# Before the runway

**By Professor Sidney Dekker**

> **Editors Note:** This time, we decided to invite some comments on Professor Dekker's article from subject matter experts. Their responses follow the article.

We are at 2,000 feet, on approach to the airport. The big jet is on autopilot, docile, and responsively following the instructions I have put into the various computer systems. It follows the heading I gave it, and stays at the altitude I wanted it at. The weather is alright, but not great. Cloud base is around 1000 feet, there is mist, a cold drizzle. We should be on the ground in the next few minutes. I call for flaps, and the other pilot selects them for me. The jet starts slowing down. Then we come to the top of our approach. The autopilot nudges the nose of the jet downward, onto the glideslope towards the runway.

Then something strange happens. The thrust levers that control the power to the jet's two engines move all the way to the back to their idle stop. This is very little thrust for the situation we are in, not enough for keeping the jet aloft much longer. In a split second my eyes dart up to the computer display with the various mode annunciations, which tells me what mode the various automatic systems are operating in. The autopilot is doing what it is supposed to be doing; riding the glideslope to the runway.

However, the autothrottle is another story. This is the computer that helps control how much thrust goes out of the engines and it is in a mode that I have never seen in this situation before; fully retarded. My eyes flutter down onto the display with flight information. My airspeed is leaking out of the airplane as if the hull has been punctured, slowly deflating like a pricked balloon. It looks bizarre and scary and the split second seems to last for an eternity. Yet I have taught myself to act first and question later in situations like this.

So I act. After all, there is not a whole lot of air between me and the hard ground. I switch off the autothrottle and shove the thrust levers forward. From behind, I hear the engines screech, shrill and piercing. Airspeed picks up. I switch off the autopilot for good measure (or good riddance) and fly the jet down to the runway. It feels solid in my hands and docile again. We land. Then everything comes to a sudden standstill. The screens freeze, the world outside stops moving. We are in a simulator. "Nice work" says the instructor from his little pedestal behind the two pilot seats. I turn around and smile at him, knowing that he knows what I know.

At that very moment an accident was still being investigated on which the scenario was based. A big jet crashed short of the runway because, in a one-in-a-million chance, the autothrottle was tricked into a wrong mode by some rare indication failure of the airplane's altimeter system. The radar altimeter erroneously told the autothrottle that the jet was on the ground (even though, pertinently, it was not) and that it was time to retard the thrust levers and to pull the power.

However, the autothrottle computer never bothered to tell the autopilot about its intentions. The autopilot was happily doing its thing, riding down the glideslope to the runway, blissfully unaware that the other computer system had just robbed it of the only factor responsible for being able to fly at all: airspeed. None of the books available to pilots about this jet ever revealed this possibility. As far as most pilots were concerned, it was an unknown-unknown.

But no more. Here I was sitting in a simulator for a regular four-hour proficiency session to keep my rating valid. The

