SMS HAZARD ANALYSIS AT A UNIVERSITY FLIGHT SCHOOL

Don Crews
Middle Tennessee State University
Murfreesboro, Tennessee
Wendy Beckman
Middle Tennessee State University
Murfreesboro, Tennessee

For the last several years, the flight school of a mid-sized university has been working to implement a safety management system (SMS). As part of the effort, a robust self-reporting system has been developed, from which data has been used to effect changes in school policies and procedures. In this project, the safety reports that have accumulated over the life of the reporting system were classified based on the hazards experienced which caused the report generation. Non-use of standard procedures was found to be the leading hazard, with 90 of the 176 reports indicating improper procedure application. The traffic pattern at the non-towered airport where the flight school operates was the phase of flight found to be most prevalent in the safety reports, with non-standard pattern procedures, improper judgement/decision-making and communication issues cited as common hazards. Student knowledge/skill and instructor technique were also frequently reported hazards.

A 14 CFR Part 141 flight school within an aviation department at a mid-sized southeastern university initiated an anonymous safety reporting program in the spring of 2010. The first report was filed on 4/22/10, and the safety report data base at the time of analysis contained 176 total reports. The department Safety Committee "owns" the database, and as such, each report in the database has been reviewed and accepted by the committee. The primary role of the safety committee is to identify safety hazards, assess the risk associated with a given hazard, and recommend steps to mitigate the hazard. An additional role of the committee is to disseminate safety information to the flight school community to promote awareness of hazards and identification of risk factors, and to encourage the use of mitigation measures.

The safety report database is primarily a catalogue of reported safety related events. It has been used to identify several metrics including: events per year (see Table 1), weather conditions (93% VFR, 3.4% MVFR, 3.4% IFR), role of reporter (78.6% instructor, 9.8% student, 8.7% dispatcher, 2.9% other), as well as to record both initial actions and further actions taken as a result of reports.

Table 1.
Number of Safety Reports Per Year

Year	Total	Percentage
2010	7	3.98%
2011	12	6.82%
2012	20	11.36%
2013	24	13.64%
2014	20	11.36%
2015	39	22.16%
2016	54	30.68%

The safety report database has been used consistently to inform instructors and students of safety issues and promote safety awareness. A synopsis of each report and related recommendations is provided to the flight school community in a timely manner as reports are submitted. However, a lack of manpower has previously halted the systemic analysis of the safety report data available at this point.

While a full scale Safety Management System (SMS) is not currently required for Part 141 flight school operations, the goal of the department is to move towards that model in as many ways as feasible. The effort undertaken in this project was to assess the information in the database by identifying and categorizing hazards in a systematic fashion to aid the flight school and the overall airport community in which the flight school exists.

Literature Review

The Safety Management International Collaboration Group (SMICG) considers hazard identification the key element in safety risk management (2010). Likewise, the FAA defines the initial step in safety risk management (SRM) as conducting a thorough system description or analysis, to be able to "understand the aspects of the operation that might cause harm," and indicates that "in most cases, hazard identification flows from this system analysis," (Federal Aviation Administration [FAA], 2015, p.6). This includes the development of a hazard taxonomy and categorization process. Bahr (1997) suggests that an effective hazard analysis process should be "…a systematic, comprehensive method to identify, evaluate, and control hazards," (p.72).

The basic definition of a hazard from the SMICG is similar to those found in almost all general safety literature. "A hazard…is an object or condition with the potential to cause injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function," (SMICG, 2010, p.2). The FAA is more pointed in its definition of a hazard, indicating that it is, "a condition that could foreseeably cause or contribute to an aircraft accident," (FAA, 2015, p.7). The development of a comprehensive hazard taxonomy for each sector of the aviation industry is acknowledged as a challenge by the SMICG, as hazards may differ greatly between organizations, depending on their specific processes and procedures (SMICG, 2013, p.3). However, the need for organizations to attempt to identify the hazards within their activities, and to use this data to develop risk mitigation strategies, is also made clear (SMICG, 2013).

This project was an attempt at capturing the hazards that have been implied in the safety reports that have been filed at the subject flight school during the past 6 years. The development of a data driven understanding of the current condition of the system will lead to the ability to more appropriately apply accepted risk management techniques.

