**Most accident investigators lack the tools and training to analyze language-related factors in aviation accidents.**

# Language Gap

**First of Two Parts**

BY ELIZABETH MATHEWS

Did language proficiency and language use play a contributory role in the 2006 collision of an Embraer Legacy 600 and a Boeing 737-800 over the Amazon rain forest? A linguistic analysis of the evidence provided in the accident investigation reports suggests that a number of subtle — but significant — language factors helped create an atmosphere in which a series of communication failures were allowed to develop.

However, most accident investigations — and this one was no exception — do not adequately examine language factors because accident investigators typically do not have the background training required to perceive any but the most blatant language errors.

The Brazilian Aeronautical Accident Investigation and Prevention Center (CENIPA) led the investigation of the Sept. 29, 2006, collision of the Legacy — just purchased by ExcelAire Services, a U.S. charter and aircraft management company — and the Gol Transportes Aéreos Boeing 737. The accident killed all 154 people in the 737; the seven people in the damaged, but still controllable, Legacy were uninjured (*ASW*, 2/09, p. 11).

CENIPA, in its final report on the accident, said the loss of situational awareness by the

Legacy pilots and by the air traffic controllers was among factors leading to the midair collision. The U.S. National Transportation Safety Board (NTSB) questioned some of the report's findings and published its own summary and comments about the accident.[1]

The CENIPA report is particularly lengthy and detailed, not unexpected for an investigation of an accident that had required an extraordinarily intricate chain of unlikely events to link up so precisely that a breach in the multilayered safety wall opened.

On the other hand, interrupting that chain of events may have been as simple as an air traffic controller saying to the Legacy pilots, "N600XL, check your transponder."

## Unanswered Questions

Accidents are almost never the result of one single error. The CENIPA report and the NTSB responses detail a complex host of factors that led the American, English-speaking pilots ferrying the new Legacy business jet from São Paulo, Brazil, to Fort Lauderdale, Florida, U.S., by way of Manaus to fly a northwest heading at 37,000 ft — on a collision course with the 737 — on a route on which northbound aircraft normally fly at 36,000 or 38,000 ft. One significant factor was air traffic control's (ATC's) loss of the transponder replies from the Legacy, approximately 54 minutes before the collision. The cause of the loss of the transmissions is unclear, but the investigation teams, after rigorously testing multiple theories, finally concluded that the pilots had most likely inadvertently shut off their transponder. Additionally, CENIPA found that distractions on the flight deck interfered with the crew's duties to monitor their instruments and maintain an awareness of ATC communications.

One question left unanswered concerns the controllers' response to the transponder failure. CENIPA noted that ATC "did not perform the procedures prescribed to contact the aircraft when the transponder signal transmission was interrupted, a contact which was mandatory for the maintenance of the aircraft under RVSM [reduced vertical separation minimum] vertical separation parameters."

What is not clear is why air traffic controllers who noticed the loss of the transponder transmissions did not notify the pilots. In its summary response to the CENIPA report, the NTSB said that the "basic investigative question centers on how the primary mission of ATC to separate aircraft was unsuccessful," finding that ATC did not take adequate action to correct a known lost communication situation with the Legacy, and that inadequate communication between ATC and the flight crew was a contributory factor in the accident. The NTSB also said that the causes behind this failure were not "sufficiently supported [in the CENIPA report] with analysis or reflected in the conclusions or cause of the accident."

Inadequate communication between ATC and the pilots of a Legacy 600 was found to be a contributing factor in the midair collision that sent a 737 into the Brazilian rain forest.

AP photo/Brazilian Air Force

This review intends to take up where the CENIPA report left off and to move in a direction suggested by the NTSB: to provide a more careful linguistic analysis of the evidence for "inadequate communication between ATC and the [Embraer] flight crew" that was determined to have been a contributory factor.

## Language Factors

A hallmark of aviation accident investigations is that they are generally meticulous and thorough. Trained and experienced specialists methodically gather information and evidence according to published protocols. The information is analyzed by technical specialists, and the team draws conclusions about the likely causes of the accident, based on the best interpretation of the evidence gathered.

There was no failure in CENIPA's willingness to look at all issues, including possible language factors, in this accident, and the agency said, "It is important to analyze the attempts to communicate made by both sides."

