I'M NO EXPERT ON ANYTHING. However, I can talk intelligently about some things that I'm familiar with such as flying an Airbus. The Airbus was the last aircraft that I flew just prior to my retirement. I logged a little over 2000 hours in the Airbus. Honestly I never got comfortable in flying that airplane. The only reason that I bid to fly it was the fact that the company was reducing the size of their Boeing fleet and increasing the size of the Airbus fleet. Thus, the schedules of flying were much better if you were a Bus pilot over being a Boeing pilot.

The sales people are always trying to sell something and when something is sold someone bought it and life goes on. The creators of the Airbus were evidently trying to make a more modern and safer Airliner. In many respects they did. I was amazed about several things I learned flying the Airbus. It is a computer-operated airplane. If you could play computer games well you would probably feel right at home in a Bus. With a little effort a novice pilot could easily impress a check airman in the simulator. It was a whole new way to think about operating an airplane.

There are computer that control everything from the synchronization flushing of the several toilets to a computer judging the integrity of another bank of computers which are all watching each other. Was it is supposed to simplify the flying of the machine? I suppose that some thought to make an aircraft so easy to operate that any 3rd world man or woman could learn to do it.

After all third world birds fly very well. But they are birds. Doesn't make sense to me. But, what do I know.

The thing I liked about the Boeing was it's simplicity. You controlled the three axis of the airplane with one hand and two feet. With the other hand you controlled the power. Push the throttles forward to go fast, pull them back to slowdown. Push the yoke forward the houses get larger, pull the yoke back the houses get smaller. All you needed to really understand was roll, pitch, power and yaw. If you keep your speed up you will continue to keep flying. That is of course, if you don't hit something.

Not so much so with the Airbus. Computers are supposed to do everything for you. As long as you know which buttons to press and when to press them the Airbus is happy. Make a mistake and alarms sound. Some times the alarms may be difficult to understand and confusing, especially if one is saying one thing and another is saying another thing. It may prove difficult to determine what is going on. As the story I recommend that you read happened to the Air France Airbus. It was a fully operating flying machine that hit the Atlantic Ocean in one piece and killed everyone on board (228 Pax and Crew).

I would fly an Airbus again, but I'd rather fly a Boeing. The main reason is that in a Boeing, when you have the Yoke in one hand, throttles in the other and both feet on the rudder peddles you are the heart and soul of the airplane. Crosswinds? No problem. Rain, sleet, snow or icing? No problem. The Boeing always did what I wanted it to do and made me look and feel good.

Not so much so with the Airbus. In the Bus the pilot is in charge of hundreds of computers. Sometimes they all get along, sometimes they don't! ~awd

What Really Happened Aboard Air France 447

Two years after the Airbus 330 plunged into the Atlantic Ocean, Air France 447's flight-data recorders finally turned up. The revelations from the pilot transcript paint a surprising picture of chaos in the cockpit, and confusion between the pilots that led to the crash.

For more than two years, the disappearance of Air France Flight 447 over the mid-Atlantic in the early hours of June 1, 2009, remained one of aviation's great mysteries. How could a technologically state-of-the art airliner simply vanish?

With the wreckage and flight-data recorders lost beneath 2 miles of ocean, experts were forced to speculate using the only data available: a cryptic set of communications beamed automatically from the aircraft to the airline's maintenance center in France. As PM found in our cover story about the crash, published two years ago this month, the data implied that the plane had fallen afoul of a technical problem—the icing up of air-speed sensors—which in conjunction with severe weather led to a complex "error chain" that ended in a crash and the loss of 228 lives.

The matter might have rested there, were it not for the remarkable recovery of AF447's black boxes this past April. Upon the analysis of their contents, the French accident investigation authority, the BEA, released a report in July that to a large extent verified the initial suppositions. An even fuller picture emerged with the publication of a book in French entitled *Erreurs de Pilotage* (volume 5), by pilot and aviation writer Jean-Pierre Otelli, which includes the full transcript of the pilots' conversation.

We now understand that, indeed, AF447 passed into clouds associated with a large system of thunderstorms, its speed sensors became iced over, and the autopilot disengaged. In the ensuing confusion, the pilots lost control of the airplane because they reacted incorrectly to the loss of instrumentation and then seemed unable to comprehend the nature of the problems they had caused. Neither weather nor malfunction doomed AF447, nor a complex chain of error, but a simple but persistent mistake on the part of one of the pilots.

