Close interactions of

by Loukia Loukopoulos and Immanuel Barshi

Note: this article is based on voluntary reports by pilots and air traffic controllers to NASA's Aviation Safety Reporting System (ASRS), which give the reporters' perspective on events that they believe compromised safety. As such, it refers to flight operations that take place in the United States national airspace system.

The relationship between a pilot and a controller is a complicated one. It is critically intimate, yet pragmatically distant. It is built on mutual trust, yet cannot afford blind reliance. Safely seated at his or her station inside a building, the air traffic controller issues instructions and clearances to the pilot of an aircraft way up in the sky, often many miles away. The interaction, which often lasts no more than just a couple of minutes, is highly proceduralised. And yet, despite its highly critical function of getting an aircraft safely to or away from the ground, and the fact that it is carried out between experts, conscientious professionals, there are occasions when this interaction goes wrong. When it does, it compromises the integrity of a flight and potentially puts an aircraft (and its crew and passengers) dangerously close to an accident. Let's examine three such cases:

Case 1. Captain (pilot flying) reporting: *"On descent into ATL on the CANUK Seven… we were asked to keep our speed up … [and] given the clearance to cross CANUK at 12,000 ft at 250 kts. We began our descent to comply with the restriction. Approximately 30 miles from CANUK, …our clearance [was revised] to level at FL230. Our descent rate was close to 4000 ft/min. [There was] no way we could level at FL230… [the PM] transmitted "Unable to comply"… as we descended through FL210…*

[ASRS 878704, March 2010, B757, IFR on descent]

the disconnected kind

While flying into a busy airport, the crew of this aircraft, is expecting (per the published procedure) to cross CANUK "at 14,000 or as assigned by ATC." Having let the aircraft automation calculate the optimal path to the 14,000 ft restriction (in line with company policy), the crew is letting the autopilot determine the appropriate angle and speed that will bring the aircraft to CANUK, at the right altitude and the right speed. The controller, concerned with managing the flow of traffic, perhaps also in an effort to help the aircraft arrive sooner at its destination, issues a new instruction. This instruction requires the aircraft to reach a lower altitude sooner, something that requires a steeper descent. When the controller reacts to changes in the traffic flow, however, and issues a different level-off altitude, the aircraft is in a high rate of descent – so much so that the crew hardly has time to respond to the controller that it will not be able to comply with the new instruction before the aircraft has already passed the desired level-off altitude by 2,000 ft.

An aircraft in motion has a lot of momentum and high inertia. The faster it moves, the harder it is to change its direction and the more time, space, and distance it requires to change or arrest its movement. It is also possible that during steep climbs and descents, the controller's display of the aircraft altitude could be misleading because the altitude encoder on the aircraft's transponder lags behind the actual altitude.

Case 2. Captain (pilot monitoring) reporting: *"We were descending…with clearance to descend via. We did not get a runway (24R) until almost the end of the STAR … I selected the runway and the transition, but could not close the discontinuity that showed up on the flight management computer. The pilot flying reselected the same and executed. We both then realized ENGLI was behind us and LNAV had disengaged… Since this was a [Boeing 737]-500 without a moving map, I relied on the FMC to know which fixes the aircraft had already passed. .. About the same time, ATC gave us a vector and cleared us direct to KONZL. We then flew the ILS 24R uneventfully to a landing."*

[ASRS 929900, January 2011, B737-500, IFR on Descent]

Long before reaching the top of descent point, the crew has entered the designated arrival route (STAR) in the flight computer and has (in line with company policy) selected the appropriate autopilot mode (LNAV), which is now taking the aircraft through the designated waypoints in compliance with the necessary path and speed restrictions. The only piece of information that is still missing is the tail end of the arrival, the approach and landing information. As soon as the controller provides that, the pilot monitoring attempts (in line with company procedure) to enter that information in the aircraft's flight management computer, so that the aircraft automation can continue leading the aircraft to a safe landing. Without the quick awareness afforded by a moving map, such as the one available on later generation aircraft of the same type and model, the crew wastes valuable time (and undoubtedly experiences frustration) by attempting to enter "invalid" information into the computer. In fact, the aircraft autopilot has already (in accordance with its design) "dropped" the commanded automation mode in response to the invalid information, and the aircraft automation is not in the mode the crew expects.

The crew relies on the approach controller to provide timely information, and also relies on the automation to the point of not always paying careful attention to their location and path. Both ATC and the automation are so reliable so much of the time that pilots are sometimes lulled into over-reliance. An early issue of the approach and runway clearance would have saved the crew from fighting the automation. But so would have more careful attention to their actual path and location.

Loukia Loukopoulos

is an aviation human factors specialist with a PhD in Cognitive Psychology from the University of Massachusetts (USA) and an Aerospace Experimental Psychology designation from the United States Navy. Her research focuses on flight crew performance during routine operations and particularly on multitasking situations. She has worked at NASA Ames Research Center and has just accepted a position as Manager, Human Performance & Systems at Swiss International Air Lines.

Many airlines now require their pilots to engage the automation to the full and to make all adjustments to flight path via the flight management computer. Yet, although its proper use can lead to an accurate and efficient flight, its programming can present the crew with substantial workload.