CENIPA reported the communication failures involving the controllers and the pilots of the business jet and their linguistic challenges. Nonetheless, a systematic linguistic review of all the information available in the report uncovers a disparity between how language proficiency as a possible factor in this accident was investigated, compared with the deliberate, more intensive, and expert investigation of other human and operational factors. For example, a number of hypotheses to explain the loss of the transponder signal were systematically tested, with the procedures and results detailed in more than eight pages of the report. In contrast, language proficiency and communication as a possible contributory factor does not appear to have been formally, systematically or expertly addressed.

As a result, it remains unclear how language interacted with other factors to — as the report said — "generate a scenario favorable to the collision" over the Amazon.

A linguistic review of the evidence provided in the accident reports suggests that language use was a more significant factor in the chain of events leading to this accident than the accident investigation teams were able to uncover. Just as the purpose of aviation accident investigations is not to assign blame, neither is the purpose of this review to criticize the accident investigation or the reports.

Language use as a contributory factor has been inadequately investigated in this — and most — accidents, precisely because language is complex, because the impact of language factors often can be subtle, and because accident investigators typically have neither the tools nor the training to systematically probe, uncover, and analyze possible language-related factors in aviation accidents and incidents. As a result, safety gaps involving language are inadequately addressed.

## Review of Reports

One of the challenges to identifying and analyzing possible language factors in accidents is that references to language are not standardized and are often included under the too-broad category of "communications," whereas communications can include a host of issues unrelated to language use, such as poor radio reception.

In the CENIPA report, there are approximately 28 references to language, language proficiency or communications.

Two of the more than 60 safety recommendations in the CENIPA report correspond to language proficiency:

- The Airspace Control Department shall ensure that all "controllers have the required level of English language proficiency, as well as provide the means for that purpose"; and,
- The Department of Teaching shall "establish a minimum level of proficiency relative to the English language."

The CENIPA report said that "communications between the control units and the [Legacy] crew presented failures," which were grouped as follows: configuration of the controller's console; standard phraseology, as specified by the International Civil Aviation Organization (ICAO); English language phraseology; operational procedures; and organizational problems.

At the time of the accident, the report says, the most recent English test of the air traffic controllers at the Airspace Control Detachment of São José dos Campos was reported to have been administered in 2003, with five controllers earning "non-satisfactory" results, one scoring "satisfactory within minima," and three self-reporting difficulties in the English language. The information regarding controller English language proficiency is unclear and non-standardized.

No information on English proficiency was reported for the Sector 5 controller who transferred control of the Legacy to Sector 7 at what CENIPA and NTSB agreed was an exceptionally early point, a fact highlighted as a latent failure in the events leading to the accident.

The report included little information on the language proficiency of the

pilots. However, the document noted that GOL requires a high level of English proficiency as part of its pilot selection process and that the first officer on the business jet reported "difficulties with the ATC use of the English language."

The report documented that both the controllers and the business jet pilots failed to communicate key information appropriately.

A miscommunication between the pilots and the controller at São José ground control is identified as the "first failure in communication between the pilots and air traffic control." The report added, "An insufficient training of the standard phraseology and the English language was clearly observed in the communications between São José ground and [the Legacy]. This insufficient training was also noticed in other phases of the flight."

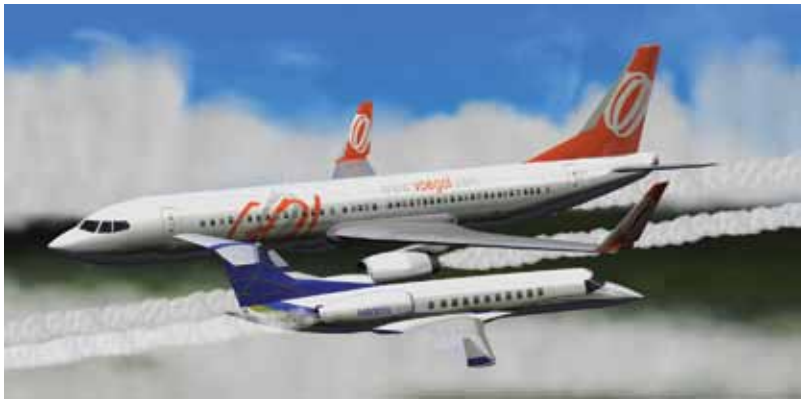
The communication gap involving the São José ground controller centered on the delivery of the clearance information. The CENIPA report said, "Another problem … relates to the English language phraseology. On two different occasions, the [Legacy] crew tried to learn the altitude to be maintained at the OREN SID [the OREN standard instrument departure], but the pilot did not get a correct answer from the ATC unit."