Human judgments, of course, are never made in a vacuum. Pilots are part of a complex system that can either increase or reduce the probability that they will make a mistake. After this accident, the million-dollar question is whether training, instrumentation, and cockpit procedures can be modified all around the world so that no one will ever make this mistake again—or whether the inclusion of the human element will always entail the possibility of a catastrophic outcome. After all, the men who crashed AF447 were three highly trained pilots flying for one of the most prestigious fleets in the world. If they could fly a perfectly good plane into the ocean, then what airline could plausibly say, "Our pilots would never do that"?

HERE IS A SYNOPSIS OF WHAT OCCURRED DURING THE COURSE OF THE DOOMED AIRLINER'S FINAL FEW MINUTES.

At 1h 36m, the flight enters the outer extremities of a tropical storm system. Unlike other planes' crews flying through the region, AF447's flight crew has not changed the route to avoid the worst of the storms. The outside temperature is much warmer than forecast, preventing the still fuel-heavy aircraft from flying higher to avoid the effects of the weather. Instead, it ploughs into a layer of clouds.

At 1h51m, the cockpit becomes illuminated by a strange electrical phenomenon. The co-pilot in the right-hand seat, an inexperienced 32-year-old named Pierre-Cédric Bonin, asks, "What's that?" The captain, Marc Dubois, a veteran with more than 11,000 hours of flight time, tells him it is St. Elmo's fire, a phenomenon often found with thunderstorms at these latitudes.

At approximately 2 am, the other co-pilot, David Robert, returns to the cockpit after a rest break. At 37, Robert is both older and more experienced than Bonin, with more than double his colleague's total flight hours. The head pilot gets up and gives him the left-hand seat. Despite the gap in seniority and experience, the captain leaves Bonin in charge of the controls.

At 2:02 am, the captain leaves the flight deck to take a nap. Within 15 minutes, everyone aboard the plane will be dead.]

02:03:44 (Bonin) La convergence inter tropicale… voilà, là on est dedans, entre 'Salpu' et 'Tasil.' Et puis, voilà, on est en plein dedans…
The inter-tropical convergence... look, we're in it, between 'Salpu' and 'Tasil.' And then, look, we're right in it...

The intertropical convergence, or ITC, is an area of consistently severe weather near the equator. As is often the case, it has spawned a string of very large thunderstorms, some of which stretch into the stratosphere. Unlike some of the other planes's crews flying in the region this evening, the crew of AF447 has not studied the pattern of storms and requested a divergence around the area of most intense activity. (Salpu and Tasil are two air-traffic-position reporting points.)

02:05:55 (Robert) Oui, on va les appeler derrière... pour leur dire quand même parce que...
Yes, let's call them in the back, to let them know...

Robert pushes the call button.

02:05:59 (flight attendant, heard on the intercom) Oui? Marilyn.
Yes? Marilyn.

02:06:04 (Bonin) Oui, Marilyn, c'est Pierre devant... Dis-moi, dans deux minutes, on devrait attaquer une zone où ça devrait bouger un peu plus que maintenant. Il

faudrait vous méfier là.
Yes, Marilyn, it's Pierre up front... Listen, in 2 minutes, we're going to be getting into an area where things are going to be moving around a little bit more than now. You'll want to take care.

02:06:13 (flight attendant) D'accord, on s'assoit alors?
Okay, we should sit down then?

02:06:15 (Bonin) Bon, je pense que ce serait pas mal… tu préviens les copains!
Well, I think that's not a bad idea. Give your friends a heads-up.

02:06:18 (flight attendant) Ouais, OK, j'appelle les autres derrière. Merci beaucoup.
Yeah, okay, I'll tell the others in the back. Thanks a lot.

02:06:19 (Bonin) Mais je te rappelle dès qu'on est sorti de là.
I'll call you back as soon as we're out of it.

02:06:20 (flight attendant) OK.
Okay.

The two copilots discuss the unusually elevated external temperature, which has prevented them from climbing to their desired altitude, and express happiness that they are flying an Airbus 330, which has better performance at altitude than an Airbus 340.

