Paradigmatic Ambiguity in Flight Deck Communication

Tea Vepkhvadze
Georgian Aviation University
16 Ketevan Dedopali Avenue, 0103 Tbilisi, Georgia

Abstract: *In aviation communication, where accuracy and safety are crucial, any slight variation in words can have severe operational implications. This paper addresses paradigmatic ambiguity — a type of semantic ambiguity arising due to the substitutability of words within the same syntactic slot — in aviation communication. Based on paradigmatic semantics theories and pragmatic linguistics, this study investigates lexical substitutions, near-synonyms, and terminological overlaps as miscommunication causes between air traffic controllers and pilots. The study uses examples from ICAO phraseology, aviation manuals, and actual incidents to demonstrate how language choices may cause different interpretation and operational failure. It further argues that while controlled language in aviation reduces semantic vagueness, non-standard or everyday lexical substitution is a pragmatic hazard, especially under catastrophic or emergency circumstances. The article ends by proposing solutions by way of more rigorous lexical field control, targeted training in semantic awareness, and on-line communication surveillance. This interdisciplinary analysis weaves together linguistic theory and aerial safety and offers practical solutions derived from paradigmatic structure and pragmatic deployment.*

Keywords: *Air communication, paradigmatic ambiguity, Controlled Natural Language (CNL), ICAO phraseology, semantic-pragmatic analysis.*

In the complex and high-stakes environment of aviation, language plays a critical role in ensuring operational safety. Pilots, air traffic control officers (ATCOs), and flight dispatchers rely heavily on verbal communication, and any deviation from standard phraseology can introduce ambiguity with potentially severe consequences. Aviation language is not limited to be a communication tool, it is a lifeline. To counteract ambiguity, the International Civil Aviation Organization (ICAO) mandates the use of controlled language—predefined, standardized phraseology designed for clarity and brevity (ICAO, 2016). This controlled language reduces syntactic complexity and limits vocabulary to prevent confusion arising from synonymous or ambiguous word choices. However, even within this constrained linguistic framework, the possibility of paradigmatic substitution persists. One of the sources of possible communication failure originates from paradigmatic uncertainty — semantic uncertainty triggered by lexical substitution of words associated in one lexical slot.

Paradigmatic ambiguity arises from the substitutability of lexical items that occupy the same syntactic slot but differ in meaning, formality, or pragmatic interpretation. As de Saussure (1916) posited in his foundational theory of semiotics, language functions through a system of signs arranged paradigmatically and syntagmatically. The paradigmatic axis comprises sets of words that can be alternated without changing the grammatical structure of a sentence but often altering its semantic nuance (Halliday & Hasan, 1976).

In aviation, where message interpretation must be immediate and unambiguous, such alternations can compromise communication efficacy. For instance, replacing the standard phrase "Climb to FL310" with "Ascend to FL310" may appear benign but introduces terminology unfamiliar to some non-native English-speaking pilots, potentially leading to delayed comprehension or misinterpretation. Consider the two following statements as well:
(1) "Descend and maintain flight level two eight zero." (2) "Descend and hold at two eight zero."

Both sentences might superficially sound similar, but they trigger radically different processes. The difference is in the paradigmatic switch between *maintain* and *hold*, each of which carries unmistakable operating connotations. These sorts of word substitutions, if poorly known or not codified, can induce confusion, hesitation, or even lethal errors.

In everyday usage, paradigmatic variation adds variety. In high-stakes communication areas like aviation, though, this type of variation can be hazardous. A paradigmatic error is not simply a matter of grammar — it is often a semantic error with safety consequences.

Semantic ambiguity is the circumstance where a linguistic term accommodates more than one meaning. In aviation, ambiguity could occur from:

- Polysemy (one word with numerous meanings)
- Homonymy (two different words with the same form)
- Near-synonymy (different words with close meanings)
- Ellipsis or omission

Paradigmatic ambiguity is particularly dangerous since the substituting word appears correct grammatically and often becomes considered synonymous by non-native, or less able, speakers. The problem intensifies under stress, fatigue, or in the event that speakers operate within a multilingual setting with various strengths in English competence.