The report also cited an earlier apparent problem in communication, when the ground controller at São José "said that later on, when reading the transcription of the communications with [the Legacy], he noticed that the pilot did not understand 'Pocos de Caldas' [a city in southwestern Brazil]. Nevertheless, the pilot accepted the instruction."

The CENIPA report said that the crew dynamics of the Legacy pilots were a significant factor in the accident, and that of special significance was the crew's "lack of concern with the air traffic control communications." The crew flew for 57 minutes without establishing or receiving any ATC communications, the report said.

CENIPA found that "the lack of situational awareness also contributed to the crew's not realizing that they had a communication problem with the ATC," the report said. "Although they were maintaining the last flight level authorized by the [Brasilia Area Control Center], they spent almost an hour flying at a nonstandard flight level for the heading being flown, and did not ask for any confirmation from the ATC."

Regarding ATC communication to the Legacy, CENIPA and the NTSB agreed that a number of critically important communications should have occurred but did not:



- ATC did not issue a level change instruction when the airplane crossed the Brasilia VHF omnidirectional radio (VOR);
- ATC did not notify the Legacy's pilots of the lost transponder signal;
- ATC did not provide the separation required in response to loss of transponder in RVSM situations; and;
- ATC did not take adequate action to correct a known lost communication situation with the Legacy.

Language factors likely were at play when the Legacy crew was not informed about the loss of their transponder signal and remained at an improper altitude for almost an hour before colliding with the 737.

A related factor, determined to be a latent failure, was that the Sector 5 controller handed off the Legacy crew to the next sector at an unusually early point, well before the aircraft crossed the Brasilia VOR — the point at which the level change was scheduled to occur — and 60 nm (111 km ) before the sector boundary.

In addition to the communication and language factors identified by CENIPA, an analysis of the cockpit voice recorder data uncovered other linguistic anomalies not highlighted in the report.

Photo Illustration/Wikimedia

For example, a routine exchange with the Sector 5 controller revealed brief but compelling evidence of probable English language insufficiency. Although the message was brief and consisted entirely of routine phraseology (so that it should be very familiar to the controller), the controller stammered and repeated himself, compounding the challenge to understanding English spoken with an accent not easily understood by the Legacy pilots.

In response, although the Legacy first officer replied, "Roger, radar contact," the area cockpit voice recording registered the pilot's expression of frustration: "I've no idea what the hell he said."

An additional communication difficulty occurred at São José, when a Legacy pilot failed to use standard ICAO phraseology to communicate the number of persons on board the flight. "Souls on board," he said, instead of the ICAO-required "persons on board." Although this was a minor and inconsequential exchange, it nonetheless revealed a lack of awareness of the ICAO requirement to use standard ICAO phraseology and of the threats inherent in cross-cultural communications.

## Language as a Human Factor

After summarizing the accident investigation teams' findings regarding language proficiency, it was possible to analyze the information that was available to them. Although these references to language proficiency, language use and communication problems were included in the CENIPA report, the information is not gathered, presented or analyzed systematically. In essence, CENIPA uncovered evidence of linguistic factors that were at play but did not establish the relationship between language proficiency and use, and the key communication failures that contributed to the chain of events.

The ease with which we normally use our first language belies the complexity of the cognitive, neurological, social, behavioral and physical processes and phenomena that interact to allow humans to produce and process language. A superficial review of communications fails to uncover the subtle cues that shed light on why the communications between the Legacy and ATC failed so significantly. All the communications bear analysis at multiple levels of linguistic inquiry: at the level of phonology (or sound), lexis (word choice), syntax (structure), semantics (meaning), pragmatics (interplay of context and meaning) and more.

A more detailed linguistic analysis suggests that inadequate language proficiency, a low level of awareness of the threats inherent in cross-cultural communications and inadequate communication strategies were the weak foundation upon which the series of unsuccessful communication events were able to develop. A complete linguistic analysis is too lengthy for this article; however, a partial analysis will point to the conclusions drawn here.

