THE CRASH OF FLIGHT 90:

DOOMED BY SELF DECEPTION?

BY ROBERT TRIVERS AND HUEY P. NEWTON

Two biologists offer a startling interpretation: this tragic event, they say, was triggered by behavior that has evolved over eons as a survival tactic.

The following article is unsettling. The editors believe that its disturbing thesis may help us to understand why some disasters occur and enable us to place what is sometimes labeled negligence in a larger context. While some of the language of the story may seem brutally frank, the editors believe the story has a constructive purpose, and they feel only sympathy for the aircrew and the others who perished.

Seven months after a Tampa-bound Air Florida 737, Flight 90, slammed into a bridge and plunged into the Potomac River, killing 78 people, the National Transportation Safety Board reached its verdict. It attributed the crash to several factors. First, the crew failed to activate the anti-ice system of the plane's engines before takeoff. This in turn caused an engine-pressure-ratio (EPR) sensor to give false readings that registered more thrust than in fact was there. Also implicated were the pilot's decision to take off with snow and/or ice on the plane's wings and his failure to abort takeoff after being informed by the copilot (who was at the plane's controls) that the EPR readings were inconsistent with other instrument readings. The board also concluded that the pilot could have averted the crash by applying full thrust seconds after liftoff.

Air Florida has disputed these findings, charging that the crash was caused by a flaw in the design of the 737 that makes it pitch sharply and by "undetected and undetectable" ice that formed on the leading edge of Flight 90's wing.

Drs. Robert Trivers and Huey P. Newton, biologists at the University of California, Santa Cruz, have drawn a more startling conclusion after reviewing the available mechanism of self-deception, they say, doomed Flight 90. Their article offers a unique interpretation of a tragic event.

The benefit of self-deception is the more fluid deception of others. The cost is an impaired ability to deal with reality. Ultimately we measure the cost of self-deception by its negative effects on reproductive success and survival, but we are often far from able to make this final connection. One approach is to begin with a disaster and work backward, looking for evidence of a pattern of self-deception leading up to the event.

REALITY EVASION

Consider, for example, the crash of Flight 90, immediately after takeoff on January 13, 1982, during a heavy snowstorm. The transcript of the final 30 minutes of conversation between the pilot and copilot suggests a pattern of self-deception and reality evasion on the part of the pilot that contributed directly to the tragedy. By contrast, the copilot comes across as reality-oriented, but insufficiently strong in the face of his captain's self-deception. These are relatively crude characterizations, but useful to bear in mind as we try to capture the complex way in which patterns of self-deception may generate a human disaster.

Let us begin as the airplane is cleared for takeoff and its engines are fired up to head down the runway. It will roar down the runway for 47 seconds before reaching the speed at which the final decision must be made about whether to go or not. At any moment during this time the pilot can abort the flight safely. Ten seconds after starting

Then, four seconds later:

Copilot: That doesn't seem right, does it?

Three seconds later:

Copilot: Ah, that's not right.

Two seconds later:

Copilot: Well…

Two second later:

Pilot: Yes it is, there's 80.

It takes 11 seconds for the pilot to respond to the copilot. Apparently referring to an airspeed of 80 knots, he seeks to explain away the instrument readings that are troubling the copilot. This fails to satisfy the copilot, and one second later:

Copilot: Naw, I don't think that's right.

Nine seconds later, having received no support from the pilot, the copilot wavers:

Copilot: Ah, maybe it is.

Two seconds later, the pilot states the speed at which they are traveling:

Pilot: 120.

Two seconds later:

Copilot: I don't know.

Caught between his own doubts and the pilot's certainty, the copilot finally lapses into uncertainty. Eight seconds later, the pilot says "V-1." This is the go/no go decision speed. After this point, the flight can no longer be aborted safely because it would run out of runway. Now we note a striking reversal in the roles of the pilot and copilot. So far the copilot has done all the talking, the pilot only giving routine information. Now that they have passed the speed at which there committed to their course, the copilot no longer speaks, and the pilot speaks repeatedly. Two seconds after V-1, the pilot says "Easy." Four seconds later he says "V-2." This is the speed that you must maintain to clear the end of the runway if an engine fails. Two seconds later

signals an impending stall, is heard in the cockpit.

