What Really Happened Aboard Air France 447

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This case is designed to accompany the Heliprops article: The Effects of Stress on Our Physiological, Perceptual, and Cognitive Performance

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There is still a great deal of controversy over this accident and my point is not to argue facts or try to determine a root cause for the accident but to use this article to demonstrate the principles we have been looking at in the series of articles.

- Read the case completely.
- Stop when you see a number (1) and read my comments which are in bold. The footnote numbers in this article are also referenced in the article: The Effects of Stress on Our Physiological, Perceptual, and Cognitive Performance
- We are not trying to figure out what the crew should have done but why they may have done what they did.

Much of what has been written about this accident mentions the inexperienced crew and their lack of training. Experience and training are very subjective. The crew was qualified under the regulatory standards and met the regulatory requirements for training. Expecting a company to go beyond that standard is beyond the scope of this article.

Experience: Captain Marc Dubois had joined Air France in 1988 and had approximately 11,000 flight hours, including 1,700 hours on the Airbus A330; the two first officers, 37-year-old David Robert and 32-year-old Pierre-Cedric Bonin, had over 9,000 flight hours between them. Pierre-Cedric Bonin had only 800 hours in-type, and had not met the qualifications specified by Air France to be a first officer on an A330 aircraft
Following the article published by Jeff wise On 29 July 2011, the Bureau of Enquiry and

Analysis for Civil Aviation Safety (BEA) released a third interim report on safety issues it found in the wake of the crash. It was accompanied by two shorter documents summarizing the interim report and addressing safety recommendations.

The third interim report stated that some new facts had been established. In particular:

- The pilots had not applied the unreliable airspeed procedure.
- The pilot-in-control pulled back on the stick, thus increasing the angle of attack and causing the plane to climb rapidly.
- The pilots apparently did not notice that the plane had reached its maximum permissible altitude.
- The pilots did not read out the available data (vertical velocity, altitude, etc.).
- The stall warning sounded continuously for 54 seconds.
- The pilots did not comment on the stall warnings and apparently did not realize that the plane was stalled.
- There was some buffeting associated with the stall.
- The stall warning deactivates by design when the angle of attack measurements are considered invalid and this is the case when the airspeed drops below a certain limit.
- In consequence, the stall warning stopped and came back on several times during the stall; in particular, it came on whenever the pilot pushed forward on the stick and then stopped when he pulled back; this may have confused the pilots.
- Despite the fact that they were aware that altitude was declining rapidly, the pilots were unable to determine which instruments to trust: it may have appeared to them that all values were incoherent.

Again the report tells us “what” the crew did but not “why” they did it. The purpose of the two Heliprops articles is to explore the relationship between stress and performance and help you understand the possible “why.”

What Really Happened Aboard Air France 447

By: Jeff Wise

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?

We now understand that, indeed, AF-447 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 AF-447, it was a complex chain of errors on the part of the crew.

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 AF-447 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, AF-447's flight crew has not changed their 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 plows into a layer of clouds.

At 1h 51m, 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. [(1)] **Think about how this unknown situation triggers a moderate fear response in Bonin.**

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 Captain gets up and gives him the left-hand seat. Despite the gap in seniority and experience, the captain leaves Bonin (Inexperienced Copilot) 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. [(2)] **The Captain is obviously unconcerned about any potential problem and gives little thought to leaving Bonin in charge and leaving Robert in the Captain's seat. This will also cause uncertainty and further increase the stress level of both Robert and Bonin.**

02:03:44 Bonin – (Inexperienced Copilot)
The inter-tropical convergence... look, we're in it, between 'Salpu' and 'Tasil.' And then, look, we're right in it... (Salpu and Tasil are two air-traffic-position reporting points.)

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 plane's crews flying in the region this evening, the crew of AF-447 has not studied the pattern of storms and requested a divergence around the area of most intense activity. [(3)] **This should have been considered during the pre-flight planning and contingency planning enroute. When a crew considers repetitious flights routine they are working at too low a stress level and often miss important information.**

02:05:55 Robert - (Experienced Copilot)
Yes, let's call them in the back, to let them know...

Robert - (Experienced Copilot) pushes the call button.

02:05:59 (Flight Attendant) Heard on the intercom
Yes? Marilyn.

02:06:04 Bonin – (Inexperienced Copilot)
Yes, Marilyn, it's Pierre ... 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)
Okay, we should sit down then?

02:06:15 Bonin – (Inexperienced Copilot)
Well, I think that's not a bad idea. Give your friends a heads-up.

02:06:18 (Flight Attendant)
Yeah, okay, I'll tell the others in the back. Thanks a lot.