02:06:50 (Bonin) Va pour les anti-ice. C'est toujours ça de pris.
Let's go for the anti-icing system. It's better than nothing.

Because they are flying through clouds, the pilots turn on the anti-icing system to try to keep ice off the flight surfaces; ice reduces the plane's aerodynamic efficiency, weighs it down, and in extreme cases, can cause it to crash.

02:07:00 (Bonin) On est apparemment à la limite de la couche, ça devrait aller.
We seem to be at the end of the cloud layer, it might be okay.

In the meantime Robert has been examining the radar system and has found that it has not been set up in the correct mode. Changing the settings, he scrutinizes the radar map and realizes that they are headed directly toward an area of intense activity.

02:08:03 (Robert) Tu peux éventuellement le tirer un peu à gauche.
You can possibly pull it a little to the left.

02:08:05 (Bonin) Excuse-moi?
Sorry, what?

02:08:07 (Robert) Tu peux éventuellement prendre un peu à gauche. On est d'accord qu'on est en manuel, hein?
You can possibly pull it a little to the left. We're agreed that we're in manual, yeah?

Bonin wordlessly banks the plane to the left. Suddenly, a strange aroma, like an electrical

transformer, floods the cockpit, and the temperature suddenly increases. At first, the younger pilot thinks that something is wrong with the air-conditioning system, but Robert assures him that the effect is from the severe weather in the vicinity. Bonin seems ill at ease. Then the sound of slipstream suddenly becomes louder. This, presumably, is due to the accumulation of ice crystals on the exterior of the fuselage. Bonin announces that he is going to reduce the speed of the aircraft, and asks Robert if he should turn on a feature that will prevent the jet engines from flaming out in the event of severe icing.

Just then an alarm sounds for 2.2 seconds, indicating that the autopilot is disconnecting. The cause is the fact that the plane's pitot tubes, externally mounted sensors that determine air speed, have iced over, so the human pilots will now have to fly the plane by hand.

Note, however, that the plane has suffered no mechanical malfunction. Aside from the loss of airspeed indication, everything is working fine. Otelli reports that many airline pilots (and, indeed, he himself) subsequently flew a simulation of the flight from this point and were able to do so without any trouble. But neither Bonin nor Roberts has ever received training in how to deal with an unreliable airspeed indicator at cruise altitude, or in flying the airplane by hand under such conditions.

02:10:06 (Bonin) J'ai les commandes.
I have the controls.

02:10:07 (Robert) D'accord.
Okay.

Perhaps spooked by everything that has unfolded over the past few minutes—the turbulence, the strange electrical phenomena, his colleague's failure to route around the potentially dangerous storm—Bonin reacts irrationally. He pulls back on the side stick to put the airplane into a steep climb, despite having recently discussed the fact that the plane could not safely ascend due to the unusually high external temperature.

Bonin's behavior is difficult for professional aviators to understand. "If he's going straight and level and he's got no airspeed, I don't know why he'd pull back," says Chris Nutter, an airline pilot and flight instructor. "The logical thing to do would be to cross-check"—that is, compare the pilot's airspeed indicator with the co-pilot's and with other instrument readings, such as groundspeed, altitude, engine settings, and rate of climb. In such a situation, "we go through an iterative assessment and evaluation process," Nutter explains, before engaging in any manipulation of the controls. "Apparently that didn't happen."

Almost as soon as Bonin pulls up into a climb, the plane's computer reacts. A warning chime alerts the cockpit to the fact that they are leaving their programmed altitude. Then the stall warning sounds. This is a synthesized human voice that repeatedly calls out, "Stall!" in English, followed by a loud and intentionally annoying sound called a "cricket." A stall is a potentially dangerous situation that can result from flying too slowly. At a critical speed, a wing suddenly becomes much less effective at generating lift, and a plane can plunge precipitously. All pilots are trained to push the controls forward when they're at risk of a stall so the plane will dive and gain speed.

The Airbus's stall alarm is designed to be impossible to ignore. Yet for the duration of the flight, none of the pilots will mention it, or acknowledge the possibility that the plane has indeed stalled—even though the word "Stall!" will blare through the cockpit 75 times. Throughout, Bonin will keep pulling back on the stick, the exact opposite of what he must do to recover from the stall.

02:10:07 (Robert) Qu'est-ce que c'est que ça?
What's this?

