FROM THE GROUND UP: A STUDY ON GENERAL AVIATION FLIGHT SAFETY IN BRITISH COLUMBIA, CANADA

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Abstract

Over a ten-year period, the flight safety trend in Canada shows a 19% decline in accidents (TSBC, 2017). However, there is a stark contrast between those incidents involving commercial airline operators, and those of privately operated, termed “general aviation”, aircraft (TSBC, 2017). In 2016, the number of flight accidents relating to GA privately operated aircraft was in excess of 120, roughly six times the incidence of all other flying categories (TSBC, 2017). My research sought to uncover why the rate of GA accidents was much higher than that of other categories, with a particular focus on a hypothesized complacency in GA pilots. A secondary investigation objective predicted that aviation culture negatively contributes to flight safety. In phase-I of the research project, a survey was sent to 224 (26.79% response rate) members of a large general aviation association via email. Ten survey participants were selected at random to partake in phase-II of the study. Phase-II involved an interview session followed by evaluation in a flight simulator.

Despite the fact that emergency scenario training is a major component of present day pilot education regimes, and that survey responses revealed a high comfort and confidence for handling in-flight emergencies, 90% of flight simulator participants failed to recognize the in-flight emergency from the aircraft’s instrument panel that was presented to them. While many did recover from that emergency, no participant applied the correct steps in the correct sequence, as they would have previously demonstrated during their initial flight training to a standard worthy for the earning of pilot license privileges (Transport Canada, 2017b). In a second simulated emergency scenario, only 20% of pilots could pre-designate their intentions for resolving the issue and then successfully perform to resolve it. These findings are supported by statistical feedback derived from the survey, as well as themes uncovered during the interview.

Because the training for pilot licensure would have covered the maneuvers tested during the experiment, that current rules and regulations dictate pilots to undergo some form of recurrent biannual training, and that the majority of GA pilots seem to falsely perceive their own ability as higher than actual, my research reveals that current educational and regulatory standards surrounding aviation training in Canada is insufficient for preserving aircraft operating proficiency in general aviation, non-professional pilots (Transport Canada, 2016a, 2017b). Further, an aviation culture of ego and fear negatively contributes to flight safety by discouraging effective communication, and creating a blockade to information sharing.

Introduction

Airplane pilots in Canada may pursue the following tiers of flight training: Recreational Pilot Permit (RPP), Private Pilot License (PPL), Commercial Pilot License (CPL), and Airline Transport Pilot License (ATPL). Of these, the latter two designations represent a level of professional training (Transport Canada, 2016b). For non-professional aviators, the most common level of training pursued is the PPL (Transport Canada, 2008, 2010b).

Current aviation education regimes ensure that pilots become proficient in knowledge and develop hands-on skill relating to aircraft systems and operation, navigation and radio aids, interpreting weather phenomena, and air law as applied to the above concepts before being issued their license (Transport Canada, 2016b). Within the major learning topics are a series of subtopics to be studied, these include such concepts as emergency recognition and resolution, aerodynamics and unusual attitudes (a term that infers a situation where the aircraft is positioned irregularly within relative space), aviation communications, and human factors (Transport Canada, 2017b). An individual wishing to acquire a PPL must demonstrate to their instructor, and then to a certified flight test examiner, their proficiency of knowledge and skill in the

aforementioned topics (Transport Canada, 2017b). Additional requirements for the granting of the PPL include five hours of instrument training, where the pilot must learn to navigate and control the aircraft by reference to cockpit instrumentation alone, and the ability to obtain at least a class III proof of medical suitability certificate (Transport Canada, 2015b).

Once a non-professional pilot graduates from flight school with a valid PPL, they may continue onto additional professional training and aviation careers, where they are subject to rigorous recurrent training laws stipulated by commercial/airline operators and the federal government (Transport Canada, 2016b, 2017c). Those pilots who do not enter a professional career in aviation are held to a different standard. Instead, these non-professional, termed "general aviation" (GA) pilots are required to adhere to different laws for recurrent knowledge and skill training (Transport Canada, 2016a). These include the necessity to fly at least once in a five-year period and within six months if taking passengers (Transport Canada, 2016a). Additionally, GA pilots are required to meet biennial requirements through one of seven methods, the most popular of which appears to be a self-paced, non-invigilated study program available through the Transport Canada website or their safety newsletter.

A longitudinal study conducted by the Transport Safety Board of Canada revealed an overall 19% decline in aviation safety incidents over a ten-year period. Comparing incidents by category reveals general aviation to have the highest incident rate (TSBC, 2017). In 2016, the number of flight accidents relating to GA privately operated aircraft was in excess of 120, roughly six times the incidence of all other flying categories (TSBC, 2017).

With such a stark contrast between incident rates involving GA pilots in comparison to professionals, and the fact that current recurrent training requirements for GA pilots are meager at best, it is questionable as to whether or not current educational and regulatory requirements are

sufficient for preserving aircraft operating proficiency in those pilots and therefore, for upholding flight safety in Canadian general aviation. The purpose of this research was to determine whether or not current educational and regulatory status surrounding general aviation is conducive to producing complacency in Canadian GA pilots, and whether or not they are sufficient for upholding flight safety. Further, the role of pilot culture on flight safety was explored. To achieve understanding, the research project comprised of two major phases; in phase-I, a survey was sent to general aviation pilots in British Columbia, Canada, while phase-II involved the interview and evaluation of ten Canadian general aviation pilots using a flight simulator.

