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Language-Related Communications Challenges in General Aviation Operations and Pilot Training

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Introduction

Systems thinking dominates the current approach to organizational safety (Cooper, 2000; Reason, 2000). A Safety Management System (SMS) provides an organization the framework to manage hazards and is comprised of several facets including safety policy and objectives, risk management, assurance, and safety promotion (Federal Aviation Administration [FAA], 2015: International Civil Aviation Organization [ICAO], 2013a, 2013b). Stolzer, Friend, Truong, Tuccio, and Aguiar (2018) wrote, "The [sound] system is designed to continuously improve safety by identifying hazards, collecting and analyzing data, and assessing risks" (p. 55). A SMS encompasses reactive, proactive, and predictive methods to systematically identify, assess, and eliminate or mitigate hazards to the operation. Data captured from various sources become the enabler. One valuable data source is the individual who has firsthand knowledge and participates by self-reporting incidents. Through this relationship of reporting and learning, individual organization members report their own errors for the benefit of others. Another valuable source of data is the reports of incidents from others in the greater aviation community. One reporting mechanism occurs through the Aviation Safety Reporting System (ASRS). The ASRS is a voluntary safety reporting system operated by the National Aeronautics and Space Administration (NASA) enabling interested parties a venue for being involved in system safety. The ASRS process also protects inadvertent rule violators from punishment actions as long as the act was not deliberate, did not lead to an accident, was not a repeated offense, and was reported promptly (FAA, 2011).

Language-related communication challenges can manifest in many ways. Consider the following example from a *New York Times* article. "The plane's aural pull-up warning activated. '10 seconds before impact, the ground-proximity warning system gave its alarm -- in English. Just before impact, one crew member said to the other, in Chinese, "what does 'pull up' mean"?'" (Wald, 1996, n.p.). Researchers have concluded many accidents involve communications issues but are not identified as such. For every accident there are possibly many precursor incidents that do not materialize in a mishap. The ASRS database is a repository of incidents of use to improve system safety in preventing accidents. This research seeks to determine the level to which language-related communications issues are reported in the broad general aviation (GA) community and specifically in GA pilot training. This understanding can help improve aviation safety by providing vital data inputs to a GA SMS.

U.S. Government regulations mandate commercial flight organizations establish a SMS and therefore, most of the subject literature is written to address practical applications relating to this type of operation. Many GA operations have voluntarily established a SMS as a safety best practice without the benefit of specific publications for reference in building their respective programs. This

study seeks to help fill the gap by researching communications issues in the GA community.

Problem Statement

Language-related communication errors have been a contributing factor in many fatal accidents. Previous studies have largely focused on issues related to commercial aviation and have established communications aspects are underreported and under-investigated. It is likely communications issues are also under-classified in both incident and accident reports within the GA community. While studies on communications issues in GA have been conducted in other countries, what appears to be missing is literature on unique aspects and perspectives in the US. This is especially true as it relates to incident reporting and data collection. Without robust reporting, the depth of the problem cannot be fully understood and safety systems degraded. This information is especially needed in large culturally-diverse GA pilot training operations such as that seen at aviation universities throughout the country.

Literature Review

In the past 45 years, more than 2,000 people have died in crashes where some kind of miscommunication was a major factor (Patty, 2016). Captain Dan Maurino, in his speech to the International Civil Aviation English Association (ICAEA) conference, cited research from the International Civil Aviation Organization (ICAO) database that found 81 commercial aviation accidents and 14,555 incidents with communication breakdowns. Using a different taxonomy, an additional 157 accidents were linked to English language proficiency (Maurino, 2018). Problems with communications can take different forms. They can occur between pilots in the cockpit, or between the cockpit and air traffic control (ATC) as in the 1977 Tenerife disaster (Roitsch, Babcock, & Edmunds, n.d). Problems can also occur between all combinations of native and non-native English speakers.

The Federal Aviation Administration (FAA) cautions the most important aspect of communication is *understanding*. This is why using standardized phraseology for aviation communications is stressed (FAA, 2017a). In regards to language, the need for improving communication skills does not only apply to those who are non-native English speakers. ICAO stated native English speakers have a responsibility to support less proficient speakers because misunderstandings in aviation communications have such high consequences (ICAO, 2010). In the coming years, the need for training new pilots in solid communications skills will be increasingly important. Boeing estimates 637,000 new commercial pilots will be needed worldwide by 2036 with 82% of the demand coming from outside the United States (Boeing, 2018).