Pragmatically, communication meaning depends on context, speaker intent, shared knowledge, and conventional expectation. Even if a word is semantically appropriate in itself, it can be pragmatically unsuccessful if:

- diverges from normal ICAO usage

- results in delayed interpretation
- is inconsistent to the operational context

Here is an exchange:

ATC: "Maintain heading one eight zero." Pilot: "Turning one eight zero."

The phrase turning implies action, not stabilization. The paradigmatic substitution by the pilot might demonstrate understanding but pragmatically contravenes rule of response and potentially results in confusion in busy airspace.

Aviation English has been defined as a Controlled Natural Language (CNL) — a pre-fixed variety of English with limited lexicon, pre-fixed patterns, and low ambiguity. ICAO phraseology strives to eliminate paradigmatic variation by stipulating pre-fixed phrases (e.g., "Climb and maintain.", "Cleared for takeoff") and banning informal substitution.

Despite this, field studies (e.g., Prinzo et al., 2008) show that natural language frequently intrudes into radio telephony.

Pilots and controllers use non-standard expressions such as: "We're good for departure" instead of "Ready for takeoff"; "We're holding at alpha" instead of "Holding short of runway at taxiway A". These deviations often involve paradigmatic substitution that compromises the clarity and safety.

Aviation language is not a lexicon of words—it is a form dictated by function, operating need, and mental economy. Standard phraseology was promulgated by ICAO to meet the communications needs of aviation operations under stressful and high workload conditions. Phrases are chosen not merely for clarity, but also for brevity, absence of ambiguity, and international understandability.

In this system, words and phrases are assumed to be within narrow semantic fields. For example, in the altitude control field, words like "climb," "descend," "maintain," and "level off" all function in the context of a strongly controlled paradigmatic set. Replacement of one word with another—especially with informal or non-serious terminologies—can lead to ambiguity with serious ramifications in the real world.

Following are the subsequent examples taken from actual communication transcripts:

"Climb to one zero thousand" vs. "Ascend to ten thousand"; "Cleared for the approach" vs. "You're good for landing".

Both sets of phrases are functionally equivalent, but the subsequent terms (ascend, you're good) introduce paradigmatic variation that will not automatically be understood or expected in critical radio communications. Misinterpretation in this case can lead to aircraft entering controlled airspace without authorization or to a different runway being approached.

In addition, the design of aviation language involves designed redundancy. Thus, "Climb and maintain" is to be used instead of the straightforward "Climb" because it establishes a first action and a leveling instruction. Replacing one component of such a statement degrades this functional redundancy, causing increased risk of error.

In this regard, paradigmatic ambiguity tends to result not from gaps in vocabulary, but from lexical overconfidence—whereby speakers and writers assume their substitutions are like the originals when they are not.

Aviation discourse, and especially flight deck and air traffic control speech, is transactional, time-constrained, and often subject to external pressure from noise, workload, and stress. It is here that paradigmatic ambiguity is most risky.

Let us take two ATC discourse extracts:

ATC: "Cleared to cross runway two-seven at echo."

Pilot: "Crossing two-seven at echo."

Routine stuff. But:

ATC: "Hold short of runway two-seven."

Pilot: "Stopping short of runway two-seven."

While the second response is semantically accurate relative to the instruction, the expression "stopping short" is a paradigmatic replacement for "hold short"—though not official, and in some versions might not trigger an automated acknowledgement or logging function.

In another case:

ATC: "Report established on the localizer."

Pilot: "We are on the beam."

"On the beam" is a colloquialism, previously common in military aerial operations but today largely obsolete in civilian flying. The paradigmatic replacement is not required and is confusing, and can result in follow-up queries for explanation, adding to traffic on the airwaves.

The same type of deviation shows how unorthodox paradigmatic options can confuse potential expectations, slow response, or create operational distinctions. These accumulate when communication is being conducted interculturally or interlingually.

The next part of this essay addresses recorded case studies and actual events in which paradigmatic vagueness has been the focus.