Methods

In phase-I of the research project, a survey was sent to 224 members of a large general aviation association via email. Over a time period of 29 days, a response rate of 26.79% was achieved. The survey was created using the web-based SurveyMonkey platform (SurveyMonkey, 2018). There were 71 questions in total encompassing a variety of investigation areas such as respondent demographics, flight experience, method of recurrent training, aviation culture and communication, technological dependency, and questions designed to screen respondents for participation in the second phase of the study. Any survey respondent who expressed interest for inclusion in phase-II was automatically sent an email to re-confirm their intent to participate. Of those participants who still expressed interest, the first ten respondents were scheduled for the interview and simulator sessions (phase-II).

Before partaking in any interviewing or simulator sessions, all participants were asked to sign experimental confidentiality agreements, informed consent agreements, and to consent to the use of data recording devices (action camera and voice recorder for the flight simulator and

interview portions, respectively).

The interview portion of the project involved ten participants who ranged in age, sex, and flight experience. Interviews were recorded using a Sony UX543 audio recorder. Following the interview, voice recordings were transcribed verbatim into written form and then analyzed for major themes. Following the interview, participants took part in a one-hour flight simulator session. The study used the ALSIM 250 advanced simulator implementing the Cessna 172 Skyhawk flight algorithms.

Image 1: ***EXPERIMENT FLIGHT DECK. Vancouver, BC. Source: Davis, 2018a.***

During the flight simulator evaluation, three practice landings were completed at the beginning of each session at the participant's home airport (or an airport they frequented often) and each pilot provided with 25 minutes to familiarize themselves with the location of all required instruments and the layout of simulator flight controls. Additionally, participants were

requested to perform general maneuvering such as turning, climbing, and descending to altitudes and directions specified by the investigator. At the end of the 25 minute trial, participant were asked to rank their familiarity with finding all required instruments and controls from 1 to a maximum score of 10, this was after being asked to point to and identify, one by one, all instruments and controls. All participants initially took off from the same runway (R07) at Boundary Bay Airport (CZBB). Following the 25 minute familiarization period, participants were challenged with spotting conflicting traffic while distracted, accidental flight into IMC conditions followed by the graveyard spiral recognition and recovery drill, and then finally, the forced approach scenario at fields near Abbotsford International Airport (CYXX).

For traffic spotting, participants were challenged with distraction by the investigator having a conversation with them, and by task completion requests such as change of direction or altitude. The purpose of this distraction was to simulate those encountered by pilots in the real world, such as position reporting from multiple aircraft and communication and task delegation issued by air traffic controllers. At a point unknown to the participant, an intercepting aircraft (conflicting traffic) was initiated at a one-minute time-to-collision setting. The one-minute intercept setting allowed for the inbound aircraft to begin at such a great distance that it would not be initially obvious. The intercepting aircraft would initially begin as an inconspicuous tiny speck masked against the horizon.

Participants were then challenged with an accidental Visual Flying Rules (VFR) flight into Instrument Meteorological Conditions (IMC) scenario by manipulating simulated outside environmental conditions to be 0 visibility. Participants were then asked to conduct turns, and were observed for a tendency to over or under-control the aircraft during flight-path corrections. Participants were then asked what the relationship between angle of bank and lift was prior to

initiating the graveyard spiral simulation as, “What happens to lift as angle of bank increases?”. Observations and responses were recorded, and the graveyard spiral initialized by asking participants to increase their angle of bank until a negative vertical trend was recognized on the Vertical Speed Indicator (VSI), and then selecting the corresponding “spiral dive” direction button on the ALSIM 250 control panel. All spiral dives were initiated from a simulated altitude of 5000 (+/- 100) feet above ground level (AGL). Participants were observed for their ability to recognize the spiral, and to recover from it at the investigator’s request, verbally instructed as “recover”. The recovery process initiated by the pilot and resultant altitude loss were recorded. Following the exercise, participants were asked as to what in-flight emergency they experienced. Only 10% of participants could recognize the graveyard spiral from the instrument panel alone, despite instrument training being a regular part of aviator educational regimes, including non-professional training tiers. Although many recovered from the drill, they did so without applying the most efficient recovery process for spiral dives described as, 1; throttle to idle, 2; coordinated roll to wings level, and 3; ease out of the dive by manipulating aircraft positive pitch (Transport Canada, 2010c). This finding is important as accidental VFR flight into IMC is ranked as one of the top accident types by the Transport Safety Board of Canada (TSBC), and that despite having received some amount of instrument training during their licensure – no pilot could recognize the spiral from the instrument panel alone (Transport Canada, 2015a, 2016b, 2017b; Transportation Safety Board of Canada, 2013). The first step to any recovery process is an ability to recognize the situation that one is in, this highlights the need for increased training, or a change in regulations surrounding recurrent skill upkeep. These findings are surprising given that the majority of survey respondents cited their ability to handle an emergency scenario as high. A natural tendency to over control the aircraft by VFR pilots in IMC can lead to an over-bank, loss

of lift scenario at a high throttle setting, the perfect ingredients for a spiral dive (Soderlind, 2000; Transport Canada, 2010c). Overall, an inability to recognize an in-flight emergency results in a delay or omission of correct recovery procedure and therefore – a higher likelihood for a negative outcome.

Image 2: SIMULATED IMC IN 0 OUTSIDE VISIBILITY. ***Vancouver, BC. Source: Davis, 2018b.***

Prior to the simulator session, participants were instructed that there was no need to study and/or prepare. If they were unfamiliar with the operating "V" speeds of the Cessna 172 Skyhawk, they were briefed on them at the beginning of the simulator session, and before initial takeoff. Each session was recorded using an action camera secured to the ceiling of the simulator. The camera was oriented so as to achieve a view of the simulated outside environment as well as the pilot's instrument panel and controls while preserving participant identity.