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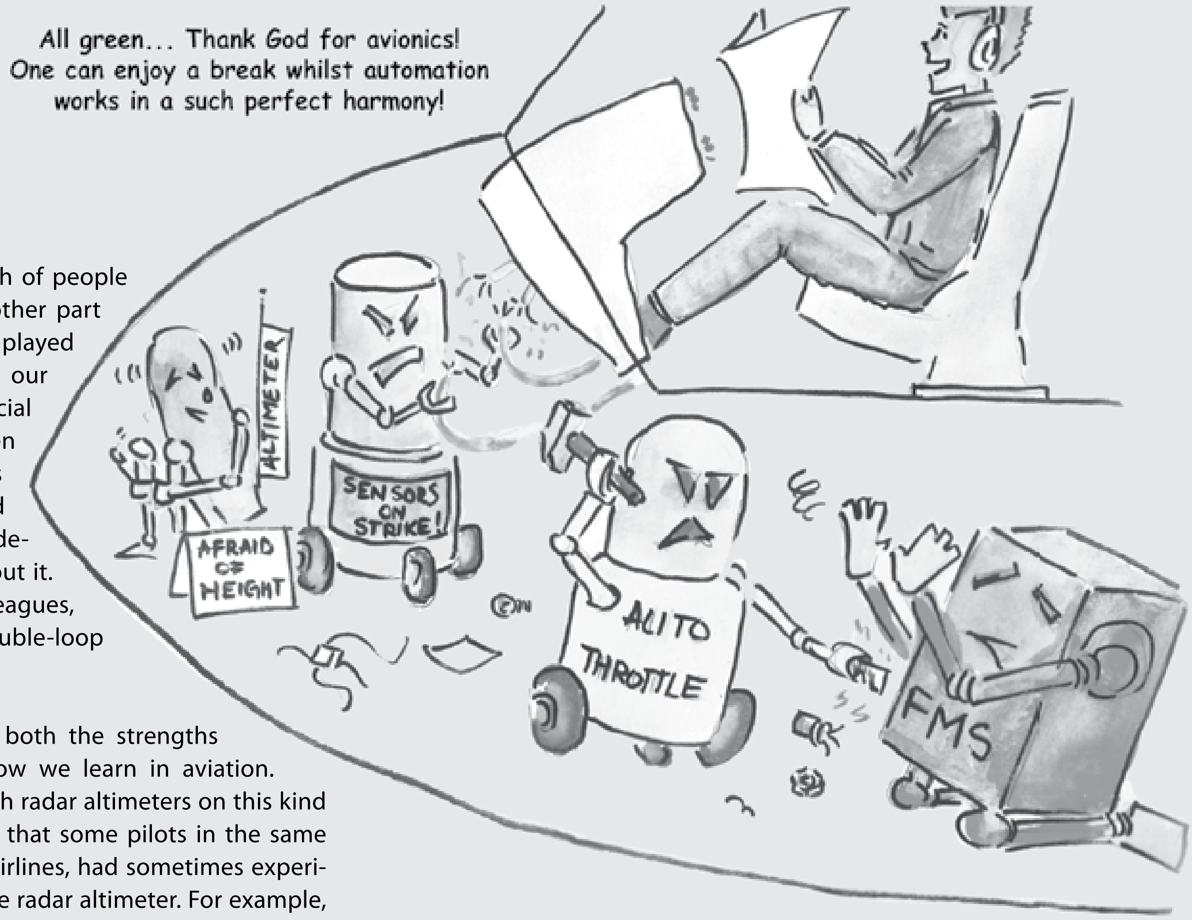
**Professor Sidney Dekker** is Professor of Human Factors & Aviation Safety at Lund University in Sweden.

He gained his Ph.D in Cognitive Systems Engineering at the Ohio State University in the US.

His books include "The Field Guide to Human Error Investigations" and "Ten Questions about Human Error". His latest book is "Just Culture: Balancing Safety and Accountability".

He flies as a First Officer on B737NG.




scenario that killed a bunch of people in the same jet but in another part of the world was being played through our flight, into our hands and minds. The official accident report was not even out yet, but plenty of pilots had realised that this could be really hazardous and decided to do something about it. For themselves, their colleagues, everybody. Now that is double-loop learning.

Yet the accident revealed both the strengths and the weaknesses of how we learn in aviation. There had been trouble with radar altimeters on this kind of jet before. It turned out that some pilots in the same airline, as well as in other airlines, had sometimes experienced funny things with the radar altimeter. For example, spurious warnings about proximity to the ground would be triggered. In some cases, even the autothrottle would go into the wrong mode. But the failures would never repeat themselves on the next leg of the trip. They were impossible to recreate on the ground.

Also, on the accident flight, the jet was turned onto the localizer less then five miles before the runway and kept at 2000 feet, so it got stuck above the glideslope. When finally given clearance to descend with the ILS (which by then needed to be captured from above), the autothrottle retard made the airplane do exactly what the crew wanted: go down and slow down (which, in this jet, is really hard to do at the same time, by the way). The jet's behaviour masked the autothrottle retard problem until it was too late for the crew to recover.

It turned out that at this airport, tight line-ups are very normal. In fact, compared to some approaches even that very morning, the accident aircraft got a relatively long final. The official rules and guidelines for ILS approaches by the ANSP had not been followed for more than a decade (deviance was normal). Never mind the 5-mile minimum line-up. We do it everyday. It's the way we teach it. It's called a job and pilots appreciate us doing it.

But if an unknown is unknown, or the deviant has become normal, then the symptoms of trouble may go unrecognised. Hey, they landed without incident, right? No harm, no incident. At best, as a pilot you sit in the crew bus after the flight and say, "Boy, that final was a little tight today, wasn't it?" But if there is no close call, there is no report from anyone.

