; 50V spike on AP with strobe discharge.

This is where S-TEC found the primary aileron cable.

Results of loose primary and bridle cable.

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It's Monday morning and you've just arrived at your office. As you head to unlock the outside door, you can't believe what you see: Mr. Beechnut's Skyspam is parked outside your shop again.

"It can't be," you think to yourself. But as you open the door, you find a note from Mr. Beechnut, which reads: "My 'bleeping' autopilot still does not 'bleeping' work! Fix it!"

This isn't the way you wanted to start out your week.

You and your technicians are not alone. Time and again, autopilots prove to be one of the most confounding components to successfully troubleshoot. Why? Unlike practically every other piece of an avionics system, autopilots are linked synergistically to so many other non-electronic parts of an airplane.

Autopilots are aviation's version of the "Six Million Dollar Man" — part electronics and part mechanical. Often, technicians aren't sure which part to look at for problems.

Start at the Beginning

Let's take Mr. Beechnut, for example. Sure, he left you a note stating his autopilot still isn't working, but what does that really mean? Is that enough to start running up the clock with a technician? No. You need more information — tangible, verifiable information. And the best place to start is with a detailed conversation with Mr. Beechnut.

"In most cases, the customer will not give you the complete squawk list," said Barry Sparks, vice president of Autopilots Central. "This is why the technician needs to ask a lot of questions, even about functions of the autopilot that the customer did not squawk."

That's important because an autopilot is so highly integrated with other avionics and mechanical systems.

"People call and say their autopilot doesn't want to follow the heading bug or whatever," said Van Dardis, customer support manager for S-TEC. "I ask them to try it in nav mode. If it works great, then you probably have a DG (directional gyro) problem and not an autopilot problem. We correct a lot more airplane issues than we ever do autopilot problems.

"Just by moving around and checking all the different modes of the autopilot, gives you a better overall feel for what is going on," Dardis said. "You never just look at one thing — most of the time (the problem) is more than one thing."

Go Fly Yourself

Another good way to shorten your list of troubleshooting suspects is to actually fly the airplane — preferably with the owner/pilot. Not only will you get a feel for how the system is working, but you'll also get an understanding of the owner/pilot's familiarity with the autopilot.

"There are so many problems you cannot recreate with the airplane on the ground. So, flying is a critical part of any troubleshooting effort," said Theo Dufresne, avionics program manager for Global Jet Services Inc.

For example, static buildup can

cause problems if the shielding is not correctly applied or is damaged.

"There is an awful lot more static in the air than we think of," Dufresne said. "When you are on the ground and the airplane is grounded, there's no static problem at all. But that doesn't mean it's good."

Dufresne said working with the pilot to narrow down possible failure scenarios is extremely valuable.

"The tech must identify inputs particular to the failed mode," he said. "Was the pilot using [the] signal from the heading bug, the VOR bearing or the FMS track? Same roll effect; three different sources."

If any of them are "bad," it may show up as an autopilot problem.

Flying also gives you a chance to feel the controls for yourself. Is there any obvious tension or binding in the controls? The owner/pilot may be so used to this situation he doesn't even pay attention to it anymore. It's like asking someone if their car needs a front-end alignment — it's been degrading for so long they probably don't even notice it pulling hard to the right.

That familiarity is another reason you shouldn't blindly take the owner's or pilot's word for what's going on with the autopilot. They often don't know the true symptoms of the problem.

"I can't tell you how many times when I have removed the cover for the manual trim wheel, the grease came out in chunks," Dardis said. "It hadn't been lubricated in who knows how long. No wonder the autopilot is having trouble — it's fighting against the aircraft's system."

Short Between the Headsets

"There are so many times a customer says they have a problem when, in fact, it is operator error," Sparks said. "A lot of customers will not have ever read the manual for their autopilot. They don't have a clue."

Case in point is a situation one technician shared about an owner who complained that whenever he put the autopilot in vertical-speed mode, the airplane would stall. After just a couple of questions, the technician easily figured out the owner had no idea what the vertical-speed mode actually did.

He was selecting too high of a vertical speed for that particular airplane in that configuration, so when the autopilot tried to match the selected rate of climb, the nose pitched up until it stalled. By asking the right questions, the technician didn't waste any time chasing a ghost problem in a system actually working exactly as designed.

That's why, Dardis pointed out, you have to be certain you and the owner/pilot are speaking the same language.

"Vocabulary is a big problem," Dardis said. "If someone says they have a pitch/porpoising problem — well, I need quantifiable data. Is it drifting up and down slowly, or pitching hard up and down? Is it a 50- or 100-foot variation or 10 feet? You have to understand the problem before you can find it."

It's Not My Fault

"Understanding a problem" means having an accurate picture of whether you are indeed dealing with an autopilot problem rather than a control, static leak or GPS problem — to name a few.