Before the forced approach exercise, participants were advised as to the target speed for achieving best glide for the aircraft modeled by the simulator, the Cessna 172 Skyhawk. Participants were guided within the simulator environment onto a long approach for R07 at

CYXX (Abbotsford, BC, Canada) and were not given any advanced notice of the impending engine failure. Along the approach line to CYXX at 1500 feet above ground and abeam of the field for the exercise, the “engine failure” button was selected from the simulator computer control station. The participant was then instructed that there was no chance of engine restart, to designate a point for landing on the field, and then to do their best to land exactly on that point. Aligning participants onto the approach line CYXX R07 at 1500 feet of altitude and abeam of the field provided a means of standardizing the starting position for the forced landing exercise. Further, starting the exercise from 1500 feet above ground applied sufficient decision-making time pressure. Further, many pilots implement various approaching and landing alignment techniques in the forced approach scenario. Each participant was observed for his or her method of setting up and conducting the zero engine-power approach, as well as for their ability to land at their own pre-determined target touchdown point. Wind conditions were set and maintained at 0 knots for all forced landing trials.

Image 3: LANDING FIELDS FOR FORCED APPROACH. ***Vancouver, BC. Source: Davis, 2018c.***

The TSBC has expressed that in many real-life forced landing incidents, the unfolding of events was made worse by the pilot's inability to land where they intended, resulting in many under- or over-shoots (Transportation Safety Board of Canada, 2015). Where water or trees surround a suitable landing point, an inability to direct the aircraft to the intended point of touchdown can result in colliding with obstructions that can negatively influence survivability of the forced landing.

Results

Phase-I: Survey

224 members of a large general aviation association received the link to participate in the survey. Of these, a total of 60 individuals completed the survey in full (26.79% response rate). 57 (95.00%) of survey respondents were male. Mean age 55.28 ± 4 years. 34 (57.63%) of participants held at least a category-III medical and 43 (72.88%) had received the private pilot license as their highest level of flight training. 96.77% of survey respondents were initially licensed in Canada. 45 (75.00%) obtained their initial licensing in the province of British Columbia. The mean experience level (measured in flight hours since licensure) in survey respondents was 2966.96 ± 1500 hours, total flight time. On average, respondents ranked their comfort and familiarity as a 9 and an 8, out of a maximum of 10, for operating within the normal abilities and for handling in-flight emergencies, respectively. The majority of survey respondents (38.33%) revealed that they fly at least once per week while 20% of participants responded that they can only achieve ≤ 1 flight/ month. 66.67% revealed that they practice and/or review slow flight and stall recovery or spin and spiral recovery techniques ≤ 1 time/ month. 25.00% indicated that they practice these upper air work examples during 1-2 flights/ month. 67.80% revealed that they practice simulated in-flight emergencies ≤ 1/ month. The majority (71.67%)

expressed that they practice both the simulated engine-out (“forced landing”) and flight with reference solely to pilot instrumentation during ≤ 1 flight/ month. 18 (38.30%) of GA pilots within the sample had additional training to receive an instrument rating on their license, while 10 (21.28%) were certified flight instructors at some point in their lives. 35 (59.32%) of participants revealed that they had experienced a true aviation emergency at some point in their flying experience. Of these pilots, the mean response for perceived ability to handle that emergency appropriately was 8.4/10. 85.00% of participants agreed with the statement, “At present time, I feel adequately prepared to handle a complete engine failure and forced landing scenario.” Survey respondents indicated a mean comfort rating of 8/10 for adequately performing a forced landing during a complete engine failure scenario.

When asked if there was ever a point in time where they had to abandon flying for greater than one month, 36 (61.02%) participants responded that they had. For the factors relating to their inability to continue to fly, 22.81% and 24.56% cited monetary and time pressures, respectively. 12.28% cited medical reasons.

In the case of increase cockpit technology, 76.67% revealed that their primary source of navigational information while flying was by referencing Global Positioning Systems (GPS) or a navigational app such as ForeFlight (ForeFlight, 2018).

Regarding aviation culture, 81.67% of survey respondents believed that aviation had a culture and its own set of norms. When asked to describe aviation culture, the prevailing themes cited by participants were a culture of safety, proficiency and continuous learning, and a culture of superiority and ego.

When asked whether or not current rules and regulations surrounding general aviation and flight training in Canada were adequate for preserving flight safety, 81.36% of participants

responded yes. When asked if Transport Canada's current presence level was sufficient for promoting and upholding GA flight safety in Canada, 63.33% of participants responded yes.

26.67% of participants strongly agreed that their flight instructor lacked the necessary experience or skill required in order to appropriately prepare them for the safe practice of general aviation flying or a career in aviation. 27.12% had witnessed their flight instructor make a significant, safety-compromising error during flight instruction or teaching demonstrations.

Phase-IIA: Interview

The interview portion of the project data collection phase involved ten participants who ranged in age, sex, and flight experience. Interviews were recorded using a Sony UX543 audio recorder. Following the interview, voice recordings were transcribed verbatim into written form and then analyzed for major themes.

Theme I: Flight Education and Doing Time: "You don't know what you don't know".