Methodology

Each reported event in the MTSU safety data base was reviewed by both of the researchers to determine the specific hazard(s) that was experienced, and to identify potential contributing factors. After a separate analysis, the safety reports were reviewed again by the researchers as a team, to further develop and clarify the hazards present in the submitted reports. As suggested by ICAO, this resulted in the development of a hazard categorization and identification process that was directly related to the available data. Cross referencing each category of safety concern with its contributing factors presented the data in a way that was more likely to identify the true nature of the hazard. The nature of a hazard was identified by the prevalence of certain kinds of events and/or behaviors found in the safety reports. These events and behaviors were related to the contributing factors in a reported safety event. Several additional passes though the data were made to clarify further the hazard categories to be utilized. To be consistent in identifying the nature of a hazard it was necessary to carefully define each type of contributing factor. The hazard categories developed following review of the data are described below:

Procedures – flight crew not following documented routines for a particular phase of flight

Judgement/Decision making – flight crew not exhibiting proper analysis of inputs, leading to failure to make a timely or correct decision

Situational Awareness – flight crew not aware of immediate circumstances or not able to project their circumstances into the future as appropriate

Checklist Use – check list not utilized; check list used but items not completed; non-optimal design of checklist

Communications – misunderstanding of communication; failure to communicate; communication not successfully transmitted

Air Proximity – when the PIC of either aircraft involved felt the need to take immediate evasive action to avoid a potential mid-air collision

Maintenance procedure discrepancy – an inoperative component was not properly reported by a previous crew, resulting in a flight taking place with this discrepancy; maintenance not being aware of a discrepancy report which has been completed; pilots not checking discrepancy reports prior to flight

Mechanical discrepancy – an inoperative aircraft component is identified by a pilot during flight operations

Student knowledge/skill – lack of student knowledge/skill that is expected, given the phase of training or experience level of the student

Instructor technique – lack of awareness of opportunity to allow students to learn from a situation; or, a lack of intervention when circumstances are beyond a student's skill level

In addition to coding the hazards, the phase of flight in which the hazard was reported was also recorded. These locations included traffic pattern (further coded as pre-flight, taxi, takeoff, departure, descent, approach, and landing).

Data Analysis

As described above, each safety report was ultimately coded with the hazards involved that led to the circumstances necessitating submission of a safety report. Multiple factors could be (and in most cases, were) found to be existent in each report. An overall analysis of contributing factors indicated revealed that non-compliance with standard procedures (90 instances) was by far the most prevalent factor found. Judgement/decision-making was the second highest factor found, with 72 instances. Student knowledge/skill (33 instances), instructor technique (29 instances) and communication issues (28) were the next three highest contributors (see Figure 1).

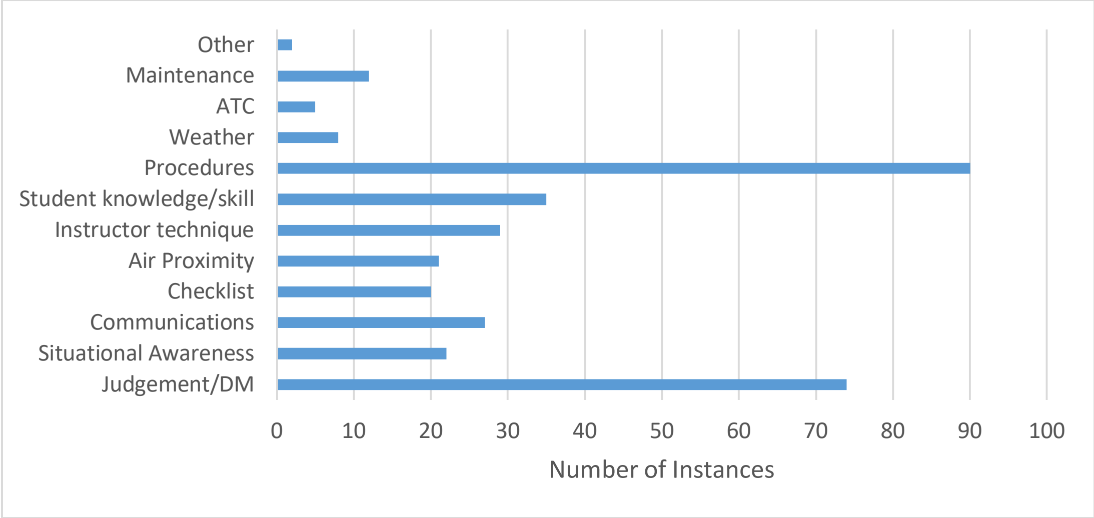

Figure 1. Contributing factors coded on safety reports

Hazard: Non-use of Standard Procedures

Given the high incidence of lack of use of standard procedures, the 90 safety reports coded with this hazard were scrutinized to determine the other hazards that existed in concert with non-use of standard procedures (see Figure 2). It was found that judgement and decision-making were also present in 57% of the safety reports that had procedures indicated. Student knowledge/skill and instructor technique were both also highly prevalent hazards in the safety reports that had lack of standard procedures cited as a hazard. Multiple reports with procedures indicated also specifically included improper use of checklists. These reports include items such as fuel mismanagement (landing with fuel imbalance side to side, or with less than flight school mandated one hour minimum reserve), forgetting to shut of magnetos (multi-engine aircraft) and forgetting to remove cowl plugs.