02:10:15 (Bonin) On n'a pas une bonne… On n'a pas une bonne annonce de vitesse.
There's no good... there's no good speed indication.

02:10:16 (Robert) On a perdu les, les, les vitesses alors?
We've lost the, the, the speeds, then?

The plane is soon climbing at a blistering rate of 7000 feet per minute. While it is gaining altitude, it is losing speed, until it is crawling along at only 93 knots, a speed more typical of a small Cessna than an airliner. Robert notices Bonin's error and tries to correct him.

02:10:27 (Robert) Faites attention à ta vitesse. Faites attention à ta vitesse.
Pay attention to your speed. Pay attention to your speed.

He is probably referring to the plane's vertical speed. They are still climbing.

02:10:28 (Bonin) OK, OK, je redescends.
Okay, okay, I'm descending.

02:10:30 (Robert) Tu stabilises...
Stabilize…

02:10:31 (Bonin) Ouais.
Yeah.

02:10:31 (Robert) Tu redescends... On est en train de monter selon lui… Selon lui, tu montes, donc tu redescends.
Descend... It says we're going up... It says we're going up, so descend.

02:10:35 (Bonin) D'accord.
Okay.

Thanks to the effects of the anti-icing system, one of the pitot tubes begins to work again. The cockpit displays once again show valid speed information.

02:10:36 (Robert) Redescends!
Descend!

02:10:37 (Bonin) C'est parti, on redescend.
Here we go, we're descending.

02:10:38 (Robert) Doucement!
Gently!

Bonin eases the back pressure on the stick, and the plane gains speed as its climb becomes more shallow. It accelerates to 223 knots. The stall warning falls silent. For a moment, the co-pilots are in control of the airplane.

02:10:41(Bonin) On est en… ouais, on est en "climb."
We're... yeah, we're in a climb.

Yet, still, Bonin does not lower the nose. Recognizing the urgency of the situation, Robert pushes a button to summon the captain.

02:10:49 (Robert) Putain, il est où... euh?

The plane has climbed to 2512 feet above its initial altitude, and though it is still ascending at a dangerously high rate, it is flying within its acceptable envelope. But for reasons unknown, Bonin once again increases his back pressure on the stick, raising the nose of the plane and bleeding off speed. Again, the stall alarm begins to sound.

Still, the pilots continue to ignore it, and the reason may be that they believe it is impossible for them to stall the airplane. It's not an entirely unreasonable idea: The Airbus is a fly-by-wire plane; the control inputs are not fed directly to the control surfaces, but to a computer, which then in turn commands actuators that move the ailerons, rudder, elevator, and flaps. The vast majority of the time, the computer operates within what's known as normal law, which means that the computer will not enact any control movements that would cause the plane to leave its flight envelope. The flight control computer under normal law will not allow an aircraft to stall, aviation experts say.

But once the computer lost its airspeed data, it disconnected the autopilot and switched from normal law to "alternate law," a regime with far fewer restrictions on what a pilot can do. In alternate law, pilots can stall an airplane.

It's quite possible that Bonin had never flown an airplane in alternate law, or understood its lack of restrictions. Therefore, Bonin may have assumed that the stall warning was spurious because he didn't realize that the plane could remove its own restrictions against stalling and, indeed, had done so.

02:10:55 (Robert) Putain!
Damn it!

Another of the pitot tubes begins to function once more. The cockpit's avionics are now all functioning normally. The flight crew has all the information that they need to fly safely, and all the systems are fully functional. The problems that occur from this point forward are entirely due to human error.

02:11:03 (Bonin) Je suis en TOGA, hein?
I'm in TOGA, huh?

Bonin's statement here offers a crucial window onto his reasoning. TOGA is an acronym for Take Off, Go Around. When a plane is taking off or aborting a landing—"going around"—it must gain both speed and altitude as efficiently as possible. At this critical phase of flight, pilots are trained to increase engine speed to the TOGA level and raise the nose to a certain pitch angle.

Clearly, here Bonin is trying to achieve the same effect: He wants to increase speed and to climb away from danger. But he is not at sea level; he is in the far thinner air of 37,500 feet. The engines generate less thrust here, and the wings generate less lift. Raising the nose to a certain angle of pitch does not result in the same angle of climb, but far less. Indeed, it can—and will—result in a descent.