The majority of Canadian flight school graduates enter flight instruction with low experience and out of necessity to build hours toward industry career hiring minimums. In this regard, instructing may be viewed as a stepping-stone toward another career. There is a general perception of macho-ism/ ego and a hierarchy within the flight school system; where a sense of confidence is passed onto the student pilot. Many participants expressed that a certain amount of confidence is required to be a good pilot, but over-confidence could be a risk factor when experience in the same pilot is low.

Upon reflection, many trained pilots come to the conclusion that their initial instruction was provided by pilots with low-experience who were sometimes unable to demonstrate required skills at an expert level. When the phenomena of primacy is considered, this reveals a vulnerability in present day learning dynamics, as bad habits or passive mistakes of an instructor

may be carried forward by the student (Transport Canada, 2010a; Troyer, 2011). In other words, the true competence of flight instructors may be falsely perceived by new trainees whose own experience is low and therefore – will trust the experience of the flight instructor based on that false assumption. A false sense of knowing and confidence in piloting skill is therefore obtained early in the piloting career.

Overall, there is a belief that flying education of today is expedited so as to preserve the budget of students who struggle to pay for flying lessons (due to its costly nature), and that flight training of today favors efficiency over effectiveness. Alternatively stated, interviewees were under the impression that present-day flight training is better at producing many moderately prepared pilots, than it is at producing a smaller number of adequately prepared aviators. Overly-efficient, expedited training can result in knowledge omission or gaps in understanding. Further, piloting knowledge and skillsets are not fully developed upon exiting flight school, mostly because the training is modeled after the requirements to pass the flight test, and not for securing situational awareness and confident decision-making in students. This is especially apparent at the PPL level of training, the level most associated with the GA flying community (Transport Canada, 2008, 2010b, 2017a).

Encapsulating illustrations of this theme include:

"*Now the unfortunate part is, as we know, aviation is one of the only industries where you have the least experienced pilots teaching brand new pilots. I mean, you don't have somebody go to med school for however many years and then all of a sudden they're a professor at that med school teaching doctors to perform open-heart surgery. But that's what's happening here.*"

"I believe that the [pilot] training regimes of today teach the pilot just enough to not kill themselves and leave a lot to the pilot to kind of learn on their own after the fact. They're not being trained to be safe, competent, well-rounded pilots. They're being trained to pass the test."

"It was kind of the blind leading the blind in those days. I think [my instructors] made me feel good, maybe too good. Maybe they made me feel like I knew more than I knew."

"I thought that instructing was just something they did and I had a feeling that, in a lot of occasions, they just wanted to get out of there."

On flying with a Chief Flying Instructor: "We started the spin at about, well, well over 5000 feet and ended well below 2000 feet. And so, that was interesting."

"When someone is learning to fly, they don't have a lot of judgment as to what's right or what's wrong or what's good and what's bad, or what's correct or not. They're taking everything from their instructor as it's presented as the gospel, as the truth, as the way it should be."

Theme II: The Rules Alone Cannot Preserve General Aviation Flight Safety.

Many interviewees expressed that within the Canadian Air Regulations (CARs), there are too many rules, and that these rules are sometimes overly complex. Due to its complexity, it is believed that many students may not fully grasp these rules on graduation and therefore – may have problems applying the rules to their flying. As students graduate and enter general aviation flying, there is little enforcement of the rules – many of the study participants expressed that in

order to uphold flight safety, the rules need some form of repercussion to encourage rule adherence. Others expressed that we need a way to share knowledge without penalty. A common belief across all interviewees was that the Canadian general aviation community could benefit from a form of skill proficiency monitoring in order to encourage the preservation of operating proficiency. Participants cited that the high cost of flying can make it difficult to stay proficient, and that cost pressure can lead to a diminished aircraft operating proficiency. All participants expressed that they did not feel Transport Canada's presence in contributing toward flight safety in the general aviation community and that, in comparison to decades before, ramp checking or real invigilation no longer occurs. This contributes to the general belief that pilots will ignore certain rules when it is likely that an officer of the Minister of Transport will not check them. Further, pilots expressed that the only thing upholding a pilot's willingness to maintain safe rule adherence was their own attitude.

Encapsulating illustrations of this theme were:

"There's nobody enforcing. Other than your five takeoffs and landings in six months to take passengers, that's the only real currency requirement. And the bi-annual [recency] training thing at the back of the Transport [Canada] booklet, which is a joke right?! It's a complete joke. As an aircraft owner I could not fly for a year, hop in my airplane, complete the takeoffs and landings and tell myself, 'Oh I'm good. I didn't kill myself so I must be good.'"

"Rules and regulations mean absolutely nothing without enforcement. You can stack the regulations to the ceiling! If they are not disseminated, trained, and enforced, then they don't mean anything."

"I know I could be safer but I don't prioritize it because I know I have the license for life."

Theme III: Reaching Out and Communication Barriers.

90% of GA interviewees cited their willingness to reach out for instruction before attempting a new flying skill or endeavor from a person with experience in that area. This is viewed in a positive manner by the GA community, in that knowledge sharing can prevent pilots from making the same mistakes as others. However, respondents also thought there was little to regulate the validity of that knowledge passing. From an opposite aspect, there is a general willingness to provide instruction or knowledge transfer to other pilots when the pilot donating that knowledge feels competent in the topic for discussion.

There is a belief that soft expectations during flight school lead to a poor grasp on knowledge that in turn contributes to slow development of situational awareness, and a decline in pilot decision-making ability. In detail, there is a tendency to pass the responsibility of decision-making onto another. A regularly cited example of this is in weather interpretation; Participants expressed that, because weather interpretation is a sometimes poorly understood knowledge area, pilots may defer the go or no-go (fly or do not fly) decision onto dispatchers or weather service specialists.