Current research indicates a need to focus on GA mishaps and safety (Aguiar, Stolzer, & Boyd, 2017; Boyd & Stolzer, 2016). According to the FAA (2018a), there were 209 fatal accidents in Fiscal Year 2017. Though the overall GA accident rate has generally declined, there is still a need to further reduce fatal accidents as shown by the FAA's goal to reduce the rate 1% each year. And, with 220,000 active GA aircraft in the U.S., there is a need to stay vigilant (FAA, 2018a). Furthermore, the need for commercial pilots translates to an increase in flight training activity worldwide with many individuals pursuing flight training in the United States beyond the current roster of 11,658 foreign student pilots (FAA, 2018b).

Overview of aviation language use. Speaking a single language is becoming less common in the world (ICAO, 2010). Recognizing this situation, ICAO developed a mandate requiring a certain level of English proficiency prior to obtaining a pilot or ATC certificate (ICAO, 2010). This mandate recognizes clear and standardized communications is a key to global aviation safety. The standards recognize needs to develop pronunciation, structure, vocabulary, fluency, and comprehension skills. The FAA (2017b) published guidance for determining whether a pilot meets Aviation English standards. Mirroring ICAO's mandate, the FAA affirmed the need for communicating in a manner understood by other pilots, air traffic controllers, and other individuals responsible for safe flights. The published guidance is clear; English proficiency applies to all participants, not just those categorized as non-native English speakers.

Communication in aviation. Miller (1951) proposed the information theory of communications to explain the process of transmission and receipt of messages. This often-used model is represented as a communication loop including the coding and decoding of messages (ICAO, 2010). A depiction of this model can be viewed at Figure 1.

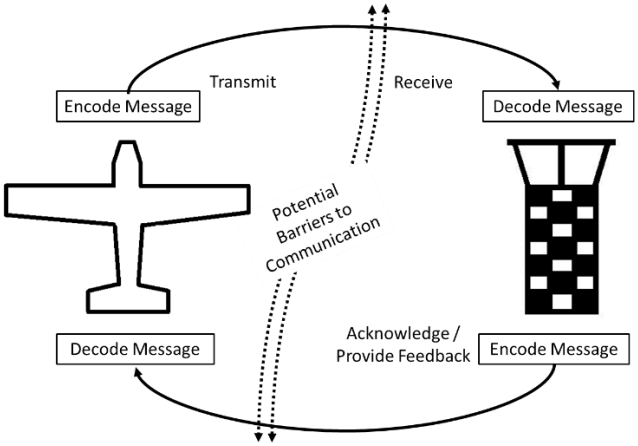

Figure 1. Communications model. Adapted from ICAO (2010) and Project Management Institue (2018).

Miscommunication can occur at any point in the communication process. Understanding communications barriers, just as in other facets of safety risk management, becomes a starting point for developing mitigation strategies. An illustration of the need to understand communications issues in aviation comes from Prinzo, Hendrix, and Hendrix (2008) who conducted a study to quantify language errors in pilot-ATC transmissions. Of their sample, 23% of all communications contained some kind of problem. Further, 75% of those problems related to English proficiency with foreign carriers and foreign aircrew versus 29% with U.S. aircraft and English aircrew.

Communication in general aviation training. English used in aviation is different from conversational English in terms of vernacular, pauses, intonations, and patterns (Trippe, 2018). Other factors also contribute to communication challenges including the lack of visual cues between participants communicating via radio transmissions (Estival & Molesworth, 2009). Their study on miscommunications, while noting English proficiency standards may be inadequate, did not detect evidence non-native English speakers played a primary role in communications problems (Estival & Molesworth, 2009). This suggests additional areas of inquiry are required to determine the interplay of variables. Molesworth and Estival (2015) pointed to moderating factors such as accent, nonstandard phraseology, workload, and background noise. Other research has shown language-related communications issues surface during nonstandard and emergency situations (Gontar, Schneider, Schmidt-Moll, Bollin, & Bengler 2017; Hart, & Bortolussi, 1984). This research seems to indicate a point of conflict between English tests conducted on the ground in a testing center and English in practice when under stress in the flight environment.

Current Study

There is a growing body of evidence supporting the claim communications are under-investigated because accident investigators are not trained to go beyond the most egregious errors (Matthews, 2011; Maurino, 2018). What is less understood is the level to which the problem may exist in the absence of an accident. More specifically, there appears to be a gap in the literature regarding language-related communications issues in the U.S. GA training communities. The purpose of this study is to determine if evidence of language-related communications issues exists in GA generally and in the GA training community specifically and if there is evidence the problem is greater than reported. Understanding the magnitude of the problem is essential to improving SMS effectiveness in GA training operations and may prove useful in reducing aviation mishaps.