Six seconds later:

Pilot: Forward, forward.

Two seconds later:

Speaker undetermined: Easy.

One second later:

Pilot: We only want 500.

Two seconds later:

Pilot: Come on, forward.

Three seconds later:

Pilot: Forward.

Two seconds later:

Pilot: Just barely climb.

AVERT A STALL

The pilot is apparently urging the copilot to reduce the rate of climb to avert the stall. Before the pair were committed to the fatal flight, the pilot had little or nothing to say. Now that they have made their mistake, he comes out into the open and tries to reason. Four seconds later:

Speaker *undetermined: Stalling, we're falling.*

One second later:

Larry, we're going down, Larry.

One second later:

Pilot: I know it.

Almost simultaneously, the recorder picks up "sounds of impact."

The copilot did all his talking while it still mattered. At the end, he is only heard from telling his pilot what the pilot has been so reluctant to see: "Larry, we're going down, Larry." And the pilot finally says, " I know it."

The dichotomy between self-deceiver and reality-seeker was evident in earlier exchanges between the pilot and copilot as they sat in the cockpit together prior to departure in extremely cold weather and a driving snowstorm. A half hour before takeoff the following exchange took place"

Copilot: We're too heavy for the ice.

Copilot: They get a tractor with chains on it? They got one right over here.

He is referring to the unsuccessful efforts of a tractor to push the plane from the deicing and anti-icing position back to its runway position. The tractor has failed because of the icy ground.

Copilot: I'm surprised we couldn't power it out of here.

Pilot: Well, we could if he wanted me to pull some reverse.

The copilot is suggesting using the plane's own power to get back into position. The pilot replies that it could be done with reverse thrust. They try, but the attempt fails, and in the end a tractor with chains on does the job.

Just before takeoff, the condition of the winds is also considered. Given the seating arrangements in the cockpit, each man checks

Copilot: D'they get yours? Can you see your wingtip?

Pilot: I got a little on mine.

Copilot: This one's got about a quarter to half inch on it all the way.

We see that the self-deceiver gives an imprecise and diminutive answer concerning a danger, while the copilot gives precise description of the extent of the danger. The copilot also curses the snow, saying it is "probably the [expletive deleted] snow I've seen."

Seven minutes before takeoff:

Copilot: Boy, this is a losing battle here on trying on trying to deice those things, it gives you a false sense of security, that's all it does.

Pilot: That, ah, satisfies the Feds.

Copilot: Yeah---As good and crisp as the air is and no heavier than we are I'd…

Pilot: Right there is where the icing truck, they oughta have two of them, you pull right..

Before takeoff, pilot and copilot explore a fantasy about how ice should be removed from planes on the runway.

The pilot and copilot now explore a fantasy together on how the plane should be deiced just before takeoff on the runway. Note that the copilot begins with an accurate description of their situation; they have a false sense of security. The pilot notes that the arrangement satisfies the higher ups, but then switches the discussion to the way the system *should* work. This is not without its value and may, indeed lead to an improved system in the future, but in their immediate situation concentration on the general issue rather than diverted attention from the difficulties at hand.

Just before takeoff the copilot asks the pilot for advice on their next situation:

Copilot: Slushy runway, do you want me to do anything special for this or just go for it?

Pilot: Unless you got anything special you'd like to do.

Copilot: Unless just takeoff the nose wheel a little early like a soft field takeoff or something.