GA pilots believe that the appearance of online video tutorials may instill a false sense of "I can do that too." Before paying for instruction, pilots may too readily turn to these videos and then attempt new skills or endeavors on their own. An example of this within the province of British Columbia is sand bar landings, where pilots attempt to land their aircraft on areas of beach rock and/or sand exposed by low water levels before taking off again.

New pilots of an E.S.L. background were commonly cited as a risk factor contributing to

decreased situational awareness amongst GA pilots in British Columbia, Canada. The general consensus was that, because English proficiency is required by aviation law (as the official language of aviation), and that flight schools may be overly willing to let E.S.L. students continue their training before their command of English is high, there is a breakdown of communication in many of the converging flight activity areas, such as zones designated for the practice of aircraft flying skills (Transport Canada, 2016b, 2018). Poor ability to communicate detracts from the situational awareness of all GA pilots involved in that area when requirements such as position reporting are ambiguous or lack clarity. It is believed that this issue is not solely due to an influx of pilot trainees from other countries, but is also readily apparent in other parts of Canada, particularly Quebec and New Brunswick. There is a sense of urgency surrounding the need for an increased level of English proficiency prior to a pilot's first solo flight.

Other types of communication breakdown include that between pilots and air traffic controllers (ATC), and that between pilots and Transport Canada. Participants revealed that there is a need to deconstruct this communication safety blockade. The major perceived contributors to the pilot-ATC communications were 1; use of non-standard phraseology that created ambiguity, and 2; a hesitance to speak out of fear of being wrong, and anxieties toward facing repercussion for being wrong.

Encapsulating illustrations of this theme include:

On deferred decision-making: "<u>They</u> said that the weather was flyable, although marginally so. And of course I got myself into IMC."

On the Glenn Valley practice area and ambiguous communication: "Well, something is

going to happen there sooner or later. Some day. You know, which gravel bar is it? Is it the one over there? Or the one over there?"

On qualifying new E.S.L. pilots in English proficiency: "They are not doing a good job and there is- after the midair in Quebec… a need for it!"

Note: The mid-air collision in Quebec involved three different languages being spoken during aerial communications (Riga, 2017; Transportation Safety Board of Canada, 2017).

Theme IV: Transport Canada has left the field.

GA pilots in British Columbia do not feel the presence of Transport Canada. The rules exist, but without enforcement. This may lead GA pilots to ignore rules as it is expected there will be no penalty. There is a low sense of threat relating to the possibility of being ramp-checked by an officer of the Minister of Transport. Respondents feel that Transport Canada needs to be more proactive in preventing accidents, and to do more than just develop additional rules when accidents occur. A common saying brought to surface by participants was, "The CARs (Canadian Aviation Regulations) are written in blood."

Encapsulating illustrations of this theme include:

"They've got a bunch of regulations but they concentrate on the paperwork and bookwork. They don't really play an active role in the real world. Transport [Canada] spends too much time on the regulations and rules and not enough time out there monitoring what's actually happening."

"It's my perception that they've (Transport Canada) removed themselves from being involved in checking standards or seeing if anybody is safe out there. If we meet the licensing standard then they license us but then I really don't think they care. As a system I do not think they are involved in aviation safety in general aviation really."

"You know I've been ramp checked in the U.S., but I've never been ramp checked in Canada. I've never really had to talk to anybody outside of the [Transport Canada] licensing department – period. And I fly a lot, I mean, I get around an awful lot, and I've never been ramp checked with my aircraft."

"My impression is that they've left the field, that they're not there. You don't see them on ramp checks, you don't really see them when you do check rides anymore. They're just absent from the playing field as far as I'm concerned."

Theme V: Soft Recurrent Requirements and GA Knowledge Decay.

Taking the Transport Canada non-invigilated, self-paced study program via online or through a mail out letter for satisfying legal biennial training was a consistent finding across all interviewees, some of whom expressed concern that these questions were not arduous enough or did not seem to carry relevance toward achieving meaningful continuous learning. Participants seemed to believe that being able to look up the answers to their learning via online search engines or in aviation books did not confer real learning or did not encourage the knowledge to be withheld in the mind. Overall, participants felt that there is a need for increased recurrent training requirements to guide GA pilots. Many revealed a decay of skill or knowledge sets

relating to flying, and some were openly apprehensive about flying within the normal operating limits of their own aircraft, let alone in abnormal or emergency scenarios. Pilots expressed that once they graduated from flight school and gained significant experience with general aviation flying, there is hesitance to seek lessons from flight instructors for the purpose of satisfying biennial training requirements. This is because seasoned GA aviators do not believe they gain valuable insight from pilots with less experience than themselves. In that case, they question the true value for investing in expensive flight training to satisfy a biennial review and therefore turn to cheaper options, namely the Transport Canada study program. The most cited area of knowledge decay was weather phenomena and air law, as well as these two topics together for the purpose of flight planning and decision-making. 30.00% of respondents discussed having unintentionally flown into Instrument Meteorological Conditions (IMC).

Encapsulating illustrations of this theme include:

"[The Transport Canada self-study exam] is just a series of questions you have to look up the answers to. You know, they ask questions that I sometimes think are immaterial like, 'With a ten knot wind, what angle does the wind-sock hang at?'"

"You get yourself into certain configurations where you have to demand more out of the airplane than maybe it can provide, or you have to demand more from yourself than maybe you can provide. Do I think I can operate the airplane? Yes. Do I think I can operate it when the shit hits the fan? I'm not sure I'd want to find out."