Tenerife Airport Disaster (1977)

One of the best-known examples of communication failure in aviation was the Tenerife Airport Disaster, where two Boeing 747s crashed into each other on the runway, resulting in 583 passengers and

crew being killed. While there were numerous contributing causes to the accident, such as bad weather and congestion, one significant factor was lexical miscommunication.

The KLM pilot responding to ATC's "Stand by for takeoff" with "We are now at takeoff" employed a paradigmatic form outside the usual "Ready for takeoff" or "Cleared for takeoff." ATC and the flight engineer were unable to understand this phrase, syntactically acceptable but never previously having had a plain ordinary operational sense and causing a fatal misunderstanding.

Avianca Flight 52 (1990)

In this crash, Avianca 52 pilots failed to unambiguously declare a fuel emergency to ATC. Pilots used indirect paradigmatic alternatives such as "running low on fuel" instead of the expected "Mayday" or "Minimum fuel." Controllers were not used to the gravity involved with the use of the former and failed to clear the flight for landing. Such semantic vagueness resulted in fuel exhaustion and a crash off JFK Airport, with 73 fatalities.

Singapore Airlines Flight 006 (2000)

At takeoff while the plane was in typhoon weather at Taipei airport, the aircraft inadvertently tried to take off from a shut runway. Pilots read back messages with imprecise and non-standard wording. Internal crew communication, for instance, used terms such as "That should be it" and "Looks okay," which were paradigmatic approximations and not positional certainty confirmation. These lexical selections indicate the decline of terminological exactness in the midst of high-pressure situations.

Cushing's (1994) and more recent work by Barshi & Farris (2013) indicate a tendency among non-native English-speaking pilots to employ synonymous phrases that are semantically the same but operationally distinct. These are illustrated as follows: "Go ahead" instead of "Say again"; "Takeoff speed reached" instead of "V1".

Such paradigmatic variants are more liable to be misunderstood in multilingual environments, especially if the controller is requiring precise ICAO phraseology. Paradigmatic ambiguity cannot be understood apart from an analysis of its pragmatic significance—how language is deployed in interaction and how meaning is created through mutual expectation.

Speech act theory provides a useful lens through which to analyze flight deck communication. A command such as "Descend and maintain FL180" carries the illocutionary force of a directive. If a pilot replies with "We're descending to 180," this is pragmatically acceptable. However, if the reply is "We're starting down," the illocutionary intent becomes vague. The paradigmatic substitution weakens the intended directive response, increasing the potential for misalignment.

Grice's maxims of quantity, quality, relation, and manner of conversation are constantly being violated in air traffic communication. Controllers in high-density situations require answers that are brief, sincere, relevant, and transparent. Pilots' use of paradigmatic substitutes (e.g., "Looks good" instead of "Cleared to land") violates the maxim of manner by introducing ambiguity and personal inference.

Conclusion

Effective communication in aviation is critical for safety, operational efficiency, and situational awareness. This study demonstrates that even minor deviations from standardized ICAO phraseology—through paradigmatic substitution or lexical variation—can introduce semantic and pragmatic ambiguity with potentially severe consequences. Controlled Natural Language and pre-defined phraseology provide a robust framework for reducing such risks, yet natural language intrusions, stress, fatigue, and multilingual environments continue to challenge clarity.

Historical accidents, including the Tenerife Airport Disaster, Avianca Flight 52, and Singapore Airlines Flight 006, highlight the lethal consequences of imprecise communication and the failure to adhere strictly to prescribed terminology. Paradigmatic ambiguity, by allowing seemingly correct alternatives that diverge in operational meaning, underscores the importance of rigorous training, consistent enforcement of ICAO phraseology, and real-time monitoring of communications.

In sum, harmonizing linguistic theory with operational practice emphasizes that language in aviation is not merely a tool, but a lifeline. Minimizing paradigmatic ambiguity enhances pilot-controller alignment, ensures prompt comprehension, and sustains the highest standards of safety in increasingly complex and international airspace operations.