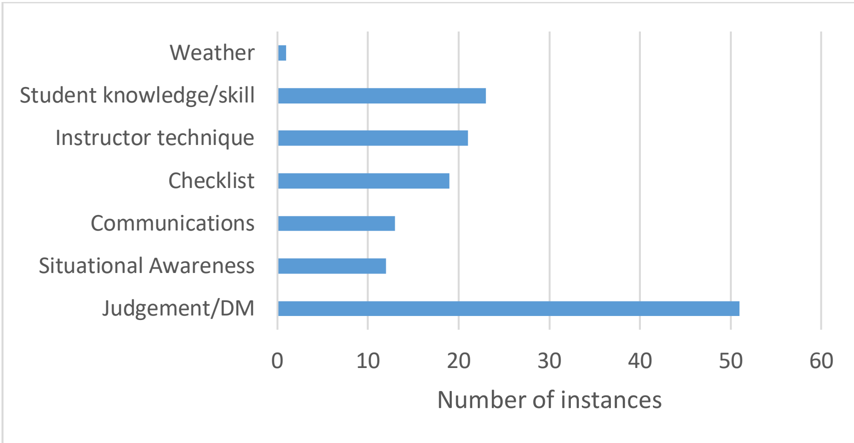

Figure 2. Frequency of occurrence of additional hazards in conjunction with lack of standard procedures usage

Hazard: Traffic Pattern

It is worth noting that 31 (34%) of the 90 reports that were found to have "procedures" as a hazard experienced were due to non-standard procedures conducted by aircraft in the traffic pattern. Similarly, 17 of the 54 (31%) of the reports with "judgement/decision-making" were from traffic pattern experiences. While a few cases involved flight school aircraft using non-standard procedures, the vast majority cited non-flight school aircraft which were not following standard traffic pattern procedures. The flight school is based at a non-towered public airport, where the traffic pattern is shared with another flight school and an active GA community, as well as significant itinerant traffic. The traffic pattern is often busy and just as often it is thought of as a hazard. Given the MTSU expectation of strict adherence to AIM recommended non-towered airport procedures, MTSU instructors and students have been quick to notice and file reports of aircraft that depart from those recommendations.

The traffic pattern issue was of concern to the researchers prior to beginning the formal analysis of hazards, as simply based on the anecdotal experience with safety reports over the years it was clear there was a high frequency of safety reports involving events in the local traffic pattern. An analysis of the safety reports revealed that 54 of the 176 total reports (31%) indicated the phase of flight in which the circumstances which caused the filing of the report was experienced was in the traffic pattern. While this is quite a large number, further analysis revealed that 14 of these "traffic pattern" reports indicated an air proximity (i.e. potential collision threat) danger. This means 26% of the traffic pattern reports were felt to be at the level of a potential mid-air collision threat, while the majority of the others cited lack of procedures (31 reports), lack of judgement/decision making (17 reports) and communication issues (16 reports). Figure 3 below gives a complete breakdown of the issues cited in the traffic pattern reports.

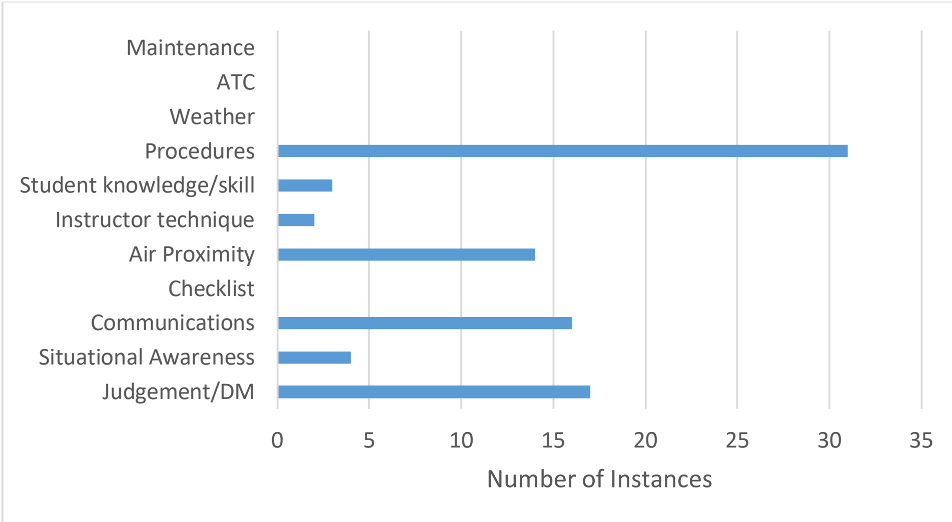

Figure 3. Hazards identified within traffic pattern operation safety reports

The phase of flight within the traffic pattern was also analyzed. The majority of the reports detailed circumstances within the landing phase (23 reports), with the approach phase (12 reports) next, followed by takeoff (10 reports) and departure (3 reports). Figure 4 below depicts the phase of traffic pattern reported.