In a newly licensed PPL pilot: "There's always the self-recurrence study program with TC, I've done that a couple of times as well."

"There are always those people that have their license valid by the regulation standards, but if they were to go flying they would be a safety concern."

"I think the recurrency requirements are pretty relaxed. Anybody who hasn't flown in 20 years can renew their medical and then jump in an airplane and take off again. Anybody with zero tailwheel time can jump into a [Cessna] 180."

"I feel like my knowledge is atrophying even with the recency of experience. I can fly the airplane, but you know – in terms of regulations and things like that, I just don't remember them."

"I think some of us are content just having the [pilot] license without thinking about it as a living document and something showing ability for skills that should be exercised regularly."

Theme VI: A Culture of Ego and Fear.

When exploring the culture of general aviation, interview participants revealed that many GA aviators are fearful of the Civil Aviation Daily Occurrence Reporting System (CADORS) because the system seems to highlight a pilot's perceived failure if they are the subject of a report. Further, there is anxiety and hesitance regarding communications between pilots and Transport Canada, and between pilots and air traffic controllers.

There is a perception of passive arrogance within the GA community and a belief that this attitude may subtly lead to a false confidence in operating ability. While pilots will preach their own safety and precision, they will not always align their actions with those values. An example of this is intentionally disregarding wright and balance limits, or deciding to omit a pre-flight safety inspection of an aircraft.

Overall, and according to recurring mentions derived from interview discussions, there is a belief that the culture of GA is one of high ego and fear.

Encapsulating illustrations of this theme include:

"We have old school [air traffic] controllers that are very authoritarian, which to me is a communication issue. Communication is a system. If someone within that system is afraid to speak up it's dangerous. So if a controller chews out a baby pilot – they're less likely to communicate. Effectively, they don't want to admit a mistake."

On instructor-student hierarchies: "It was almost like a fear for the instructor. That they had your future in their hands."

"I think the biggest way we can make GA flight safety better is to enable pilots to speak openly about things that they're not sure about without fear of repercussion. Non-punitive self-reporting."

"And the flight schools are instilling a culture of don't speak and get ATC mad at you."

"Punitive action carries shame for the one being punished in an egotistical culture."

"I think pilots tend to be fairly individualistic and you know, many of us, the older pilots were trained with the "Top Gun" attitude or "The Right Stuff" and [we] really don't submit ourselves to coaching and or know how to take criticism as well as we should."

On instructors during initial training: "The more someone has the swagger or the bravado, the more you tend to realize you have to listen to them. Questioning them is not an option."

"I've seen experienced pilots with hundreds and hundreds of hours say something like, 'oh you don't really need to do the walk-around [inspection], you don't really need to check out the plane as much because you just looked at it the last time you flew and its been sitting in the hangar', and younger, less experienced pilots take that as the gospel because of their [instructor's] swagger, because of the bravado."

Theme VII: The GA Technology Shift.

GA pilots are noticing a technology shift for avionics that once could only be found in professional airline flight decks. These technologies are now available at readily accessible price points and therefore, have made their way into light aircraft.

Encapsulating illustrations of this theme include:

"I'm just like everyone else, I've taken the easy route. I'm on Foreflight and GPS."

"My aircraft has dual EFIS. I have a traffic monitor, and this little MRX thing. I've got two GPSs, a VOR, and an ILS as well."

On a pilot's mal-use of GPS: "I speak to the pilot about their error and its always, 'I'm sorry, the autopilot was acting up.' That reliance, in my opinion, is unacceptable."

On advanced systems finding their way into GA aircraft instrument panels: "Absolutely. 100 percent. I can give you lots of examples where people are flying their GPS instead of looking out the frickin' window. Ok, they're relying on this piece of kit instead of flying!"

"You tell him that he's cleared downwind, and he pushes this little button on his GPS that brought him to mid-downwind. But he turned into the face of traffic to join downwind!"

Phase-IIB: Flight Simulator Session

Within the flight simulator participant group, 80.00% were male and 20.00% female. Mean age of participants was 54.3 years (range 18-79). Mean flight experience was approximately 3689.00 flying hours (range 50.00-24,000.00 hours). This approximation was based on participant self-declaration, and could not be confirmed by the investigator.

By the end of the 25-minute simulator familiarization period, all participants had a good command of aircraft control under normal Visual Flying Rules (VFR) circumstances before starting the experimental portion. The use of simulated VFR conditions is consistent with the mode of flight most commonly undertaken by the general aviation community (flying when the

weather is good). “Good command” equates to being able to maintain altitude, heading, and throttle and airspeed settings during normal cruise, climbs, and descents in VFR conditions. All participants were easily able to establish themselves onto the glide path and to place the aircraft onto the surface of a runway during the three allotted practice landings using appropriate power and flap control. The practice landings were completed using the participant’s simulated home airport, or an airport that they frequently visit. After the familiarization period, mean rating for ease and familiarity for finding all necessary controls and instrumentation within the simulator was ranked at 8.4/10 (range 6/10 - 10/10).

Traffic Spotting.

70% of participants displayed rapid spotting and evasion of conflicting traffic. “Conflicting traffic” designates another aircraft travelling at a direction and altitude that, left unresolved, will collide with a pilot’s own aircraft. “Rapid spotting,” means the conflicting traffic did not get within 10 seconds of a collision. 20% of participants were able to spot a traffic speck at a distance and masked against the horizon while simultaneously challenged with communication distraction. 30% of participants did not detect the conflicting traffic until within 10 seconds of a collision, and 10% within 5 seconds of a collision.