02:06:19 Bonin – (Inexperienced Copilot)
I'll call you back as soon as we're out of it.

02:06:20 (Flight Attendant)
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. [(4)] **Discussions like this appear frequently in transcripts and are often a crews attempt to make them feel better about a situation they are uncomfortable with. An effective crew would have discussed the aircraft's performance in relation to temperature and altitude.**

02:06:50 Bonin – (Inexperienced Copilot)
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 – (Inexperienced Copilot)
We seem to be at the end of the cloud layer, it might be okay. [(5)] **Comments like this are often made to make us feel better about the situation and reduce our stress but they do nothing to identify a potential problem. It is obvious from the comment "it might**

be okay" they he is still concerned. Their communications with each other are focused on making them feel better about the situation and reducing their stress.

In the meantime Robert - (Experienced Copilot) has been examining the radar system and has found that it has not been set up in the correct mode. [(6)] **It should have been set correctly during the cockpit checks which may have been missed due to a low level of initial stress and complacency.** 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 - (Experienced Copilot)
You can eventually pull it a little to the left.

02:08:05 Bonin – (Inexperienced Copilot)
Sorry, what?

02:08:07 Robert - (Experienced Copilot)
You can eventually pull it a little to the left. We're agreed that we're in manual, yeah?

Bonin – (Inexperienced Copilot) 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 - (Experienced Copilot) assures him that the effect is from the severe weather in the vicinity. Bonin – (Inexperienced Copilot) 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 – (Inexperienced Copilot) announces that he is going to reduce the speed of the aircraft, and asks Robert - (Experienced Copilot) 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. [(7)] **Due to a convergence of factors at this point the stress level increases greatly. Start looking for the symptoms experienced when the stress level is between 115-145 HBPM.**

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 – (Inexperienced

Copilot) nor Robert - (Experienced Copilot) 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 – (Inexperienced Copilot)
I have the controls.

02:10:07 Robert - (Experienced Copilot)
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 – (Inexperienced Copilot) 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. [8] **At this point stress elevates further and irrational behavior and default responses are the norm. Memory is impaired by cortisol so any information that was previously stored is inaccessible at this level of stress.**

Bonin's – (Inexperienced Copilot) 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." [9] **Logic does not prevail at this point. Logic and thought require frontal lobe activity and at this point the hormone cortisol blocks the frontal lobe. It is important to note that at this point that the only way out of this situation is to reduce the stress so you are able to assess and solve the problem. That may require Robert to assume control until Bonin can think clearly.**

Almost as soon as Bonin – (Inexperienced Copilot) 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. [(10)] **We are trained to do this but our training is not repetitious enough to build unconscious habit patterns. It requires thought.**

The Airbus's stall alarm is designed to be impossible to ignore. [(11)] **That is an engineer's response. Tunnel hearing and auditory exclusion can ignore any level of sound if the stress level is high enough.** 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. [(12)] **If they had heard the stall warning I would expect to see some comment from the crew or an interruption in communications while they thought about it. I see no indication that they heard the warning.** Throughout, Bonin – (Inexperienced Copilot) will keep pulling back on the stick, the exact opposite of what he must do to recover from the stall.

02:10:07 Robert - (Experienced Copilot)
What's this?

02:10:15 Bonin – (Inexperienced Copilot)
There's no good... there's no good speed indication.

02:10:16 Robert - (Experienced Copilot)
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 - (Experienced Copilot) notices Bonin's – (Inexperienced Copilot) error and tries to correct him.

02:10:27 Robert - (Experienced Copilot)
Pay attention to your speed. Pay attention to your speed. [(13)] **Robert is obviously still able to focus and think but his communication to Bonin is not clear in exactly what he wants him to do. Bonin, under extreme stress, is unable to process subtle communications. Robert communicates clearer in the next few seconds.**

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

02:10:28 Bonin – (Inexperienced Copilot)
Okay, okay, I'm descending.

02:10:30 Robert - (Experienced Copilot)
Stabilize…

02:10:31 Bonin – (Inexperienced Copilot)
Yeah.

02:10:31 Robert - (Experienced Copilot)
Descend... It says we're going up... It says we're going up, so descend.

02:10:35 Bonin – (Inexperienced Copilot)
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 - (Experienced Copilot)
Descend!

02:10:37 Bonin – (Inexperienced Copilot)
Here we go, we're descending.

02:10:38 Robert - (Experienced Copilot)
Gently!