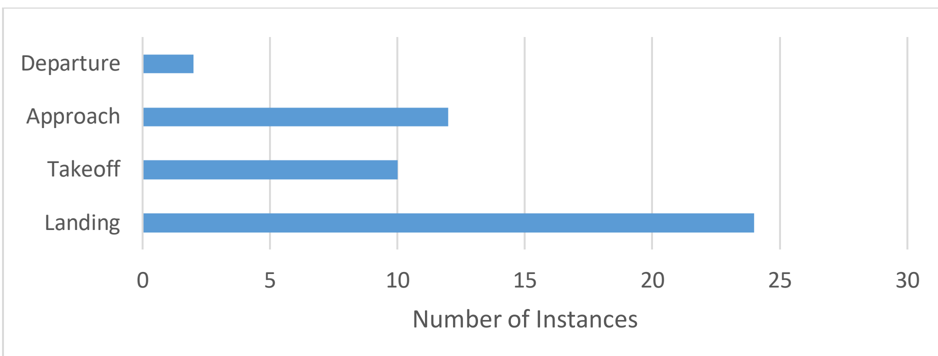

Figure 4. Phase of flight within traffic pattern when event was experienced

Hazard: Student Knowledge/Skill and Instructor Technique

Given the training environment inherent in a flight school, the hazards of “student knowledge/skill” and “instructor technique” were two specific items of interest. As indicated previously, 33 reports were found to have “student knowledge/skill” as a contributing factor, while 29 were found to have “instructor technique” as a contributing factor. When the overlap between these two hazards was evaluated, it was found that 14 of the reports indicating “instructor technique” were also found to have “student knowledge/skill” as a hazard. This was not surprising, as in these cases what caused the hazard was the instructor not realizing and responding to a lack of student knowledge until a situation warranting a safety report was encountered. In particular, 7 of the 14 reports indicating both instructor technique and student knowledge/skill occurred within the landing phase of flight, when instructor vigilance of and reaction to student actions is obviously much more time sensitive than in other phases of flight.

Conclusion

Unlike the hazards experienced by other aviation operations such as air carriers, flight schools operations by definition are associated with students in training. Even when the 31 traffic pattern procedures, mostly observed with non-flight school aircraft, are removed, 59 of the 176 reports (34%) indicate procedure issues, by far the largest category of hazards. While non-adherence to procedures is often cited by all aviation operators as a predominant hazard, this analysis of reports indicates the need to emphasize the importance of procedure use from the earliest days of flight training, even in relatively simple aircraft. This mitigation, in the form of specific communication to flight school students of the fact that non-adherence to standard procedures is the largest hazard, must continue to be a priority. Additional ways of making this point clear, such as during safety meetings and in academic classes, will be investigated. As a subset of procedures, checklist compliance must also continue to be emphasized.

If a student were asked what the most significant hazard experienced by students during flight training at this flight school would be, it is likely that operations in the traffic pattern would be cited. However, it is important to understand that the traffic pattern itself is simply a place and a phase of flight, not a hazard in itself. Analysis of the contributing factors suggest that the hazard(s) in this case are related to certain kinds of behavior in the traffic pattern. Aircraft non-compliance with recommended procedures in the traffic pattern is the hazard, coupled with lack of judgement/decision-making. Therefore an effort to improve procedural integrity, communication, and pilot judgment and decision making appears to be an avenue for effective mitigation. Mitigation in this example might involve providing all airport operators at this field with insight into the nature of the real hazard(s) in order to promote a common approach to traffic pattern procedures, communication, and pilot judgment and decision making.

An additional recommendation to come from this study is the need to further refine the safety reporting form that is currently in use. To assist in the continuing identification of trends in hazards, self-selection by reporters of the hazards experienced would be beneficial. While safety committee review, oversight, and coding of the reported hazards will be continued, this initial coding by users will greatly assist in the maintenance of an up to date hazard analysis database.

Acknowledgements

The authors would like to thank the MTSU Airport Safety Committee for their willingness to share this data for analysis and subsequent publication. And, a particular thank you is extended to Mr. Matt Torres for his diligence in maintaining the Safety Committee data base.

References

Bahr, N.J., (1997). *System safety engineering and risk assessment: A practical approach.* Taylor & Francis, NY.

Federal Aviation Administration (2015). AC No: 120-92B Safety management systems for aviation service providers. Retrieved from https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_120-92B.pdf

Safety Management International Collaboration Group (2013). Hazard taxonomy examples. Retrieved from http://www.skybrary.aero/bookshelf/books/2301.pdf

Safety Management International Collaboration Group (2010). Development of a common taxonomy for hazards. Retrieved from http://www.skybrary.aero/bookshelf/books/1779.pdf