Image 4: EARLY DETECTION. ***Vancouver, BC. Source: Davis, 2018d.***

Image 5: LATE DETECTION. ***Vancouver, BC. Source: Davis, 2018e.***

Inadvertent Flight Into IMC and Graveyard Spiral.

90.00% of participants were able to accurately describe the inverse relationship between angle of bank and lift. 40.00% of participants showed no tendency to over-correct aircraft directional and altitude deflections in normal straight and level flight under Instrument Meteorological Conditions (IMC), although some of these pilots had additional IFR training (30.00%). The majority, 60% had a tendency to over-correct unintentional aircraft pitch and roll (banking) that lead to initial flight path instability including unintentional change of direction, climbs, descents, and changes in airspeed. “Significant” means direction change greater than 10 degrees, altitude changes beyond 100 feet, and airspeed changes greater than 10 knots. Additionally, 30.00% of participants rolled the aircraft beyond 30-degrees of bank during normal straight and level flight in IMC prior to initiation of the spiral dive exercise.

Of the ten flight simulator participants, none were able to collectively identify the spiral dive from the instrument panel alone, and then apply the correct recovery actions, in the correct sequence, in order to recover from the dive. The correction action sequence is instructed as 1; throttle to idle, 2; roll the aircraft’s wings to level, and 3; pitch to the horizon to exit the dive

(Soderlind, 2000; Transport Canada, 2010c). The identification and recovery from spiral dives is standard within the Canadian PPL training syllabus (Transport Canada, 2010c, 2016b, 2017b). Mean altitude loss using Cessna-172 Skyhawk algorithms in height above ground was 1610.00 feet (range 1000.00 – 2250.00 feet).

Two (20.00%) participants brought power to idle, but only one of these in a timely fashion so as to avoid over-speeding of the aircraft's structural limits. 90.00% of participants did not save the aircraft from significantly busting the aircraft's "never exceed" structural limit speed (Vne) due to a failure to adjust power setting in a timely fashion.

Following the spiral dive exercise, and when asked what emergency was presented, only 1 participant (10.00%) correctly stated that they had entered an inadvertent spiral dive.

Engine-Inoperative Emergency (Forced Landing).

All participants were able to slow to and maintain the best gliding speed of the Cessna Skyhawk (65 knots) during the engine-inoperative forced landing experiment. Of the sample, only 20.00% could pre-determine their point of landing then successfully maneuver the aircraft to land at that point. 20.00% significantly overshot their intended point of touchdown, described by nearly running off of the field and into the simulated tree line. 60.00 % undershot their intended point of touchdown, failing to reach the field altogether. 20.00% of participants who over or under shot the approach to landing ended significantly left or right of the initially intended point of touchdown.

Three (30.00%) simulator participants, upon selecting full landing flap early in the approach to land, and upon recognizing a significant rate of descent (sink rate) that would not allow them to reach the field, chose not to raise the flap to its prior setting. One participant (10.00%) motioned to raise the flap, but did not action that motion. All pilots who recognized a

sink rate that would not allow them to make their intended field still had sufficient altitude and inertia to allow raising them without stalling the aircraft or colliding with the ground. A sole participant (10.00%) selected flap up after recognizing an excessive sink-rate, only to overshoot their intended point of touchdown.

20.00% of participants decided on their final point of touchdown early in the approach, 80.00 % modified it as the scenario unfolded.

Discussion

At the outset of this study I predicted that current educational and regulatory deficiencies in Canadian aviation are negatively influencing flight safety practices in general aviation pilots by promoting complacency and erroneous decision-making, and that aviator culture encourages unsafe practices in aircraft operation.

Current requirements to maintain baseline piloting privileges under the Canadian Aviation Regulations are not very demanding, solely requiring five takeoffs and landings within a six-month time period in order to carry passengers, and to fly just once in a five-year period in order to operate aircraft (Transport Canada, 2016a). These requirements are significantly less than those expected from aviators working professionally (Transport Canada, 2017c). Because license retention requirements at the non-professional level are meager at best, and without a requirement for recurrent invigilation nor mandatory, intermittent flight proficiency checking, it does not appear that current aviating knowledge review schedules confers a preservation of airplane operating proficiency or skill retention, especially in those general aviation pilots who are unbound to professional standards.

The CADORS system is generally met with apprehension, and detracts from willingness to share knowledge when pilots are fearful of punishment or retribution for making mistakes.

Promotion of knowledge sharing may be achieved by the adoption of a non-punitive self-reporting platform, similar to that of NASA's Aviation Safety Reporting System (ASRS) (NASA, 2018). This could serve to combat the knowledge-sharing barricades created by a culture of ego and fear that is apparent within the GA community.

Current recurrent training regimes, such as the Transport Canada self-paced study program is not an appropriate method for retaining aircraft operating proficiency in GA pilots. Further, it does not seem to encourage preservation of aviating knowledge. Unfortunately, the majority of general aviation pilots turn to this method to satisfy current aviation regulations stipulating the requirement for biennial knowledge review.

Despite an increase in GA cockpit technology, GA aviators seem to upkeep their outside scanning technique. This is a positive finding. However, pilots who come from an IFR background, or who have completed additional instrument flight training, may carry their tendency to monitor instrumentation when they should be alert to the outdoor environment while flying under Visual Flying Rules in VFR weather conditions.