Methods

This study is a quantitative and qualitative non-experimental research project using an archival approach and explanatory design (Bordens & Abbott, 2011; Edmonds & Kennedy, 2017). Archived data was extracted from the publicly available ASRS database hosted by NASA. The ASRS allows customizable searches of voluntary safety reports submitted by all types of aviation professionals from the flightline to the back shops (ASRS, n.d.).

Procedures and Materials

Extraction procedures. The ASRS search function contains multiple options for searching the report fields. The current study included reports filed between March 2008 and July 2018. The query was limited to reports filed as a FAR Part 91 (general aviation) operation. Search terms in the narrative/synopsis field included *English*, *foreign*, *communications*, *misunderstanding*, *language*, and *accent*. Using the menu option to select *training* in the type of operation category did not prove fruitful because multiple reports were not fully coded by the reporter or investigator.

Analysis Methodology

The reports meeting the broad search criteria were exported to Microsoft Word and Excel files to facilitate analysis. Demographic and descriptive data were isolated and reviewed. Qualitative aspects contained in the narrative sections were analyzed using NVivo version 12, a computer assisted qualitative data analysis software (CAQDAS) program developed by QSR International Pty Ltd. The procedures used follow the spirit of Heglar and Cuevas (2017) who outlined a foundational framework for qualitative inquiry in scientific inquiry. In addition to a keyword search, the narratives were analyzed for references to flight training and issues with language in communications. The study was limited to those reports submitted after March 2008 when the ICAO language proficiency requirements became applicable on March 5, 2008 (ICAO, n.d.). Statistical predictions of correlation were not attempted because of the possibility the data did not reflect the magnitude of the issues. The data was analyzed and inferences drawn based on descriptive and thematic elements found in the reports.

Results

The initial search for FAR Part 91-coded (general aviation) ASRS reports yielded 14,029 results. This number was reduced using the previously mentioned search terms to focus on communications issues. Reports dealing solely with mechanical issues (i.e., radio malfunctions), navigational aids, and aviation publications were excluded because they did not match the research criteria. Additionally, communications reports based on pilots not communicating as required but not related to language issues were excluded. An example of an

excluded case is a pilot transiting controlled airspace without contacting ATC, regardless of whether ATC tried to initiate communications. In the end, the search yielded 108 language-related reports.

Quantitative Results

GA reports involving students was an area of focus based on the research questions. Of the 108 reports, there were 38 reports of incidents involving students. The majority of student issues occurred at the airport or in the ATC Tower pattern with only 3 of the 38 occurring outside of the airport area. Categorizing student flights by flight plans and weather conditions revealed 30 of the 38 training related reports were on a VFR flight plan. Finally, the student incidents involved 10 near midair collision (NMAC) reports. A further breakdown of various aspects of the entire data sample is included in Table 1.

Table 1
Selected ASRS Report Totals

Year	Report Totals	Training Related	Reporter		Phase of Flight		Location	
			ATC	Pilot	Airport	Transit[a]	US	Foreign[b]
2008*	8	2	1	7	3	5	6	2
2009	13	2	1	12	5	8	8	5
2010	10	4	2	8	7	3	8	2
2011	10	4	3	7	7	3	6	4
2012	13	4	8	5	8	5	10	3
2013	11	2	1	10	5	6	7	4
2014	14	4	4	10	6	8	13	1
2015	9	3	1	8	6	3	5	4
2016	13	10	6	7	11	2	13	0
2017	7	3	1	6	5	2	4	3
2018*	0	0	0	0	0	0	0	0
Totals	108	38	28	80	63	45	80	28

Note. Years denoted with an asterisk are partial years.
[a]This sub-category captures all flights outside of the airport and ATC Tower airspace.
[b]This sub-category captures incident reports by pilots involved in incidents at foreign locations.

Qualitative Results

The 108 reports were imported into NVivo for analysis. A word cloud was produced based on the most prominent words found in the reports (see Figure 2).