Bonin – (Inexperienced Copilot) 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. [(14)] **I feel that if Robert has assumed command at this time he would have been able to stabilize the aircraft and Bonin's stress level would have had a chance to subside. This did not happen.**

02:10:41 Bonin – (Inexperienced Copilot)
We're... yeah, we're in a climb.

Yet, still, Bonin – (Inexperienced Copilot) does not lower the nose. Recognizing the urgency of the situation, Robert - (Experienced Copilot) pushes a button to summon the captain.

02:10:49 Robert - (Experienced Copilot)
Damn it, where is he?

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 – (Inexperienced Copilot) 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. "You can't stall the airplane in normal law," says Godfrey Camilleri, a flight instructor who teaches Airbus 330 systems to US Airways pilots.

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. "Once you're in alternate law, you can stall the airplane," Camilleri says.

It's quite possible that Bonin – (Inexperienced Copilot) had never flown an airplane in alternate law, or understood its lack of restrictions. According to Camilleri, not one of US Airway's 17 Airbus 330s has ever been in alternate law. Therefore, Bonin – (Inexperienced Copilot) 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 - (Experienced Copilot)
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 – (Inexperienced Copilot)
I'm in TOGA, huh?

Bonin – (Inexperienced Copilot)'s statement here offers a crucial window into 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 – (Inexperienced Copilot) is trying to achieve the same effect: [(16)] **If this is Bonin's mental picture of what he wants to accomplish then it will become his default response. Under extreme stress he will persist in this default action and not other options will come to mind. You will see during the remainder of the flight he persists in this course of action.** 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 – (Inexperienced Copilot)'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 – (Inexperienced Copilot) 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 - (Experienced Copilot)
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 - (Experienced Copilot)
We still have the engines! What the hell is happening? I don't understand what's happening. [(17)] **This is a clear indication of hypervigilance and confusion in the high red or black zone.**

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 - (Experienced Copilot) has no idea that, despite their conversation about descending, Bonin – (Inexperienced Copilot) 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. [(18)] **This is a common observation or comment we see in many accident reports but it has a basic flaw from a human factor's perspective. The crew is unable to employ the principles of CRM because they are unable to think. Pilots who think CRM is great in emergencies need to understand that CRM, by its very definition, is the application of the principles of human factors. Human factors show us the limitations we suffer under stress.** 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 – (Inexperienced Copilot) 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 – (Inexperienced Copilot)
Damn it, I don't have control of the plane, I don't have control of the plane at all! [(19)]
Helplessness and desperation creep in at this level.

02:11:37 Robert - (Experienced Copilot)
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 – (Inexperienced Copilot) 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)
What the hell are you doing?

02:11:45 Bonin – (Inexperienced Copilot)
We've lost control of the plane!

02:11:47 Robert - (Experienced Copilot)
We've totally lost control of the plane. We don't understand at all... We've tried everything. [20] **You can hear the desperation in their voice and see their inability to be able to properly assess the situation. Their cognitive impairment at this point is total.**

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 - (Experienced Copilot)
What do you think? What do you think? What should we do?

02:12:15 (Captain)
Well, I don't know! [(21)] **I assume the Captain was caught by surprise and is also unable to think clearly at this point, regardless of his experience.**

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 – (Inexperienced Copilot) 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 - (Experienced Copilot) 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 – (Inexperienced Copilot) who continues to pull back. The nose remains high. [(22)] **With no clear communication, the difficulty in seeing the other crew members control inputs, and no physical feedback in the controls, each pilot persists in their default behavior. Note: The A330 control stick has a minimal range of movement, does not provide feedback to the other pilot, and since it is side mounted you have to clearly look at to see the other crew members stick..**

02:13:40 (Robert - (Experienced Copilot): *Climb... climb... climb... climb...*

02:13:40 (Bonin – (Inexperienced Copilot): *But I've had the stick back the whole time!*

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

02:13:42 (Captain): *No, no, no... Don't climb... no, no.*

02:13:43 (Robert - (Experienced Copilot): *Descend, then... Give me the controls... Give me the controls!*

Bonin – (Inexperienced Copilot) yields the controls, and Robert - (Experienced Copilot)

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 – (Inexperienced Copilot) once again takes back the controls and pulls his side stick all the way back. [(23)] **Bonin again persists in his course of action (pulling back on the stick) at the sound of the new alarm.**

02:14:23 (Robert - (Experienced Copilot): *Damn it, we're going to crash... This can't be happening!* [(24)] **Sadly it is happening but the mind does not want to go there (denial).**

02:14:25 (Bonin – (Inexperienced Copilot): *But what's happening?*

02:14:27 (Captain): *Ten degrees of pitch...*

Exactly 1.4 seconds later, the cockpit voice recorder stops.
