Pre-Accident Investigator

Preventing the **crash** by **finding the cause** first

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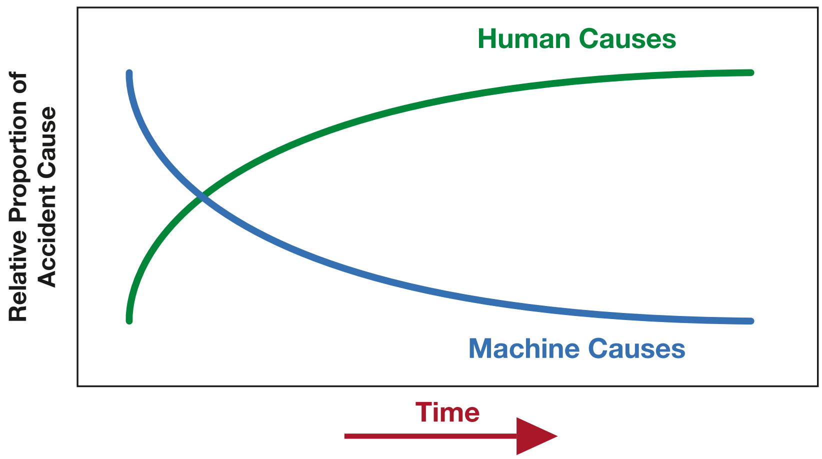
The primary purpose of investigating any aircraft accident is to prevent recurrence. Legal teams may wrestle with "who" when assigning blame, but investigators are focused on the "why" to make sure the "what" never happens again. The NTSB sleuths have a solid track record of finding the cause of a mishap, and have had a demonstrable impact on making all facets of aviation and other modes of transport safer.

Of course, their efforts are for the most part after the fact. First comes the accident, then comes the investigation, and finally the recommendations to prevent a repeat. They are quite literally "post-accident" investigators. This post-accident mindset was needed in the early days of aviation because causal factors seemingly came from everywhere, and many were not well understood. Early turbine engine and airframe failures, microbursts, wind shear, wake turbulence and controlled flight into terrain all come to mind. Back then, aviation was more of an art than a science. But now that we've got a handle on most of these threats, wouldn't it be better to investigate the causes behind accidents before they happen? In other words, can we start thinking as "pre-accident" investigators?

This shift in focus from examining wreckage to examining what goes on in the human brain makes perfect sense now that accident causes have dramatically shifted from the machinery to the humans involved. The false notion that airplanes haves gotten better and pilots worse feeds the common narrative that we need better training, new cockpit gizmos, stricter rules and regulations, and must obsess over our shortcomings as crewmembers, mechanics and other aviation professionals. It is an idea promulgated by a 1984 International Civil Aviation Organization (ICAO) study and circulated by various crew resource management (CRM) texts.



Changes in accident causal factors from ICAO

The study's signature chart in the series shows an unmistakable rise in a line labeled "human causes" while another line called "machine causes" takes an equally precipitous drop. According to this chart, our shortcomings as humans are increasing. But the entire chart is an exercise in agenda-driven statistics. It gives "relative proportion of accident cause" but doesn't reflect actual numbers at all. You may say this is an innocent exaggeration whose only intent is to motivate us humans to constantly improve. But it hides an important fact: The actual numbers of aircraft accidents caused by machines and by humans have both fallen. So, the humans have gotten better, and the machines much better. A properly drawn chart would show that when we first took to the air, the accident rate in both categories was quite high, but as we learned from airplane crashes, the accident rates fell. Now that both human and machine performance have improved, it is getting harder to progress further in either category. We've faced the easy challenges and solved most of the big problems; further improvement will be incremental and will come by focusing on the smaller problems. And those problems won't be as easy to solve.

In the pilot arena we've come a long way. We know to forego dive and drive approaches, we understand better how to manage our fatigue on long flights, and CRM has transformed our cockpits from autocratic fiefdoms to command centers for cohesive, problem-solving teams. What remains to be conquered are the items we've previously assigned to the broad category we know as "technique."