The pilot, to whose greater experience the copilot appears repeatedly to defer, has no help to offer on how to take off in these particular circumstances. This makes their final conversation all the more vivid. The copilot is at the controls of the plane. Having failed to give his copilot any advice and having failed to plan in the slightest for difficulty in takeoff, the pilot's only

the copilot who first calls attention to the strange instrument readings. It is the copilot who refers to them three times before the pilot responds to him.

The transcript suggests how easily the disaster could have been averted. Imagine that earlier conversations about the snow on the wings, the heavy weight of the airplane and the slushy conditions underfoot had induced a spirit of caution in both pilots. How easy it would have been for the pilot to say "Well, this is a somewhat tricky situation. I think we should take off with full speed but watch our instruments carefully, and if we fail to develop insufficient power, I think I should abort the takeoff." Yet the conversation never had a chance to turn in this direction, for every time the copilot approached the subject, the pilot chose either to not respond or to divert attention from the problem that they faced. Mechanisms of self-deception, having deprived him of even the most rudimentary advance planning, offer him a quick fix for the disturbing instrument readings and, after the fateful decision is made, a 10-second illusion that he may be able to get the airplane into the air safely.

Dr. Aaron Waters, a noted geologist and professor emeritus at the University of California, Santa Cruz, who has been a member of mountain rescue groups, responded to our account as follows (in a letter dated 2/23/82):

A DISTURBED FEELING

Your example of the Flight 90 crash, however, left a disturbed feeling about the way you wrote it up. You correctly blame the pilot for the crash, but maybe you do not bring out clearly enough that it was the pilot's complete insensitivity to the copilot's doubts, and to his veiled and timid pleas for help, that was at the root of all this trouble. The pilot, with much more experience, just sat there completely unaware and without any realization that the copilot was desperately asking for friendly advice and professional help. Even if he (the pilot) had gruffly grunted, "If you can't handle it, turn it over to me," such a response would have probably shot enough adrenaline into the copilot so that he would have either flown the mission successfully, or aborted it without accident.

From limited experience in mountain rescue work, and considerable experience with dangerous work in abandoned mines, I've found that the people who lead others into trouble are the hale and hearty insensitive jocks trying to show off. They cannot perceive that a companion is so terrified that he is about to "freeze" to the side of a cliff---and for very good reason. And once this has happened the one that led

think the copilot "froze" and immediately the pilot "froze" even worse and began talking to the airplane. However, the copilot is also at fault; left to himself he would have called the tower and not flown the mission, but in the presence of his companion he was guilty of self-deception.

The media have concentrated on the icing on the wings, but the master geologist sees a human parallel to the freezing weather. Each man, in turn, "freezes" in fright and the disaster is complete. The most recent evidence on the faulty instrument readings bears out Dr. Waters' interpretation. It is now known that the airplane was getting 25% *less* thrust than its instrument readings showed!

Like the weather, the copilot was cold prior to takeoff. By contrast, the pilot was cool—nothing was fazing him.

The takeoff consumed almost 17 seconds more time (and a greater length of the runway) than it should have. Had the pilot, in fact, aborted at the go/no-go speed, he would have run out of runway.

If the copilot was cold prior to takeoff, the pilot was positively "cool." Nothing fazed him. The situation in which he found himself was nothing new to his industry nor his company. In the previous September, for example, Air Florida's chief 737 pilot attached a 737 winter-flight note to the monthly Air Florida crew newsletter. He specifically warned of the dangers of winter flying at the more northerly airports. "Nobody can be *too* prepared for LaGuardia, O'Hare, White Plains, or Washington National." He told crews to look for snow and ice buildup and to arrange for as late an airframe dicing as practical: *"If heavy freezing precipitation exists, it may be necessary to get deiced again if significant ground delays occur"* (emphasis added). Nine airliners taking off before Flight 90 were deiced between 9 and 44 minutes before takeoff, but Flight 90 went 49 minutes its last deicing and anti-icing and takeoff.

We now see that the final discussion between pilot and copilot in a new light. Both the pilot and copilot know that their plane needs a second deicing, but instead of seeking it, the pilot leads them into a fantasy world in which they get their second deicing without losing their place in the line waiting to takeoff.