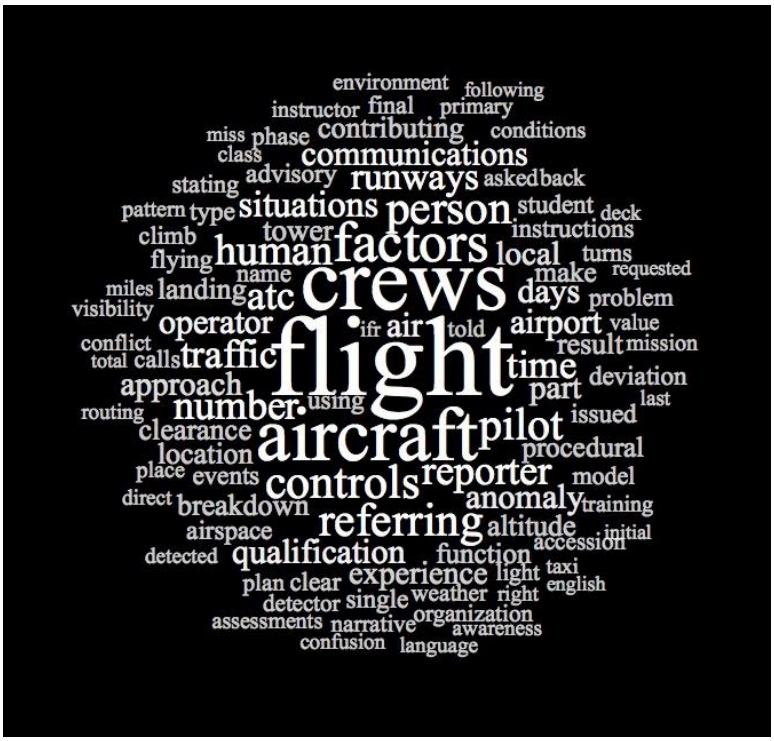

Figure 2. Word cloud depicting the most often used words in the ASRS narratives.

The most prominent words are depicted in larger fonts and brighter shades. This cloud captures the phrases used in the initial search such as *English*, *language*, *accent*, and *student*. Other prominent words include *breakdown* (as in communications breakdown), *deviation*, *contributing*, *conflict*, and, *confusion*. Searches for word pairs and themes led to the discovery of common terms such as *phraseology*, *proficiency*, and *solo*. These were added as key focus subjects. Accent was often used in terms of misunderstood calls, requests for repeats, and challenges with prosody and numbers. Phraseology was paired with ideas of its vital nature and lack of standard use by both pilots and controllers. Proficiency was linked with the ideas of a need for better proficiency, need for higher standards, and a lack of application of standards. Solo was found with reports of lacking proficiency, lacking comprehension, and the need for better language preparation.

Discussion

The current study was undertaken to assess language-related communications issues in the GA community, to better understand the nature of the issues, and search for practical lessons to improve aviation system safety. As

in any safety system, incident and hazard reporting are key enablers to reducing safety risk. The ASRS can provide valuable data inputs into a SMS, but only to the extent the reporting system is used as intended by the aviation community.

A review of the quantitative data showed 74% of the reports were made by pilots and 58% were from incidents at the airport- or in tower-controlled airspace. Interestingly, 26% of the reports were related to foreign locations. This further reduces the number of U.S.-based reports to 80 reports and adds credence to the assertion language-related issues are underreported. Again, while difficult to infer much beyond descriptives, the number of NMAC reports involving students (26% of the 38 reports) is a stark reminder of the potentially high cost of errors and the seriousness of reducing errors.

A review of ASRS narratives for the years March 2008 to June 2018 revealed several themes. First, there were references to the need to use ICAO/FAA phraseology (or Aviation English). This follows research by Howard (2008) who found ATC phraseology errors compounded miscommunication issues. Communications challenges due to accents were noted in multiple reports. Interestingly, the reports citing accents were not limited to non-native English accents. In two reports, a U.S. southern accent and a New York accent added to the challenges of understanding aviation communications. This appears to agree with ICAO's (2010) caution regarding intelligible speech by both native and non-native English speakers and the findings of Tiewtrakul and Fletcher (2010) who studied regional accents as they relate to pilot-controller communications challenges. Accents sometimes make it difficult to understand certain parts of speech (prosody) and numbers (Estival & Molesworth, 2009; 2011). High speech rate hindering understanding was noted in several reports adding credence to the works of Prinzo, Campbell, Hendrix, and Hendrix (2011) who recommended a need to study optimal speech rates and Cardosi, Falzarano, and Hans (1998) who advocated a need for slower speech rates. Proficiency in English was mentioned by incident reporters, especially in relation to student solo flight where comprehension was believed lacking and better screening needed. The perception of a need for better English screening was noted multiple times. This theme encompassed reports regarding students on solo flights who purportedly did not possess adequate English skills. One thing not clear from any of the reports is whether the language skills did not meet ICAO level 4 or higher standards (ICAO, 2010) or if the reporters had a perception different from the international standard. It is possible some of the language errors, especially during solo flights, could be stress-related as described by research on stress in the cockpit (Gontar, Schneider, Schmidt-Moll, Bollin, & Bengle, 2017), though further analysis in this area would be required.