The notion that there's always more than one way to accomplish a certain

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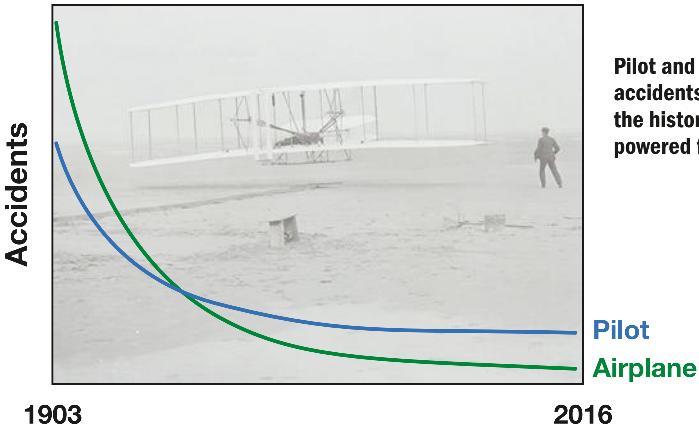

Pilot and airplane accidents over the history of powered flight

task seems to make sense in most endeavors. But in aviation that idea ignores an important fact: If someone discovers a best practice that can save lives, shouldn't we at least consider adopting it? To that point are three cases in which a good pre-accident investigator could have spotted a poor technique before the accident happened in the first place. Gulfstream IV accidents tend to make excellent

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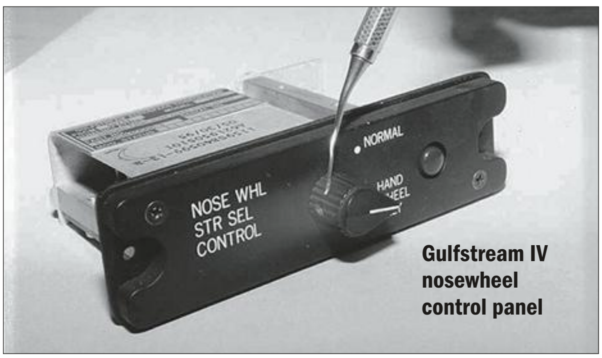

Gulfstream IV nosewheel control panel

human factors studies because the airplane is well built and easy to fly, and mishaps with this airframe are almost always the result of pilot error, somewhat predictable, and more often than not, misunderstood.

Case Study: Palwaukee GIV

If you mention "Palwaukee GIV" to any Gulfstream pilots, chances are they will say the same thing: "Nosewheel steering switch." Earlier Gulfstreams did not have any connection between the rudder pedals and the nosewheel steering. Steering control was strictly through a handwheel, or tiller, located on the captain's left. Starting with the Gulfstream IV, however, pilots were given limited control through the rudder pedals as well as the handwheel.

Because older Gulfstream pilots objected to this change, the aircraft had a switch that essentially removed the rudder pedal interface.

On Oct. 30, 1996, a GIV pilot lost control of his airplane during a gusty crosswind takeoff and crashed at what is now known as Chicago Executive Airport, Wheeling, Illinois (KPWK). The crew of three and the sole passenger were killed. The loss of control was not inevitable, as conditions were well within the airplane's capabilities. In this case, the nosewheel switch is merely a red herring; the real cause of the accident is still to this day widely misunderstood.

While some pilots who flew the airplane preferred the "Handwheel Only" option of the nosewheel steering system, both pilots on the accident flight preferred the "Normal" option. But neither pilot noticed "Handwheel Only" was selected. The NTSB cited the pilot for failure to maintain directional control of the aircraft during the takeoff roll and noted the nosewheel control switch as an additional factor relating to the accident. Hence most people reading the report attribute the crash to this switch. But they're wrong.

Buried in the middle of the NTSB report, but not commented upon, is this: "The PIC tended to unload the nosewheel on the GIV during takeoff to make it easier on the airplane on rough runways."

That airport, of course, does not have a rough runway and this technique ignores the important fact that the aircraft's large tail acts as a weathervane in a crosswind. The airplane must be kept in a three-point attitude until rotation speed. The elevator may become effective before the rudder and unloading the nosewheel before rotation is not only a poor technique, it is contrary to Gulfstream procedure.

Other pilots in the flight department noticed this pilot's technique of unloading the nosewheel. Had any of them had the expertise to know the flaw of the technique and spoken up, the accident could have been prevented.

Case Study: Teterboro GIV

While not as infamous as the Palwaukee crash, the Dec. 1, 2004, accident of a GIV at New Jersey's Teterboro Airport can spur similar snap judgments about its cause. The aircraft landed in a gusty crosswind. The pilot was unable to deploy the thrust reversers and felt the wheel brakes were unresponsive. He then tried to stop the aircraft using the emergency wheel brake system but was unsuccessful. The aircraft departed the paved surface and was destroyed in the aftermath. Luckily, no one was hurt.

