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Flight Deck Confusion Cited in Many Aviation Incident Reports

A survey of incident reports filed with the U.S. National Aeronautics and Space Administration's Aviation Safety Reporting System indicates that better intracockpit communication can help prevent confusion-related incidents.

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Examination of the U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) data base revealed that pilot confusion was a factor in roughly one in 10 of reported occurrences.[1] The term *confusion* denotes mental fuzziness, a state of perplexity or an inappropriate melding of ideas. Cognitive errors such as misidentification, misclassification, disorientation, simultaneous belief in two inconsistent ideas and error of substitution are manifestations of confusion.

Because the concept of confusion is invoked to explain aviation safety incidents so frequently by ASRS reporters, the authors decided to study the matter more closely to determine how confusion promotes and/or exacerbates such occurrences.

The study was limited to reports in which reporters explicitly used the word *confusion* (or the variants *confused* and *confusing)* to describe the cognitive state of one or more pilots, during an aviation safety incident in a multicrew aircraft. A further proviso was that the usage of the word *confusion* correspond to one of four common meanings (Table 1, page 2).

The goal of this research was to identify strategies for reducing confusion on the flight deck to enhance aviation safety. The following questions were addressed:

- What meanings do pilots attach to the word *confusion* in their ASRS reports?
- In each incident, which pilots indicated that they were confused? Did more than one pilot share in the confusion?
- About what were the pilots confused? Did the confusion relate to the interpretation of symbolically encoded information? To direct observations of the external physical world? To factual recollections? Or to correlations among these?[2]

Table 1
Four Uses of the Word *Confusion*

Sense	Pilots were said to have …	Citations
1	**Been confused** — In the sense that they were bewildered, or had trouble "making sense" of a situation. Example: Inbound to PDX, we called the airport in sight at 1 o'clock and 14 miles [22.5 kilometers] … We were then cleared for a visual approach as per the Mill Visual Runway 28R profile … We were unable to accurately determine the paper mill and the antennas as depicted on the chart, as it was night, creating some ***confusion*** as to how far out we were, and how high we should be … (Report # 158897)	52
2	**Gotten confused** — In the sense that they accepted a confused idea as true. Example: I received a traffic advisory from the TCAS [traffic-alert collision avoidance system] II system. The traffic was at 11 o'clock, two miles [3.2 kilometers] and 1,000 feet [305 meters] above us. Why this would produce a TA [traffic-alert] warning I don't know … At the same time ATC [air traffic control], or so I thought, gave us a climb to FL290 [flight level], but as it turned out, they were just giving us traffic at FL290. I can't believe what I did next. I actually started to climb … I thought they wanted us to climb because of the traffic. In other words, I got ***confused*** … (Report #201152)	81
3	**Confused something** — In the sense that they misinterpreted or misidentified something; developed a misconception; or created a "confused idea". Example: On an approach to Runway 30 at MIA … ATC then asked if we had an [air transport] in sight, and the airport. We had the airport. They [ATC] stated that the other carrier was crossing the shoreline. We spotted an aircraft crossing the shoreline of the harbor, so [we] called "traffic in sight" … ***confusion*** resulted from the term "shoreline". The controller apparently meant the ocean shoreline. We all looked to the harbor shoreline … (Report #201070)	78
4	**Confused someone else** — In the sense that they provided erroneous, ambiguous or misleading inputs that led someone else to become bewildered or accept a confused idea as true. Example: Cleared into position and hold … captain still had aircraft rolling and started moving power levers forward. I took over from there and asked if we were cleared for takeoff. He said yes, go, go … the captain … continued the roll, which ***confused*** me enough to take his word that we were cleared to go … (Report #157037)	23
	Total (234 citations from 100 of 100 reports)*	**234**

* Multiple answers are possible. Therefore, table totals exceed 100, the number of ASRS incident reports used in this study.

Source: U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS)

- Did the confusion in some way cause the event, or did it obstruct its resolution? How?

- What were the sources of the confusion? What conditions foster the development of confusion?

- Did flight crew interactions, and flight crew/air traffic control (ATC) interactions cause the confusion? Did they help uncover and resolve it? Or both? How was the confusion ultimately dispelled?

One hundred recent ASRS reports were used to accomplish this analysis[3], drawn from a universe of 1,836 incident reports in which confusion was *explicitly referenced* by pilots in multicrew aircraft. These 1,836 account for roughly 7 percent of the multicrew reports in the data base.[4]

ASRS data are not randomly sampled, and suffer from self-reporting biases. Nevertheless, they have excellent human-factors and operational content. The data are useful in identifying aviation safety issues and hypotheses that can then be evaluated more rigorously through laboratory or field research.

A coding instrument was developed to extract information from the ASRS records relating to the study's six objectives. The development of the coding instrument involved several trial codings and interrater comparisons. It was concluded that acceptable levels of accuracy could only be accomplished if each report was coded separately by two individuals, who then reconciled any differences between their codings. This was the approach employed.