This is one of the biggest challenges for learning in aviation: how do we decide what counts as bad news? Learning after nine people are dead is one thing, but what is "near" enough to a bad outcome to count as a close call, as something that should be reported? People are expert at adapting their readings of risk so as to make the world look more normal, less hazardous. Norms for what counts as risky get renegotiated the whole time, particularly as operational experience with a procedure accumulates. Base to a three and a half-mile final for a 747? No problem, we do it all the time. And if he can do it, a four-mile final for a 737 should be a piece of cake. It is called production at this airport. It is, however, the kind of normalisation of deviance ("oh, we've seen this before, it's OK.") that eventually brings an unsuspecting jet with a funky radio altimeter down before the runway, rather than on it.

All the data from the accident in question here are from the official published accident report only.

**See http://www.skybrary.aero/bookshelf/books/1175.pdf** ▸

# Responses and comments from experts

## [1] A formal response from ATC The Netherlands

**by Job Brüggen, Safety Manager**

Sidney's account addresses a well known aspect which is called "drift into failure'. By absence of any mishaps the ongoing activities are declared as safe and risk barriers can slowly erode. If we are not constantly and credibly reminded of hazards, we tend to think the hazard is non-existent. Sidney's account nicely paints the picture for this with his bus ride at the airport where the crew decides not to file an ASR about a particular short line-up. The accident of a 737-800 that crashed on final approach because of lack of airspeed serves as a sad reminder of how many small contributions can turn an otherwise normal flight into a tragedy. The full report about this from the Accident Investigation Board (AIB) is publicly available .

The flight was a Line Flight Under Supervision with the Captain acting as instructor, the First officer acting under supervision and a third pilot acting as safety pilot. Whilst the AIB report about the accident is a long account of what happened, the report does little to help understand the behaviour in the cockpit. The captain actively calls "one thousand", as audible proof that he was indeed monitoring the altitude, yet it is not understood why he does not command a missed approach as the aircraft is not in a stable approach. Maybe he thought things would be working out okay? Not unlikely: at 1000 ft the autopilot was nicely tracking the glide slope and localizer, he had set the right speed on the autothrottle and although a little fast still, he may have expected the aircraft to settle on this reference speed. But at 500 ft, 33 knots (!) below his reference speed, with an unusual nose-up attitude, elevator trim visibly and audibly running to compensate, thrust levers at full retard, speed tape flashing, there can be little doubt about being in a non-stable approach. Thanks to the investigation report, we are made aware of how a technical failure in the aircraft, combined with a lack of awareness by the crew, joins up with an approach that puts the aircraft above the glide slope, which in turn partly masks the technical failure of the aircraft. But why were these experienced captains and two colleague pilots not responding to this (in hindsight) obvious threat?

This question mark is so enormous that, in absence of any suitable explanations, one may feel compelled to look for other clarifications. Here is where Sidney suggestively redresses the contributing factors in this accident as primary causes and without wanting to downplay the contributing factors of course, it is better to refer to the accident report: the principal cause of the crash was lack of airspeed on approach and subsequent stall.

Evidently, this aspect has been picked up by some airlines as shown by Sidney's simulator ride and put this aspect into their training programs. This seems a good and reasonable response to otherwise unexplained events. Although airlines cannot possibly fully understand what happened: better safe than sorry.

On the navigation support side, the ANSP is now undertaking renewed research into 'stabilised approaches' and the contributing role of the ANSP to achieve this. A stabilised approach is an important enabler to achieve consistently safe landings. Not without reason, this is a crucial requirement within all IOSA registered airlines. Efforts are underway to analyze how the ANSP can further support this requirement by putting in extra safety barriers and make another small step towards even better achievement of stabilised approaches.

## [2] Comment from a Pilot perspective

**by Captain Ed Pooley**

Usually I enjoy reading Professor Dekker's human factors take on flying commercial aircraft. However, following an advanced opportunity to read his column this time, I offer what I believe is a more realistic examination of the pre-crash sequence.

If we forget for a moment the minor initiating malfunction of a radio altimeter, and that it had a long and not too illustrious history, we are left with a complete failure by any of the three flight crew to individually notice that the aircraft was attempting to stay airborne with idle thrust set. Since none of them noticed as individuals, CRM was not going to be relevant. So what did they all apparently not notice over a significant period on an undemanding Cat 1 ILS approach being flown to a non-limiting runway? Well, two things really stand out. Firstly, idle N1 (thrust), idle fuel flow and a steadily decreasing indicated airspeed must all, yes all, not have been 'noticed'. Secondly, the most abnormal aircraft attitude which began to develop as the aircraft tried to stay on the ILS glide slope with only idle thrust and the usual drag items (landing gear, trailing edge flaps) deployed, could not have been noticed either. Despite this drift into failure, the situation was still recoverable even when the stick shaker activated, if the response had been timely - but unfortunately it wasn't.