Case 3. Captain (pilot flying) reporting: *"We were cleared for [the] approach and to land on runway 21... Citation traffic ahead touched down and was asked to hold short of [the] south runway for departing flight... Tower then … instructed the Citation to back taxi on runway 21 [so as] to turn off at one of the taxiways that they had already passed. At this point we were 300 feet above the ground within a mile to touchdown… We were in the process of beginning a go-around when Tower instructed us to cancel landing and climb to 4,000 feet."*

[ASRS 885498, April 2010, IFR on initial approach]

The final approach to land phase is a busy time for pilots even if all goes according to plan. For many pilots, a go-around, especially one that has not been anticipated, is a potentially stressful time despite their simulator training. As a consequence, it is not unknown for pilots to exceed speed and altitude restrictions on a go-around, since many modern jet aircraft require the initial selection of a great deal more thrust than the crew is expecting (or used to). At busy airports, where the controllers work hard to sequence arrivals and departures carefully, a single go-around can mess up many good plans. This may be an unanticipated consequence of the effects on the pilots of late changes or it might be a direct and almost inevitable consequence of an ill-judged back taxi clearance in the face of traffic on short final.

It is not the point of these selected cases to say that controllers or pilots make mistakes (which they, like all humans, undoubtedly make). The point is to illustrate that, to a certain degree, the intimacy of the relationship between controllers and pilots can also be accompanied by a paradoxical disconnect. This disconnect stems from the fact that controllers don't always know enough about aircraft and pilots' capabilities and limitations, or about the demands and constraints of the cockpit as an operational environment. Other than its make and model, what else does the controller really know about the flight capabilities of the aircraft s/he is controlling? Other than the airline's name, what does the controller know about the policies and procedures the pilots must comply with?

The actions of the controllers (and their repercussions) in the cases cited above have a direct relevance to these questions. These controllers cannot tell whether the crew is using the aircraft automation to guide the aircraft, and if so, at what level. Different air carriers have different policies regarding use of automation, and different pilots, to the extent that they can exercise discretion, have different preferences for when and how to use the automation. Different aircraft, even of the same model, "wear" different technologies so controllers cannot know whether every aircraft of the same type necessarily has, say, a moving map display on board. Controllers have a generally good understanding (mostly built through experience) about differences in descent capabilities of, say a Boeing 737 versus an Airbus A320 - as a function of aircraft design - but lack more in-depth knowledge about speed, altitude, or other criteria dictated by air carrier policies that would affect the details of how the particular aircraft is flown and what instructions the crew can comply with.

As a result, whether it is the outcome of a sincere intention to help (expedite traffic, assign a requested runway, etc.), or of an intense focus on the ultimate goal of managing complex traffic flows from their radar scope, controllers sometimes make judgments and calls that inadvertently introduce risk to a flight. Drastic, unexpected changes in altitude level-offs, landing runway changes with little notice, late runway assignments, and other such instructions on approach may introduce considerable extra workload in highly automated aircraft (reprogramming of the computer, reviewing charts, re-briefing, assuring compliance with stabilised approach criteria, conducting checklists, etc.). Sometimes, an early decision to perform a go-around may be the best option. Leaving a go-around until nearer the ground in the hope that the necessary pilot response to late changes can be completed can end up making the task more difficult, especially if the flight crew rarely experiences go-arounds. There is also the concern felt by some passengers as the expected imminent touch-down suddenly changes to a steep climb.

Pilots are frustrated when such interaction disconnects occur. In their own words:

Case 1: *"My only thoughts as to how this happened … [was the] controller's failure to understand [the] aircraft level-off capabilities."*

Case 2: *"ATC should give us more time to program the correct runway arrival."*

Case 3: *"From our perspective, ATC failed to have adequate awareness of the traffic they were controlling. In the future, I think back taxis should only be allowed if there is no conflicting landing traffic within 10 miles."*

The issue is not new. Recommendations have been produced[1] to help address certain aspects of this disconnect, and the subject of stabilised aircraft approaches has been presented specifically for controllers[2]. There have also been efforts to alleviate such disconnects through familiarisation programmes that encourage controllers to ride the "jump seat" and gain a view of operations from "the other side." Such programmes were suspended in the USA after the 2001 terrorist attacks but they were due to be reinstated this year. Based on our own research, we are passionate believers in focusing any type of training on real-world operations. It would therefore be interesting to explore the actual level of participation in such familiarisation/ training programs, as well as to examine just how they are structured and what elements and means would be required to really acquaint controllers with aspects of operations that are critical to their jobs and that could alleviate the occasional disconnects. S

Immanuel Barshi

Immanuel Barshi is a Senior Principal Investigator in the Human Systems Integration Division at NASA Ames Research Center in California, USA. His current research addresses cognitive issues involved in the skilled performance of astronauts and pilots, as well as mission controllers and air traffic controllers, their ability to manage challenging situations, and their vulnerability to error. Dr. Barshi holds PhDs in Linguistics and in Cognitive Psychology. He holds an Airline Transport Pilot certificate with A320, A330, B737, and CE500 Type Ratings; he is also a certified flight instructor for airplanes and helicopters, with over 35 years of flight experience.

1- Effective Pilot / Controller Communications. Airbus Flight Operations Briefing Notes. Available at http://www.skybrary.aero/bookshelf/books/172.pdf

2- Stabilized Stabilised Approach Awareness Toolkit for ATC. Developed jointly by the Civil Air Navigation Services Organisation (CANSO), the Flight Safety Foundation, EUROCONTROL and Cotswold Airport. Available at http://www.skybrary.aero/index.php/Solutions:Stabilised_Approach_Awareness_Toolkit_for_ATC