The term *confusion* can assume different meanings depending on who uses the term and in what context. This research is based on the common meanings that ASRS pilot reporters attach to the word *confusion*, which may vary from the way human-factors practitioners use the term. This approach to the research topic exploits the basic strength of ASRS data, which is their strong operational content.

Four common usages of the word *confusion* were discerned in the pilot reports. These are described in Table 1 (page 2), which also shows the frequencies with which the various meanings were used.

Table 2 (page 4) shows that in most of these incidents the reported confusion related to ATC clearances and instructions. In many other instances, flight crew members were confused about where something (airborne traffic, a hold line, an intersection, etc.) was located. These two principal types of confusion were frequently related. Pilots were often confused about how to implement an ATC instruction because compliance required them to locate something that they had trouble finding. For example, pilots were confused about how to comply with altitude restrictions because they were unable to locate the intersections to which the restrictions applied.

Only a minority of reports (13) involved the misidentification of a physical object or the confusion of two physical objects with each other. Almost all of these events happened during approach or during ground taxi operations. The confusion usually involved a ground object — a taxiway, runway, airport or landmark — rather than airborne traffic.

In roughly half of the reports, a quantity, name or other item of symbolic information was misheard, misread or misinterpreted. The confusion generally related to numbers including altitudes, speeds, headings, runway identifiers and air carrier call signs (the carrier name plus an identifying number). These were usually part of verbally delivered ATC clearances. In only a few instances, names such as intersection and navigational aid identifiers were misunderstood. These findings may simply result from the prolific use of numbers in the ATC system, but it is also possible that names are less easily confused with each other than numbers.

Factors predisposing human error, such as high workload and deficiencies in the presentation of information, were present in most incidents.

In most of the incidents, the confused parties were instrumental in creating the confusion (rather than becoming confused through receipt of false or misleading information). Sometimes, they misidentified an object or misinterpreted spoken or written information. In other cases, they failed to cross-check data or question inconsistencies. Lack of knowledge, familiarity and experience by the confused party was judged to be a factor in many occurrences.

Factors predisposing human error, such as high workload and deficiencies in the presentation of information, were present in most incidents. Most important was time pressure — when there was minimal time to sort through facts, resolve inconsistencies and draw deliberate conclusions. Thirty percent of these events occurred as flight crews were complying (or attempting to comply) with amended ATC clearances. Amended clearances can generate sudden increases in pilot workload in time-pressured settings.

Before this study was begun, it was unclear whether interactions within flight crews, and between flight crews and ATC, were the source of confusion, the means by which it was detected and dispelled, both or neither. We sought first to understand the scope of the confusion on the flight deck, and found that in 87 percent of the reported incidents both captain and first officer were confused. The two pilots shared misbeliefs and perplexity, or in some cases held different but equally incorrect understandings of the truth.

Table 2
What Flight Crews Were Confused About

Flight Crew Members Were Confused About …	Citations
What they were *required to do* at a particular time to comply with clearances, U.S. Federal Aviation Regulations (FARs), company regulations, etc.	86
Where *something was located* in absolute space, or relative to them (traffic, a hold line, an exit, an intersection, a wake vortex, etc.).	34
Where their *aircraft was located* in the *air.*	13
The *status* of their *aircraft* or its *systems.*	12
Where their *aircraft was located* on the *ground.*	9
What the *physical consequences* of an *action* (activating or deactivating a system, etc.) would be.	5
How a piece of *equipment worked.*	4
The *identity* of airborne *traffic.*	4
The *identity* of a *ground object* (city, airport, landmark, etc.).	3
Other.	1
Total (171 citations from 100 of 100 reports)*	**171**

* Multiple answers are possible. Therefore, table totals exceed 100, the number of ASRS incident reports used in this study.

Source: U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS)

Did flight crew interactions, and flight crew/ATC interactions, cause the confusion? If so, how? The study found that pilots and controllers contributed to most of these events, mainly by inaction (Table 3, page 5).

Finally, an examination was conducted on how the incidents were uncovered and resolved. Was this a team or individual process? In 30 percent of the cases, a confused individual recognized his or her own confusion and took steps to resolve it. In the remaining cases, the confusion was detected and resolved through combined flight crew/ATC effort. Most often, a controller realized that something was amiss and intervened.

Advances in navigation, avionics, systems sensing and monitoring have helped minimize confusion in many areas of flight operation. Pilots of modern air transport aircraft usually know precisely where they are in three-dimensional space, and if their highly reliable aircraft systems should fail, a host of devices will help them pinpoint the problem.