In its report, the NTSB was quick to blame the pilot's inadvertent engagement of the autothrottle system after touchdown. That finding led most pilots to write off the crash as just another aircraft systems problem. But it wasn't that at all.

KEVIN KNECHT

Gulfstream IV autothrottle switches

Gulfstream Aerospace's initial application of autothrottles was in the GIV and the manufacturer elected to use two sets of switches. One set was placed below and aft of each throttle knob. The switches are spring-loaded down and pilots simply push them up to engage or disengage the autothrottles. The second set of switches is forward of the throttle knobs and its only purpose is to disengage the autothrottles.

Many Gulfstream pilots immediately recognized that it would be too easy for the aft-facing switches to inadvertently disengage and then re-engage the autothrottles with a "double

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Gulfstream gust lock handle

click" while landing in a gusty wind condition. Those pilots advocated using only the forward switches to disengage the autothrottles. But since the manufacturer didn't mandate a procedure, some pilots continued to use the aft switches to disengage. It was a technique.

The double click is precisely the thing that did in the GIV pilots at TEB. The pilot-flying unknowingly re-engaged his autothrottles just prior to touchdown. As the speed decayed below the target approach speed, the autothrottles advanced, preventing thrust reverser deployment and creating the illusion of wheel brake system problems.

Of course the pilot could have simply overridden the autothrottles by pulling them back, but in the heat of battle he did not.

Instructor pilots are often reluctant to push their personal procedures on others when they are using techniques that are unwise but not specifically prohibited. Had any of the pilots flying with the pilot of this accident Gulfstream been a more forceful advocate of a better technique, the accident could have been prevented.

In such situations, we should all be instructor pilots.

Case Study: Bedford GIV

Arguably, the most infamous GIV accident of all occurred at Hanscom Field, Bedford, Massachusetts, on May 31, 2014, and is almost universally blamed on an aircraft system that has never before or since been a problem: the flight control gust lock. The crew attempted to take off with the airplane's gust lock engaged, an action that ended up killing all on board and destroying the airplane.

The NTSB almost got this one right. It pronounced the probable cause to have been the pilots "failure to perform the flight control check before takeoff, their attempt to take off with the gust lock system engaged, and their delayed execution of a rejected takeoff after they became aware that the controls were locked."

But the Safety Board buried the lead by finding that, "Contributing to the accident was the flight crew's habitual noncompliance with checklists."

In fact, that was the cause of the crash and the gust lock was a contributing factor. This may seem like splitting hairs, but it is an important distinction when the goal is preventing accidents. No pilot intends to take off with the gust lock engaged. But these pilots intended to operate without using their checklists. They had a track record of doing just that.

Had any other pilot who had witnessed their habitual noncompliance spoken up, the accident could have been prevented. All it takes is one respected voice to serve as a wake-up call. "The checklist is there for a reason," would be a gentle way to voice an objection. "None of us is perfect," would be another. "What you are doing is dangerous and I will not fly with you," might have been the perfect way to drive home the point.

Pre-Accident Plan

Of course, looking at case studies is just another way of conducting a post-accident analysis. But we can leapfrog that outcome by examining our procedures and asking what might cause the next accident?

Consider a six-step plan of action:

(1) Define the problem. A standard safety officer technique is to predict the next major accident as a way to focus one's attention where it needs to be. We can take a page from this book by examining our aircraft systems and pilot procedures and look for weak points. Sure, the fault is unlikely, but if it did occur, what would it be?

(2) Understand the procedures and techniques. You have to make yourself an expert when doing this. What does the flight manual say? What is the manufacturer's view? Are there any regulatory stipulations? Where do industry leaders and training vendors come down on this? How about your most respected peers?

(3) Apply a healthy dose of skepticism. A faulty technique often becomes accepted procedure over the years because influential people embrace it without question and the rest fall into line. You cannot blindly accept the position that "everyone does it this way" without applying your own common sense check. There might be a safer way.

(4) Apply an equal amount of empathy. Most of the room left for improved safety is in human factors, and to make the most of that, you need to get into the brain of the operator. What will the pilot really do under real-world conditions when fatigued and under time and weather pressures? Don't measure these against yourself at your peak performance; consider the worst-case conditions with an average pilot operating at his or her worst. Then you can brainstorm for the change that will prevent the next accident.