There is low-self awareness in GA pilots pertaining to their actual skill proficiency. Both the survey and interview point to a high degree of confidence for handling in-flight emergencies. Despite this perception, no pilot could correctly identify and apply the correct actions in the correct sequence in order to resolve a spiral dive emergency during the flight simulator phase of the study. This finding is important as it reveals that current educational regimes and recurrent training laws are insufficient for preserving GA flight safety, especially when PPL instrument training requirements are low, and accidental VFR flight into IMC is not an uncommon emergency occurrence (Transport Canada, 2015a, 2016b, 2017b; Transportation Safety Board of Canada, 2013). Within the PPL licensing process, pilots would have been instructed on the

correct identification and resolution process for spirals, and would have had to demonstrate the appropriate recovery technique to a certified Transport Canada examiner. Currently, the PPL syllabus requires a minimum of five hours of instrument training (Transport Canada, 2017b).

A contributing factor to accidental flight into IMC may be the complex laws that are difficult to interpret in the real world, such as perceiving distance from cloud when accounting for VFR minima. Further, when pilots are weak in instrument flying, they have a tendency to over-correct flight path deflections. When at cruise setting, and if overbanking the aircraft in IMC, a loss of lift in a turn combined with a high power setting can contribute to the entering of an inadvertent spiral dive (Soderlind, 2000; Transport Canada, 2010c). When pilots fail to identify this emergency from the instrument panel alone, or confuse it with another emergency type (such as a spin), they will likely make errors in applying the correct actions required to save their own (and their passengers) lives.

Despite the inability to appropriately react, the average height loss for recovery was near 1000 feet of altitude. This low finding may be due to the aircraft behavior algorithm applied by the simulator, as the Cessna 172 received a top ranking for stability during evaluation (Collins, 2016). If a less stable aircraft algorithm were implemented for the simulator phase of the study, recovery altitudes would likely have been excessive. In that case, I expect that all candidates might have collided with the ground.

Considering all contributing factors, it would be beneficial for the GA community to increase their proficiency in instrument flying, and for Transport Canada to raise the requirement for recurrent IFR training, even in non-instrument-rated pilots.

Another common incident type described by the Transport Safety Board of Canada pertains to pilots in a forced landing scenario who were unable to place their aircraft where they

intended, either undershooting or overshooting their target landing point. This can result in a final impact occurring in environments non-conducive to a safe stop such as forests or in waterbodies (Transportation Safety Board of Canada, 2015). My research unveils a general inability to appropriately designate a point of touchdown, and then achieve that touchdown point, possibly warranting a need for increased training for off-field precision landings.

Of the two successful forced landings, both pilots implemented a similar technique to avoid using a full landing flap setting up until they were positioned just above the intended point of touchdown. The application of a full flap-down setting was selected only just before this point in order to disrupt any remaining lift. Collectively, they were conservative with application of flap during their approach to landing.

A disturbing finding from this study was the acceptance of a perceived failure when pilots would allow the aircraft to descend at an excessive sink rate in a full flap-down configuration while knowing that they would not make the field. This is despite having safe altitude and sufficient momentum to change their fate for a positive outcome. This inaction seemed engrained within the pilot psyche as a false rule that once flaps were selected in a full-down position, they must remain there. This phenomenon may also be due to a lack of understanding between the relationship of lift, drag, and flap setting. The finding presents an opportunity for further research.

In the case of decision-making, pilots with successful landings made the decision for their point of landing early, kept that decision, and followed through with it to the point of landing. Of the unsuccessful landings (over or undershoots), pilots tended to re-adjust their point of landing as the engine failure scenario unfolded or gave ambiguous intended points of touchdown at the beginning of the forced landing exercise. Further, of the published methods of approach, those

candidates using approach types involving turning the aircraft away from the landing field (circling and figure-8) tended to lose sight of the field and fall short of their point of landing (Transport Canada, 2017b). It may be beneficial to re-consider the appropriateness of such approach techniques, and to re-evaluate their effectiveness against other published techniques.

Aviation culture has been studied at the professional piloting level, with findings revealing that culture in the cockpit can determine communication effectiveness, and that a lack of effective communication can promote aviation accidents (Helmreich & Merritt, 2000; Merritt & Helmreich, 1996). From my research, I find that cultural attitudes in aviation are likely instilled at the outset of flight training, where hierarchies encourage a culture of ego, and a fear of error-making. Combined, these attitudes synergize in a way that instills an unwillingness to communicate, or to divulge errors as an opportunity to learn from other's mistakes. Additionally, when a culture of safety is mismatched with actions, such as the encouragement of the omission of pre-flight aircraft inspections or lack of adherence to weight and balance limits, a tendency to take on unsafe practices is transferred to other pilots.

In the case of new aviators beginning their training, a culture of ego may lend itself to their willingness to take the practices and knowledge of their instructors as correct, even when they may be inaccurate or unsafe. In other words, not knowing what you don't know by way of inexperience is contributing to a false sense of confidence for knowledge competency and aircraft operating proficiency.

Soft laws pertaining to English proficiency in aircraft communications can detract from the situational awareness of all aviators within the area where that conversation occurs. The culture of ego and fear also detracts from situational awareness when pilots are hesitant to communicate with air traffic controllers out of fear of being wrong, or out of fear of repercussion

for any errors they make. There is a general need for bridging the communication gaps, and for busting down the wall of fear between pilots and air traffic controllers, and between pilots and Transport Canada, in order to open communication pathways and uphold situational awareness.

This project was designed as a broad-scope study in that it presents many opportunities for further research. Overall, my findings contribute that current rules and regulations surrounding general aviation education and recurrent training schedules, along with cultural factors, are negatively contributing to flight safety within the Canadian general aviation pilot population.

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