Because so many possible causes

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AUTOPILOT Troubleshooting Checklist

From Van Dardis, customer support manager for S-TEC

- ✓ Provide a detailed history of all aircraft damage.
- ✓ Provide a detailed description of all relevant flight characteristics and parameters, such as altitudes, autopilot modes, CG locations, airspeeds, frequency of occurrence, etc.
- ✓ Provide a static system leak rate at a simulated altitude of 18,000 feet. (Ensure that the static system is connected to the autopilot transducer.)
- ✓ Has the aircraft's control system been inspected for worn parts? (Bolts, bushings, cables, pulleys, rod-ends, etc.)
- ✓ Has the aircraft's control system been inspected for excessive play?
- ✓ Has the aircraft's control system been inspected for excessive friction?
- ✓ Has the aircraft's control system been lubricated in accordance with the aircraft manufacturer's specifications?
- ✓ Has each aircraft control surface been inspected for proper installation?
- ✓ Has each aircraft control surface been inspected for freedom of movement?
- ✓ Has the travel of each aircraft control surface been verified to be within the aircraft manufacturers specifications?
- ✓ Has the programmer/computer tray been installed in accordance with the STC?
- ✓ Is the programmer/computer tray properly supported?
- ✓ Is the programmer/computer completely seated in its tray?
- ✓ Has the autopilot wiring harness been properly separated from the aircraft's AC and DC power buses?

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are not avionics-related, Dardis has created a checklist he sends to shops to help them find non-electronics problems. (*See sidebar on page 39*)

"The thing I always find is that when something is not working, the first assumption everyone makes is that it has to be difficult," Dardis said. "Something as simple as a static leak can cause all kinds of problems. They want to change every component in the autopilot system when the autopilot is not at fault.

"The static system — the old plastic tubing — you can just touch it and it will break," he said. "And most airplanes haven't had their control system rigged or cables tightened in 15 years. A lot of simple things can cause problems."

Which is not surprising when considering most airplanes in the fleet are more than 30 years old.

"Autopilot problems are usually a chain-reaction type thing," Dardis said. "Every airplane is different and every system is different. That's why we created the checklist. It gives us a common place to begin each system inspection."

Dardis said he has seen control cable tensions, bridal cable tensions, startup voltage on servos, static systems, trim systems and other systems cause an "autopilot" problem.

Sparks also said other systems can cause the "autopilot" problem, and he always performs a complete ramp test with the airplane connected to an APU.

"Thousands of hours are wasted every year troubleshooting a problem that, in fact, was because of low voltage," Sparks said. "Written notes of the technical ramp test may save many man hours troubleshooting a problem that the customer says the technician caused when, in fact, he didn't."

Sparks said during a ground check, a technician needs to check radios and other related equipment as well.

"You can find other problems, such as nav receiver inop, glide slope receiver inop, autopilots not wired to the GPS correctly or an autopilot not coupling the approach because the recent radio installation did not wire it for ILS energize," he said.

Another simple test a technician can perform during a ground check is to make sure the connectors are tight and free of corrosion.

"When I worked for Air Canada, I found that over 80 percent of the time when an autopilot box was removed and replaced, the real cause was bad wiring," Dufresne said. "It could be a bad splice or a bad connector or corrosion. You won't find this in touch-and-go-type maintenance. It takes time to find these problems."

Dufresne said the simple act of disconnecting and reconnecting a box just might fix the problem.

"Any time you can, a normal reflex should be to put your flashlight on the pins to have a look," he said. "Is it bent or coroded or loose? Sometimes just reseating a connector will fix a problem."

An Active Problem with a Static Cause

Another simple check — and one of the first things Dardis said he looks at — is the condition of the aircraft's static port.

"I've seen it a number of times," Dardis said. "Somebody painted the airplane and stuck a toothpick in the static port hole. If you get out a magnifying glass, you can see the paint built up a ridge around the hole. That throws off the autopilot.

"The little transducers — the brains of the autopilot — are sensitive up to six inches of altitude — six inches! So, if you have a problem where the airflow is disrupted by this messed-up static port, the pressure is going to fluctuate," he said. "Not to the extent where you will see it on the VSI or airspeed indicator, but that little transducer is in there going nuts. It's going to create all kinds of problems, like pitch/porpoising. But most technicians never think to look at the static port."

It's Fixed But Not Finished

Now that you've gotten to the bottom of the problem and fixed it, it's time for the final step: flying the airplane again. This is an important part of the process because it gives you a chance to see if you took care of the entire issue or just part of the problem.

"When they're finished repairing an autopilot, lots of shops let the customer go out and fly the aircraft and then get a report back from the pilot," Sparks said. "If the technician goes with the pilot during this test flight, he can calibrate the autopilot, if necessary, and find any other problems during the flight." ❑