It is useful to start by looking at language factors in the context outlined by Sexton and Helmreich in their discussion of language in the cockpit: "The aviation industry has embraced the notion of assessing pilot ability to manage threats and errors in order to achieve safe and efficient flight, and *problem solving communications are the verbal manifestations of threat and error management*" (italics added). Threat and error management requires not only pilot-to-pilot coordination and communication but also problem-solving communications between pilots and controllers.[2]

The evidence shows that both the Legacy pilots and the controllers contributed to the communication failures that occurred at numerous points along the business jet's route. In fact, ICAO language standards are applicable to both speakers of English as a first language and speakers of English as a second, or foreign, language. Both groups share equally the ICAO requirement — outlined in ICAO's standards and recommended practices (SARPs), Annex 1 *Personnel Licensing* — to not only demonstrate English proficiency at the ICAO Operational Level 4 but also to:

- "Use appropriate communicative strategies to exchange messages and to recognize and resolve misunderstandings";
- "[Deal] adequately with apparent misunderstandings (by checking, confirming, or clarifying information)";
- Communicate effectively;
- Communicate with accuracy and clarity;
- "Use a dialect or accent which is intelligible to the aeronautical community"; and,
- Be able to manage "a situational complication or unexpected turn of events."

## Conclusions

The linguistic evidence reveals that the communication failures stem from an interplay of a number of factors.

To start, the Legacy pilots demonstrated a lack of awareness of the applicability of ICAO language

requirements for native English speakers, a lack of awareness of the threats inherent in cross-cultural and cross-linguistic communications. Additionally, they appear to have responded to several instances of difficult or failed communications with controllers with a degree of inhibition not uncommon to native English speakers when encountering workplace communication breakdowns with non-native English speakers. They failed to "deal adequately with apparent misunderstandings (by checking, confirming or clarifying information)."

The evidence also suggests that the enroute controllers at Sectors 5 and 7 had inadequate English language proficiency and may have experienced a resulting degree of "communication apprehension," a factor that could explain the otherwise nearly inexplicable failure of a series of three controllers to communicate critical and required information regarding required flight levels and the loss of transponder replies — communication failures that directly contributed to the collision. This possible explanation for the failure of three controllers to communicate critical information would have been a valid investigative question in this accident.

The accident investigators were hampered by a number of factors in their ability to document or confirm the English language proficiency of controllers involved in the accident; among these factors were the unavailability of standardized English language testing and limited access to the controllers for interview after the accident.

The legal prosecution of one of the controllers and, in particular, his defense against the legal charges — that "he does not speak English and was obliged to coordinate a flight involving foreign pilots"[3] — provides external support for the hypothesis that inadequate English language proficiency underlay this controller's failure to comply with required communication procedures.

In summary, there is evidence that factors related to language proficiency, language use and language awareness may have been the weak foundation upon which the series of assumptions, errors and dropped responsibilities leading to the accident were allowed to develop.

The linguistic analysis of the information uncovered by CENIPA and the NTSB does not change the report's fundamental conclusions. Whether one holds that the primary error involved pilots who failed to maintain proper vigilance and to notice that they were flying a nonstandard altitude for the direction they were flying, or controllers who failed to maintain proper separation between aircraft under their control, it is clear that both sides had an opportunity to interrupt the causal chain. Doing so would have required problem-solving communication in plain English.

The possibility that communication apprehension based on self-awareness of inadequate English proficiency was the underlying cause of the controllers' failure to communicate essential information is an inadequately investigated factor that lies at the heart of this accident investigation. If insufficient English language proficiency and inadequate language awareness were holes in the last barrier to the accident, then only by accurately perceiving the full extent of underlying causes of the communication failures can we adequately implement safety improvements.

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## Notes

1. Except where otherwise noted, all information and data in this review come from the Final Report A-OOX/CENIPA/2008 of Brazil's CENIPA and the NTSB summary and comments, DCA06RA076A.
2. Sexton, B.J.; Helmreich, R.L. "Using Language in the Cockpit: Relationships With Workload and Performance." In R. Dietrich (editor), *Communication in High Risk Environments*. Berlin: Humboldt Universitat zu Berlin. 2003 57–73.
3. Lehman, Stan. Associated Press. "Brazil Air Controller Convicted Over 2006 Crash." Oct. 27, 2010.