Unfortunately, the technical advances have not been accompanied by parallel improvements in aircraft/ATC communications. The primary tool used to link pilots and ATC remains voice communication via very high frequency (VHF) radio with its known limitations and deficiencies. Further, cockpit instrumentation provides little information about an aircraft's ATC status, e.g., the clearances under which it is operating. Thus, when confusion arises on the flight deck, it most often relates to the content and meaning of ATC clearances and instructions.

When implemented, data link will eliminate some of these events by conveying and recording clearances in precise visual formats, but even this would not eliminate all of the confusion seen in these data. For example, knowing with certainty that one is required to hold short of Runway 8 is not sufficient when one cannot locate Runway 8's hold line. Yet, in roughly one-quarter of the incidents where confusion surrounded an ATC clearance, the inability to locate the traffic, hold lines and other objects was a factor.

Table 3
Role of Crew/Air Traffic Control Interactions in Confusion

Role of Crew/Air Traffic Control	Citations
Failure to monitor or cross-check confused party(ies)	57
Failure to voice concerns or suspicions in a timely manner or with needed emphasis	36
Communication of incorrect information	24
Failure to communicate essential information	12
Total (129 citations from 72 of 100 reports)*	**129**

* Multiple answers are possible. Therefore, table totals exceed 100, the number of ASRS incident reports used in this study.

Source: U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS)

In the near-term, flight deck confusion can best be prevented through continuing emphasis on crew performance with the understanding that ATC is a key member of the flight team. Most of these incidents would not have happened if (1) pilots and controllers had adhered to standard operating procedure (SOP), including strict compliance with standard phraseology and communications protocols; (2) pilots had engaged in more routine intracockpit communication; and (3) pilots had dutifully monitored each others' actions and communications.

Most dismaying were frequent pilot failures to voice uncertainty or concern when confusion first arose. This behavior was observed in 36 percent of the incidents, and often involved pilot unwillingness to ask controllers to clarify confusing clearances. Crew resource management (CRM) training is intended to help solve this sort of problem. Perhaps CRM needs to place greater emphasis on flight crew/ATC interactions. Avionics advances could also help eliminate some of the confusion seen in these reports.[5]

While far from a definitive study on flight deck confusion, this examination of ASRS data did yield some understanding of the nature and dimensions of the problem. Researchers also identified ways by which the frequency and severity of these occurrences might be reduced. Following are the study's conclusions:

- In roughly one in 10 of the incidents reported to the ASRS, one or more flight crew members were confused at some point during the occurrence;
- The confusion most often related to the clearances and other rules in force at a particular time, and/or the location of something (tangible or abstract) in aircraft surroundings;
- Most of these events were rooted in human error, particularly during the expression and interpretation of verbal communications;
- Predisposing conditions, particularly the compression of time available to perform a duty, contributed to many of these events. Significantly, 30 percent occurred as pilots strove to comply with amended clearances, which often took place under elevated-workload and time pressure;
- More routine intracockpit communication would have prevented many of these incidents. Pilots must be willing to admit to confusion more readily, and they must not hesitate to ask controllers to repeat or clarify confusing clearances; and,
- Data link and other advances in communication and avionics may ultimately help eliminate a portion of the flight deck confusion evident in these data. ♦

Notes

1. This observation relates to incidents reported by pilots of multicrew aircraft that were accorded "full-form" processing by the ASRS. It includes reports in which the pilot reporters explicitly used the word *confusion* or a synonym, and those in which ASRS analysts inferred the presence of confusion.

2. Symbolically encoded information includes verbal messages, charts, publications and instrument readouts. Directly observed physical phenomena include airborne traffic, landmarks, airports and runways. The latter term also includes matters such as aircraft position in space or on the surface of an airport.

3. This and all subsequent data-base statistics relate to ASRS full-form records. Full-form records include reporter incident narratives and extensive fixed-field codings. Roughly 25 percent of ASRS data base records are full-form.

4. A broader search of the data base was also conducted using various synonyms of the word confusion. The search was also extended to include references to confusion by ASRS analysts as well as reporters. Twelve percent of data base records met the conditions of this broader search strategy. Thus, we conclude that confusion and related difficulties play a role in 7 to 12 percent, or roughly one in 10, of the incidents reported to the ASRS.

5. A display that provided an integrated portrait of an aircraft's ATC status might help pilots comply with clearances and other ATC requirements. It could indicate the type of airspace an aircraft was traversing, whether it was in an IFR (instrument flight rules) or mixed VFR (visual flight rules)/IFR environment, what ATC clearances were in effect, the name of the ATC facility controlling the flight, etc. Computer utilities could help pilots find information in data banks and locate objects in their physical environment. Pilots could use head-up display or synthetic vision devices to point out airborne traffic, taxiways, holding points and other objects pilots were seeking.

Editorial Note: This article was adapted from *Confusion on the Flight Deck*, a Battelle program report for the NASA Aviation Safety Reporting System, April 1993.

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