While Bonin's behavior is irrational, it is not inexplicable. Intense psychological stress tends to shut down the part of the brain responsible for innovative, creative thought. Instead, we tend to revert to the familiar and the well-rehearsed. Though pilots are required to practice hand-flying their aircraft during all phases of flight as part of recurrent training, in their daily routine they do most of their hand-flying at low altitude—while taking off, landing, and maneuvering. It's not surprising, then, that amid the frightening disorientation of the thunderstorm, Bonin reverted to flying the plane as if it had been close to the ground, even though this response was totally ill-suited to the situation.

02:11:06 (Robert) Putain, il vient ou il vient pas?
Damn it, is he coming or not?

The plane now reaches its maximum altitude. With engines at full power, the nose pitched upward at an angle of 18 degrees, it moves horizontally for an instant and then begins to sink back toward the ocean.

02:11:21 (Robert) On a pourtant les moteurs! Qu'est-ce qui se passe bordel? Je ne comprends pas ce que se passe.
We still have the engines! What the hell is happening? I don't understand what's happening.

Unlike the control yokes of a Boeing jetliner, the side sticks on an Airbus are "asynchronous"—that is, they move independently. "If the person in the right seat is pulling back on the joystick, the person in the left seat doesn't feel it," says Dr. David Esser, a professor of aeronautical science at Embry-Riddle Aeronautical University. "Their stick doesn't move just because the other one does, unlike the old-fashioned mechanical systems like you find in small planes, where if you turn one, the [other] one turns the same way." Robert has no idea that, despite their conversation about descending, Bonin has continued to pull back on the side stick.

The men are utterly failing to engage in an important process known as crew resource management, or CRM. They are failing, essentially, to cooperate. It is not clear to either one of them who is responsible for what, and who is doing what. This is a natural result of having two co-pilots flying the plane. "When you have a captain and a first officer in the

cockpit, it's clear who's in charge," Nutter explains. "The captain has command authority. He's legally responsible for the safety of the flight. When you put two first officers up front, it changes things. You don't have the sort of traditional discipline imposed on the flight deck when you have a captain."

The vertical speed toward the ocean accelerates. If Bonin were to let go of the controls, the nose would fall and the plane would regain forward speed. But because he is holding the stick all the way back, the nose remains high and the plane has barely enough forward speed for the controls to be effective. As turbulence continues to buffet the plane, it is nearly impossible to keep the wings level.

02:11:32 (Bonin) Putain, j'ai plus le contrôle de l'avion, là! J'ai plus le contrôle de l'avion!
Damn it, I don't have control of the plane, I don't have control of the plane at all!

02:11:37 (Robert) Commandes à gauche!
Left seat taking control!

At last, the more senior of the pilots (and the one who seems to have a somewhat better grasp of the situation) now takes control of the airplane. Unfortunately, he, too, seems unaware of the fact that the plane is now stalled, and pulls back on the stick as well. Although the plane's nose is pitched up, it is descending at a 40-degree angle. The stall warning continues to sound. At any rate, Bonin soon after takes back the controls.

A minute and a half after the crisis began, the captain returns to the cockpit. The stall warning continues to blare.

02:11:43 (Captain) Eh… Qu'est-ce que vous foutez?
What the hell are you doing?

02:11:45 (Bonin) On perd le contrôle de l'avion, là!
We've lost control of the plane!

02:11:47 (Robert) On a totalement perdu le contrôle de l'avion... On comprend rien... On a tout tenté...
We've totally lost control of the plane. We don't understand at all... We've tried everything.

By now the plane has returned to its initial altitude but is falling fast. With its nose pitched 15 degrees up, and a forward speed of 100 knots, it is descending at a rate of 10,000 feet per minute, at an angle of 41.5 degrees. It will maintain this attitude with little variation all the way to the sea. Though the pitot tubes are now fully functional, the forward airspeed is so low—below 60 knots—that the angle-of-attack inputs are no longer accepted as valid, and the stall-warning horn temporarily stops. This may give the pilots the impression that their situation is improving, when in fact it signals just the reverse.

Another of the revelations of Otelli's transcript is that the captain of the flight makes no attempt to physically take control of the airplane. Had Dubois done so, he almost certainly would have understood, as a pilot with many hours flying light airplanes, the insanity of

pulling back on the controls while stalled. But instead, he takes a seat behind the other two pilots.