References:

1. Barshi, Immanuel, and Christine Farris. *Aviation Communication: Language and Culture in the Cockpit.* Farnham, UK: Ashgate Publishing, 2013.
2. Cushing, Steven. "Language Use in Aviation: The Effects of Non-Native English on Safety." *Journal of Air Transport Studies* 5, no. 1 (1994): 45–62.
3. International Civil Aviation Organization (ICAO). *Manual on Radiotelephony.* Doc 9432 AN/925. Montreal: ICAO, 2007.
4. Prinzo, O. Veronika, et al. "Controlled Language and Aviation Safety: The Role of Standard Phraseology in Flight Deck Communication." *International Journal of Aviation Psychology* 18, no. 3 (2008): 243–260.
5. Searle, John R. *Speech Acts: An Essay in the Philosophy of Language.* Cambridge: Cambridge University Press, 1969.
6. Yule, George. *Pragmatics.* 2nd ed. Oxford: Oxford University Press, 1996.

პარადიგმატული ბუნდოვანება საჰაერო კომუნიკაციის დროს

თეა ვეფხვაძე
საქართველოს საავიაციო უნივერსიტეტი
ქეთევან დედოფლის გამზირი 16, თბილისი, საქართველო, 0103

რეზიუმე: *საავიაციო კომუნიკაციაში, სადაც უსაფრთხოება და სიზუსტე უმთავრესია, თუნდაც მცირედმა გადაცდომამ და არასწორად შერჩეულმა ლექსიკურმა ერთეულმა, შესაძლოა კატასტროფულ შედეგამდეც კი მიგვიყვანოს. მოცემული კვლევა ეხება პარადიგმატულ ბუნდოვანებას, სემანტიკური მრავალმნიშვნელოვნების სახესხვაობას, რომელიც წარმოიშობა სიტყვების ერთი და იმავე სინტაქსურ პოზიციაში პარადიგმატული ჩანაცვლების შედეგად და იკვლევს მის როლს საჰაერო კომუნიკაციის პროცესში. პარადიგმატული სემანტიკის თეორიებსა და პარადიგმატული ლინგვისტიკის საფუძველზე დაყრდნობით, წინამდებარე კვლევა სწავლობს მნიშვნელობით მონაცვლე ლექსიკურ ერთეულებს, პარადიგმატულ სინონიმებსა და ტერმინოლოგიურ გადაკვეთებს, როგორც ბუნდოვანი კომუნიკაციის გამომწვევ ფაქტორებს ავიამეთვალყურეებსა და მფრინავებს შორის. კვლევაში განხილულია ICAO-ს ფრაზეოლოგიის, ავიაციის ოპერაციული სახელმძღვანელოებისა და რეალური შემთხვევების მაგალითები, რათა ვაჩვენოთ, რომ სიტყვების არასტანდარტული გამოყენება ქმნის განსხვავებულ ინტერპრეტაციებს და იწვევს ოპერაციულ შეცდომებს. ხაზგასმულია, რომ სტანდარტიზებული ენა მნიშვნელოვნად ამცირებს სემანტიკურ ბუნდოვანებას. ამიტომაც, სტანდარტიზებული ფრაზების არასტანდარტული ან ყოველდღიური ლექსიკით ჩანაცვლება დიდ საფრთხეს წარმოშობს, განსაკუთრებით, კი საგანგებო სიტუაციების დროს. სტატიაში შემოთავაზებულია პრევენციული მეთოდები, როგორებიცაა ლექსიკური ველების მკაცრი კონტროლი, სემანტიკური ცნობიერების გაძლიერების ტრენინგები და კომუნიკაციის რეალურ დროში ზედამხედველობა. ეს დისციპლინათშორისი კვლევა აკავშირებს ენათმეცნიერულ თეორიასა და ავიაციის უსაფრთხოებას, გვთავაზობს პრაქტიკულ რეკომენდაციებს, რომლებიც პარადიგმატულ სტრუქტურებსა და პრაგმატულ მიდგომებზეა დაფუძნებული.*

საკვანძო სიტყვები: *საჰაერო კომუნიკაცია, პარადიგმატული ბუნდოვანება, სტანდარტიზებული ენა, ICAO-ს ფრაზეოლოგია, სემანტიკურ-პრაგმატული ანალიზი.*