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Confusion on the Flight Deck

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CONFUSION ON THE FLIGHT DECK

by

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In roughly 10 percent of the reports submitted to the ASRS, reporters allude to confusion on the flight deck. One hundred such reports were examined in detail to determine how such confusion arises, how it contributes to aviation safety incidents, and how it is ultimately resolved. Particular emphasis was placed on crew interactions as both the source of, and solution to, flight deck confusion. It was determined that most often the confusion relates to what pilots are required to do at a particular point in a flight (as opposed to equipment status, position, etc.), and that the confusion is often linked to difficulty interpeting or implementing ATC clearances. The confusion was generally detected and resolved through the combined efforts of pilots and air traffic controllers.

BACKGROUND AND MOTIVATION

A recent examination of the NASA Aviation Safety Reporting System (ASRS) database revealed that pilot confusion was a factor in roughly one-in-ten of the reported occurrences[2]. The term confusion denotes mental fuzziness, a state of perplexity, or an inappropriate melding of ideas. Cognitive errors such as misidentifications, misclassifications, simultaneous belief in two inconsistent ideas, and errors of substitution are manifestations of confusion. The idea of disorientation also relates.

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

SCOPE AND OBJECTIVES

Scope

The study was limited to reports in which reporters explicitly used the word *confusion* (or the syntactic variants *confused* and *confusing*) to describe the cognitive state of one or more pilots, during an aviation safety incident in a multi-crew aircraft, with the further proviso that the usage of the word *confusion* correspond to one of the four common meanings described under *Findings*.

Objectives

The overarching goal of this research was to identify strategies for reducing confusion on the flight deck in order to enhance aviation safety. More specifically, we addressed the following six questions:

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[2] This observation relates to incidents reported by pilots of multi-crew aircraft which 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.

(1) What meanings do pilots attach to the word *confusion* in their ASRS reports?

(2) In each incident, which pilots indicated that they were confused? Did more than one pilot share in the confusion?

(3) 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?[3]

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

(5) What were the sources of the confusion? What predisposing conditions foster the development of confusion?

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

APPROACH

Data Set

We used 100 recent ASRS reports to accomplish this analysis[4]. They were drawn from a universe of 1836 incident reports in which confusion was explicitly referenced by pilots in multi-crew aircraft. These 1836, in turn, account for roughly 7 percent of the multi-crew reports in the database[5].

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

Methodology

A coding instrument was developed to extract pertinent information from the ASRS records relating to the study's six objectives. The development of the coding instrument involved several trial codings, inter-rater comparisons, etc. Based on these trials, we 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 we 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 its strong operational content.

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

4 This and all subsequent database statistics relate to ASRS *Full-Form* records. Full-Form records include reporter incident narratives and extensive fixed-field codings. Roughly 25 percent of ASRS database records are Full-Forms.

[5] A broader search of the database 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 database 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-ten of the incidents reported to the ASRS.

FINDINGS

In this section of the paper, we will (1) explain how pilots use the word *confusion* and its synonyms in their reports, (2) describe the subjects flight crews were confused about, (3) provide a brief overview of the factors that contributed to the confusion, and (4) discuss the ways that flight crew/ATC interactions created, uncovered, and dispelled the confusion observed during these incidents.

Four common usages of the word *confusion* were discerned in the reports used by this study. These are described in Table 1 which also shows the frequencies with which the various meanings were used.

Table 1. Pilot Reporters Generally Use the Word *Confusion* in One of Four Ways

SENSE	PILOTS WERE SAID TO HAVE . . .	CITATIONS
	Cognitive States	
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 . . . . 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 II system. The traffic was at 11 o'clock, 2 miles, and 1000 feet above us. Why this would produce a TA warning I don't know . . . . At the same time ATC, or so I thought, gave us a climb to FL290. 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
	Acts of Cognition and Communication	
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 which 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)[6]	**234**

[6] In this and all succeeding tables, multiple correct answers are possible. Therefore, table totals exceed 100–the number of ASRS incident reports used in this study.

What Flight Crew Members Were Confused About

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

Table 2. Flight Crew Were Mainly Confused About ATC Clearances and Related Requirements

Flight Crew Members Were Confused About . . .	Citations
What they were REQUIRED TO DO at a particular point in space-time to comply with clearances, FARs, company regs, 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 rpts)	**171**

Confusion of Objects with Others of Like Kind

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 on approach or during ground taxi operations. The confusion usually involved a ground object –a taxiway, runway, airport, or landmark–as opposed to airborne traffic.

Confused Understanding of Specific Words, Numbers, or Phrases

In roughly half of all reports, a quantity, name, or other discrete 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 (which are composed of the carrier name and an identifying number). These were usually part of verbally delivered ATC clearances. There were only a few instances in which 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 Contributing to Confusion

In the large majority of incidents, the confused parties were instrumental in creating the confusion (as opposed to having become 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 is minimal time to sort through facts, resolve inconsistencies, and draw deliberate conclusions, confusion arises. 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.

How Flight Crew/ATC Interactions Created, Perpetuated, and Allayed Confusion

As we entered this study, we were uncertain 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 in one manner or another during the occurrence. The two pilots shared misbeliefs and perplexity, or in some cases, held different but equally incorrect understandings of the truth.

We looked for ways in which flight crew interactions, and flight crew-ATC interactions may have caused the confusion. As Table 3 demonstrates, we found that pilot and controller did contribute to most of these events, mainly by inaction.

Finally, we examined the ways that the incidents were uncovered and resolved. Was this a team or individual process? In these data, a confused individual recognized his or her own confusion and took steps to resolve it in 30 percent of the cases. 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.

Table 3. Confusion Arose or Persisted When Flight Crews/ATC Failed to Act As A Team

Role of Crew/ATC Interactions in Creating, Promulgating, and Delaying the Detection of Confusion	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 rpts)	**129**

DISCUSSION

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 3-dimensional space (at least in domestic operations), and if their highly reliable aircraft systems should fail, a host of devices will help them pinpoint the problem.

Unfortunately, the technical advances outlined above have not been accompanied by parallel improvements in aircraft-ATC communications. The primary tool used to link pilots and ATC remains voice communication over 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, it is not surprising that when confusion arises on the flight deck, it most often relates to the content and meaning of ATC clearances and instructions.

When it's 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.

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 SOP including strict compliance with standard phraseology and communications protocols; (2) pilots had engaged in more routine intra-cockpit 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. Cockpit 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[7].

CONCLUSIONS

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

- ❒ In roughly one-in-ten of the incidents reported to the ASRS, one or more flight crew members was confused at some point during the occurrence.
- ❒ The confusion most often relates to the clearances and other rules in force at a particular point in time, and/or the location of something (tangible or abstract) in aircraft surroundings.
- ❒ Most of these events are 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. It is notable that 30 percent occurred as pilots strove to comply with amended clearances which are often attended by elevated workload and time pressure.
- ❒ In the researchers' judgment, more routine intra-cockpit communication would have prevented many of these incidents in the data set. Pilots must admit to sensed confusion more readily, and must be more willing to ask controllers to repeat or clarify confusing clearances, even if there are impediments to doing so.
- ❒ Data link and other advances in communication and avionics may ultimately help eliminate a portion of the flight deck confusion evident in these data.

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[7] A display (or display mode) which 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 or mixed VFR/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. The latter could use HUD or synthetic vision devices to point out airborne traffic, taxiways, holding points, and other objects pilots were seeking.