This, experts say, is not so hard to understand. "They were probably experiencing some pretty wild gyrations," Esser says. "In a condition like that, he might not necessarily want to make the situation worse by having one of the crew members actually disengage and stand up. He was probably in a better position to observe and give his commands from the seat behind."

But from his seat, Dubois is unable to infer from the instrument displays in front of him why the plane is behaving as it is. The critical missing piece of information: the fact that someone has been holding the controls all the way back for virtually the entire time. No one has told Dubois, and he hasn't thought to ask.

02:12:14 (Robert) Qu'est-ce que tu en penses? Qu'est-ce que tu en penses? Qu'est-ce qu'il faut faire?
What do you think? What do you think? What should we do?

02:12:15 (Captain) Alors, là, je ne sais pas!
Well, I don't know!

As the stall warning continues to blare, the three pilots discuss the situation with no hint of understanding the nature of their problem. No one mentions the word "stall." As the plane is buffeted by turbulence, the captain urges Bonin to level the wings—advice that does nothing to address their main problem. The men briefly discuss, incredibly, whether they are in fact climbing or descending, before agreeing that they are indeed descending. As the plane approaches 10,000 feet, Robert tries to take back the controls, and pushes forward on the stick, but the plane is in "dual input" mode, and so the system averages his inputs with those of Bonin, who continues to pull back. The nose remains high.

02:13:40 (Robert) Remonte... remonte... remonte... remonte...
Climb... climb... climb... climb...

02:13:40 (Bonin) Mais je suis à fond à cabrer depuis tout à l'heure!
But I've had the stick back the whole time!

At last, Bonin tells the others the crucial fact whose import he has so grievously failed to understand himself.

02:13:42 (Captain) Non, non, non... Ne remonte pas... non, non.
No, no, no... Don't climb... no, no.

02:13:43 (Robert) Alors descends... Alors, donne-moi les commandes... À moi les commandes!
Descend, then... Give me the controls... Give me the controls!

Bonin yields the controls, and Robert finally puts the nose down. The plane begins to regain speed. But it is still descending at a precipitous angle. As they near 2000 feet, the aircraft's

sensors detect the fast-approaching surface and trigger a new alarm. There is no time left to build up speed by pushing the plane's nose forward into a dive. At any rate, without warning his colleagues, Bonin once again takes back the controls and pulls his side stick all the way back.

02:14:23 (Robert) Putain, on va taper... C'est pas vrai!
Damn it, we're going to crash... This can't be happening!

02:14:25 (Bonin) Mais qu'est-ce que se passe?
But what's happening?

02:14:27 (Captain) 10 degrès d'assiette...
Ten degrees of pitch...

Exactly 1.4 seconds later, the cockpit voice recorder stops.

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Today the Air France 447 transcripts yield information that may ensure that no airline pilot will ever again make the same mistakes. From now on, every airline pilot will no doubt think immediately of AF447 the instant a stall-warning alarm sounds at cruise altitude. Airlines around the world will change their training programs to enforce habits that might have saved the doomed airliner: paying closer attention to the weather and to what the planes around you are doing; explicitly clarifying who's in charge when two co-pilots are alone in the cockpit; understanding the parameters of alternate law; and practicing hand-flying the airplane during all phases of flight.

But the crash raises the disturbing possibility that aviation may well long be plagued by a subtler menace, one that ironically springs from the never-ending quest to make flying safer. Over the decades, airliners have been built with increasingly automated flight-control functions. These have the potential to remove a great deal of uncertainty and danger from aviation. But they also remove important information from the attention of the flight crew. While the airplane's avionics track crucial parameters such as location, speed, and heading, the human beings can pay attention to something else. But when trouble suddenly springs up and the computer decides that it can no longer cope—on a dark night, perhaps, in turbulence, far from land—the humans might find themselves with a very incomplete notion of what's going on. They'll wonder: What instruments are reliable, and which can't be trusted? What's the most pressing threat? What's going on? Unfortunately, the vast majority of pilots will have little experience in finding the answers.

Jeff Wise is a contributing editor for Popular Mechanics and the author of Extreme Fear: The Science of Your Mind in Danger. *For a daily dose of extreme fear, check out his blog.*