I will briefly return to the radio altimeter failure. Even without a history of malfunction on the accident aircraft being unrecorded and improperly dealt with, the radio altimeter has always been recognised as an instrument which, if it malfunctions, is probably going to affect other systems too. The fact that the failed system fed the auto throttle should have been readily within the possibilities reviewed by the crew, even if they were not specifically alerted to it by reading a specific

QRH drill. And besides, a design which normally links the left hand radio altimeter to the single auto throttle is entirely intuitive, as is the linking of each autopilot to its corresponding radio altimeter.

It is also worth observing that this was a line training flight for the First officer and a Safety Pilot was occupying the supernumerary crew seat and this should have lessened the chances of a prolonged failure to recognise that the aircraft energy state was not sustainable. Three pairs of eyes, including a pair of trainee's eyes, are usually thought to at least restore the margin of safety to the normal case of two fully qualified pilots.

Indeed, the short turn on and closure of the ILS glide slope from above may not be ideal, but it is well within the world of reality. Let's not forget that any pilot must be ready to decline any clearance which they believe will lead to an undesirable safety-related outcome.

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None of this interferes with the theme of 'inevitability' which comes across in Professor Dekker's piece which is over-focused on the role of the initiating radio altimeter malfunction (which the crew were aware of) and provides, at best, a rather idiosyncratic view of the descent into disaster and at worst, a rather irrational one. I will close by quoting from the Official Report :

*"When the aircraft passed 1000 ft height, the approach was not stabilised so the crew should have initiated a go around… As the airspeed continued to drop, the aircraft's pitch attitude kept increasing. The crew failed to recognise the airspeed decay and the pitch increase until the moment the stick shaker was activated. Subsequently the approach to stall recovery procedure was not executed properly, causing the aircraft to stall and crash." It was also noted that "despite the indications in the cockpit, the cockpit crew did not notice the too big decrease in airspeed until the approach to stall warning. With the cockpit crew - including the safety pilot - working to complete the landing checklist, no one was focusing on the primary task: monitoring the flight path and the airspeed of the aircraft. It can thus (also) be concluded that the system based around the presence of a safety pilot on board….did not function effectively".*

## [3] Comment from an ATCO perspective

**by Bert Ruitenberg**

On the plus side, there is nothing in the text that is not addressed in the official report (albeit in other words). On the minus side, I think Sidney is too easily accepting statements from the report with respect to what is the "normal" way of working at EHAM.

The line up given to the accident aircraft was never an intentional "short line up". It just ended up intercepting the LLZ a mile closer to touchdown than expected - which may be a result of the timing of the turn-to-intercept instruction, or of the turn rate applied by the pilots, or a combination of the two.

For a "short line up" an aircraft at EHAM is normally vectored for an interception even closer to touchdown (4.5 to 5 NM) and given descent to 1200ft after passing the CTR boundary. Some aircraft were given such an approach that morning, but not the accident aircraft. The preceding aircraft was a Heavy, after which a 5NM minimal separation is required, and that is not a situation in which a controller will consider a "short line up" for the next aircraft in a busy sequence. (And yes, the report confirms that the 5NM wake turbulence separation minimum was not breached with the accident aircraft.)

What I accept to be correct in Sidney's text is that at EHAM, the controllers have drifted into believing that vectoring aircraft to intercept the LLZ close to the GP interception point is normal, rather than giving them a 2NM level flight on the LLZ before the GP comes in (as is stated in the procedures). This "modified" interception point however is more or less the position that pilots fly to themselves when they are cleared for a "do it yourself" ILS interception. Furthermore, pilots (when asked) often indicate that "a 6NM final is "sufficient", so controllers have adapted their vectoring accordingly over the years. I suppose a psychologist could rightly call this "normalisation of deviance".

In the simulator Sidney quickly detected the anomaly between the two automated systems, yet in the accident aircraft three pilots sadly did not respond timely to similar clues on the flight deck. Not reacting to anomalous calls and signals from a radar altimeter "because it does that all the time" is I guess another example of "normalisation of deviance".

In my opinion, the real message from Sidney's text is that both controllers and pilots need a more comprehensive understanding of the importance of stabilised approaches.