This research was also undertaken to determine the level to which language-related communications issues are reported. As stated previously, the

lack of data suggests language-related incidents are underreported or under-categorized. Part of this could be related to an investigator cadre untrained in the subtleties of communications issues (Matthews, 2011, December/2012, January). It could possibly relate to a reluctance to report incidents, lack of training in completing reports, a lack of emphasis on the need for the reports, or reports submitted to ASRS but not uploaded for public review on the ASRS website. This analysis uncovered only 80 U.S.-based language-related ASRS reports in the 20-year span since the ICAO start of the language proficiency requirement. It is even more suspicious given there were only seven language-related ASRS reports since 2017 with just three relating to language in pilot training considering over 11,000 foreign student pilots in the U.S. (FAA, 2018). Admittedly, there are likely reports captured elsewhere, for instance within a training organization's Aviation Safety Action Program or another safety program, that are not included in the ASRS database. Whether by reporting elsewhere or not at all, the effect is similar. Potentially relevant safety data is not available for use in the wider GA operations and training communities.

Theoretical Applications

This research adds to the body of literature on language-related communications issues in aviation and more specifically, GA training, by synthesizing data captured through the ASRS. The ASRS is a tool to help individuals and SMS leaders identify hazards not captured through other means and provides a way to learn from other's mistakes rather than from within the organization. There are some indications in the ASRS data related issues related to non-native English speakers having to communicate through a radio without visual cues to augment understanding. Of note, Estival and Molesworth (2009) found the opposite in their sample where difficulty in radio communications was not significantly influenced by native language. Nor was pilot experience a factor in what pilots perceived to be the most difficult communications tasks. Future research could be conducted on different types of flight operations to determine if the findings are universal. Research demonstrates the need to improve English proficiency for non-native English speakers (Estival & Molesworth, 2009, 2011; Molesworth & Estival 2015). The current study adds credence to their findings. Additionally, comprehension challenges hamper communications. Further research quantifying the depth of the problem at GA pilot training locations could prove valuable in developing targeted lesson plans and regional aviation safety outreach programs. Another finding for future research is the need for native English speakers to assist in aviation communications with non-native English speakers and more specifically research on methods to meet the ICAO guidance. ICAO outlines this as an ethical responsibility (ICAO, 2010), yet it appears to not be widely taught and understood throughout the aviation industry.

Practical Applications

This work contributes to the body of knowledge by providing a new analysis of language-related communications issues in GA training operations and provides a baseline for additional studies on language in aviation. It also provides data for improving accident and incident reports and contributes to other works on the need for a specific communications taxonomy while helping improve risk analysis and training aspects of a SMS**.** Even considering the relatively small amount of language-related safety reports, several themes of practical significance were detected. Additionally, this study adds credence to the need for incident reporting.

Limitations

Using archival data is challenging because the researcher does not control the data collection and must rely on what others present. The small number of language-related ASRS reports likely represents only a fraction of the issues occurring in the general aviation world. Additionally, while some follow-up is conducted, the report narratives are written by the submitter and not trained investigators as in the case of an accident resulting in information gaps. Therefore, inferences based on the total number and depth of occurrences are not possible. Future studies could examine in greater detail the types and extent of problems encountered using sources and methods outside the ASRS. Strategies to counter the cataloged language hazards could be studied in an experimental setting.

Conclusions

Lawrenson and Braithwaite (2018) wrote, “restrictions to the rate and quality of safety reporting remains one of the greatest challenges to the effectiveness of SMS across commercial aviation at [the] operator, national and international level” (p. 251). This challenge extends to GA as well. The purpose of this study was to examine GA language-related communications errors through voluntary reports to the ASRS. Communication errors, including those related to language, have played a contributing, if not causal role in aviation accidents. Understanding the interplay of language is important to understanding incidents and accidents and learning from them. This understanding is based on a foundation of data, however, this is an area requiring improvement from aviation system users. Identifying issues related to language requires inputs from citizens of the aviation community into forums such as the ASRS so they can be cataloged, quantified, addressed, and mitigated. This study supports continuing efforts to provide the best data possible for the SMS. By continuing this line of research, organizational safety managers and leadership teams can have better information upon which to make more effective decisions in their efforts to reduce GA mishaps.

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