(5) Solve the problem. In many cases, someone has come before you and already solved the problem; you need only to discover the secret. In other cases, you will need to brainstorm and think through the solution. In some cases, your initial thought will be the right one, but in others it may take years of consideration to arrive at the right solution.

(6) Passionately advocate change. It isn't enough to come up with a fix that prevents the next accident without getting other aviators to "buy in," and adopt the change. If you think your solution will prevent an accident, you are duty bound to making that known. You can do this by politely challenging those who can benefit, by making your views known in pilot meetings, by writing to aviation blogs, or even with a magazine or website article.

Applying the Process

Let's take a look at an example of this process with a Gulfstream G450, the newest version of the Gulfstream IV.

First, let's define the problem. Ever since the first crash of a Gulfstream II in 1974, ground spoilers have been the subject of a lot of Gulfstream pilot paranoia. The six panels on top of the aircraft's wings are designed to deploy automatically after landing touchdown and throttles go to idle. These panels kill the lift and transfer weight to the wheels to improve braking effectiveness. The automatic system relies on a weight-on-wheels switch in each main landing gear to confirm the aircraft is indeed on the runway before killing that lift. If the spoilers were to deploy in flight, the results could be catastrophic.

The latest Gulfstream models, starting with the GV and continuing with the G450 and G550, have several safety features that warn the pilot when there is a problem with the weight-on-wheels system. These systems will not prevent automatic deployment, but they will warn the pilot not to arm the automatic system. Gulfstream's normal checklist flow does not place a priority on removing the inadvertent spoiler deployment threat after takeoff; in fact, the ground spoilers are not addressed until step five of the relevant checklist.

Now we have to understand the procedures and techniques. The "Climb Checklist" for the G450, used right after takeoff, has 11 steps, of which the first five are: gear, flaps, guidance panel, climb power and ground spoilers. This has been the basic procedure since the GII.

Third, we need to apply a healthy dose of skepticism. From the earliest days after that first GII crash, Gulfstream pilots realized that it would be too easy to get distracted by a weight-on-wheels system failure and forget the ground spoilers before the inevitable throttle reduction.

These pilots adopted a new technique to remove the threat early on: "gear, spoilers, flaps." They reasoned that by following the gear handle immediately with the ground spoilers their muscle memory will always get to the ground spoilers right after the gear retraction.

Next, apply an equal amount of empathy. After years of flying "gear, spoilers, flaps," we started to explore weight-on-wheels system malfunctions in the simulator. If the system fails during takeoff (say, both switches are iced over by runway contamination, for example), the first indication would be the failure of the gear handle to move to the retract position, since the airplane thinks it is still on the ground. Some pilots at this point will just stare at the gear handle and call for the checklist. However, if the pilot flying brings the throttles to idle, the conditions needed to deploy the ground spoilers will be met and the airplane will stop flying.

Fifth, solve the problem. Our "gear, spoilers, flaps" solution had long been thought of as the cure for all possible weight-on-wheels systems malfunctions, but as it turns out that was only partially true. Our muscle memory failed us when the gear handle failed to rise. What we needed was a surefire way to always get the ground spoiler system to the off position after every takeoff. Why not get them first? Why not "spoilers, gear, flaps" from now on?

True, you can go an entire career flying Gulfstreams and never have a weight-on-wheels system failure. But what if you do? This new technique could save you.

Sixth, passionately advocate change. It isn't enough to address the problem in your own cockpit. How would you feel if the next accident does involve this exact scenario? What if you knew the pilot and never passed on your pearl of wisdom? You can lead by example and demonstrate the technique at your next recurrent training. Your instructor and sim partner will benefit. That's two more pilots enlightened. How about a pilot messaging board?

JAMES ALBRIGHT

Gulfstream G450 weight-on-wheels switch

I choose to spread the word with magazine articles like this one. *BCA*'s online version gives you a chance to submit comments; the readership is vast and that feedback can be invaluable.

I've adopted many techniques over the years from unknown sources, but each is a valued tool in my arsenal. The technique of keeping your hand on the altitude select knob until the other pilot acknowledges has already saved me from an altitude bust or two. I know there are other great techniques out there about which I am ignorant. Fortunately, I am always in the learning mode. **BCA**