The American Airlines maintenance chief whose men serviced the Air Florida plane said he twice told the pilot that he should wait until just before takeoff before deicing; otherwise, the deicing fluid would cause wet snow to collect, which is precisely what happened. A picture taken of the plane just after deicing shows snow already covering the upper fuselage.

MOVING THE AIRCRAFT

The problem of snow and ice on the wings may have been compounded by the decision to use the plane's own power to try and move the aircraft back from the gate. This kind of casual incaution is exactly what one would expect from an "airplane jock." Certain types of adventurous men are especially prone to this form of self-deception. (Both the pilot (age 34) and the copilot (age 31) had been military pilots before turning to commercial work.)

The use of reverse thrust could have pushed the slush to the leading edge of the wings. This is precisely where ice and snow do the greatest damage. Indeed, in a 1980 bulletin, Boeing, the plane's manufacturer, had already warned against using 737 reversers during snowfalls. If reverse thrust *is* used, Boeing advised, the wing's edges should be cleared of any ice and snow. It can cause the plane's nose to "pitch up" too far at takeoff and roll to the side, threatening a stall. This is what seems to have happened to Flight 90.

A second consequence of using reverse thrust is that it may have caused snow to swirl up and block the sensors that caused the false readings on the amount of the engine thrust and speed of forward movement.

Superimposed on all this detailed information stands one obvious fact. On the mission in question the copilot was flying the plane. That is, he was playing the role of the pilot and the pilot, meanwhile, was playing the role of the copilot. This is intended to be educational for the copilot, since he thereby learns how to become a pilot, but the pilot is still in charge. In effect, he is to do two things at once: discharge the duties of the copilot while remaining responsible for the flight itself.

Did this confusion of roles contribute to the disaster? We believe it did. Had the pilot been flying the plane that day, we believe the chances for survival would have been better. The copilot shows himself to be a careful man. In this flight, he even discharges some of his customary duties, such as reading the instruments. By contrast, the pilot handles the airplane the way one might handle a horse, by seat-of-the-pants control. The pilot himself might have ignored the instrument readings, heading down runway at full speed as judged by his own body. In his split role he neither discharges the copilot's roll nor assumes full responsibility for the flight. Indeed, he repeatedly seeks to convey to the copilot the message that this is a routine flight, requiring nothing more than the usual self-confidence.

On the Air Florida flight, a natural question is "What were the potential benefits to the copilot of acquiescing to the pilot's self-deception? To answer this we would have to present detailed information on the way in which copilots are required to relate to their superiors. But we can speculate on the cost to the copilot of becoming known as a "chicken," someone too frightened to take on the role of a pilot when the circumstances are adverse.

Why did the pilot seem to have the illusion that overconfidence plus skill would always work in his favor?

What are the benefits of the pilot's self-deception? An analogy to fights in nature may be beneficial. When two animals are evenly matched in a fight, each will attempt to convince the other that the fight will go in his favor. As this time, a convincing false front may succeed in frightening away one's opponent. By contrast, when two fighters are poorly matched, a display of bravado by the underdog will carry little weight. Thus, we imagine that presenting a falsely positive front may often have been advantageous to the pilot prior to Flight 90, giving him the illusion that skill plus overconfidence works in all encounters. *Put another way, a pattern of self-deception can become ingrained through many small instances of positive feedback, thereby lulling the self-deceiver into the comfortable illusion that self-deception will always work in his favor.*

Summary

We have tried to show that the processes of self-deception, acting primarily in the pilot, contributed directly to the disaster of Flight 90. This pattern included insensitivity to numerous signals from the copilot and a confusion of roles between pilot and copilot. We conclude that the human element of self-deception is the main factor leading up to the disaster. This conclusion has implications for air safety and, by analogy, implications for our understanding of the way in which natural selection acts on processes of self-deception.

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