Exploring the effect of introduction of Threat and Error Management in Australian general aviation

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Abstract. *Following the International Civil Aviation Organisation's (ICAO) introduction of Threat and Error Management (TEM) into the various Annexes to the ICAO convention, the Civil Aviation Safety Authority (CASA) mandated TEM training in Australia. It has been more than four years since TEM training was introduced to notionally increase aviation safety in Australia. However, to date there has been no definitive post implementation review of the introduction of TEM. This study, exploratory in nature, is a first step in looking at how TEM training was regarded among Australian general aviation pilots in terms of its use and effectiveness.*

A total of 59 general aviation pilots participated in a survey. Just over a half of participants (n=31) either agreed or strongly agreed that they felt the number of accidents/incidents has reduced in their organisations after TEM training was introduced. This is a large decline from two surveys previously conducted by ATSB (2009) where nearly 90 per cent of participants either agreed or strongly agreed that the use of TEM principles would improve safety. Other results from the survey indicated a variable uptake of TEM principles and differing opinions as to its effectiveness, suggesting further study should be conducted in respect of TEM as an important safety initiative within Australian general aviation.

Introduction

It is often cited that approximately 70 to 80 per cent of aviation accidents are attributed, at least in part, to human error (Wiegmann & Shappell, 2003). Besco (1992) detailed that because few human (e.g., pilot) induced errors were the consequence of technical skill deficiencies, the entire industry needed to focus on knowledge and attitude to improve pilot performance. Consequently, airlines around the world have devoted many resources to human factors training. In particular, Crew Resource Management (CRM) and Threat and Error Management (TEM), both endorsed by ICAO subsequently became significant in the training syllabus within the airline sector with the aim of reducing crew-related accidents (Simpson & Wiggins, 1999). It is generally agreed that the positive impact of CRM and TEM has been evident (FAA, 2009).

Despite the positive effects of extensive human factors training in the airline sector, it often appears to be a neglected component within the general aviation sector. Indeed, to date there is relatively a smaller and limited number of formal on-going human factors training courses in general aviation, when compared to the airline environment although there has been a growing recognition of its importance in the general

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aviation sector. Sarter and Alexander (2000) explained that the overall safety of the system was determined by the performance of the weakest link (i.e., single pilot, low-technology, less rigorously trained pilots in general aviation). A lack of formal human factor training and re-currency training offered to the weakest link (i.e., lower end of pilots in the general aviation) perhaps explains as to the reason why overall aviation safety has not significantly improved.

According to a report from the National Transportation Safety Board (NTSB, 2012), general aviation accidents accounted for 96 per cent of all aviation accidents in the US, while only accounting for 51 per cent of the estimated total flight time. The report also identified that although the accident rate involving general aviation gradually declined over the period between 2001 and 2010, the number of fatal accidents remained stable for the same period (NTSB, 2012). Although the accident rate in Australia for the similar period did not seem to be as severe as the US's rates, the accident statistics in Australia involving general aviation showed a similar trend, where the general aviation accident rate was approximately three times higher than the accident rate involving airlines (ATSB, 2011).

However, it is noteworthy that although the accident rate for general aviation is clearly higher, accident rates within general aviation vary by segment (i.e., different purposes of flights) because general aviation is composed of pilots with a wide variety of experience, a wide range of aircraft types and wide diversity of flight activities (Hunter, 1999). Among the wide range of aircraft types and their involvement in accidents, the NTSB (2012) report identified that fixed-wing aircraft accounted for 87 per cent of all general aviation accidents in 2010 while helicopters accounted for eight per cent for the same year. Hence, those general aviation segments flying fixed-wing aircraft for their operations should be an immediate focus of further research.

Further, general aviation accidents involving personal flying in fixed-wing aircraft accounted for 64 per cent of all accidents in 2010, while general aviation accidents involving flight instruction in fixed-wing aircraft accounted for 10 per cent of all accidents in 2010. Conversely, general aviation accidents involving corporate segment in fixed-wing aircraft accounted for less than 1 per cent of all accidents in 2010 (NTSB, 2012). Similar trends were observed in Australia, where general aviation accidents involving private flying were 3.6 times higher than those involving flight training during the period between 2001 and 2010 (ATSB, 2011). These statistics clearly show that general aviation, personal flying in fixed-wing aircraft in particular, is the weakest end of the safety chain and, thus, deserves immediate attention.

Traditional approaches to aviation accidents focussed on a series of single events identifying human errors that are ubiquitous in nature, leading to a false notion of total error elimination strategies. However, it was later realised that it was unrealistic to believe that errors could be totally eliminated due to the physical and psychological limitations of humans (Thomas, 2004). Consequently, efforts have been made to identify errors and, more importantly, developments and refinement of training have been made to appropriately manage those errors in order to avoid or mitigate negative consequences. It was this notion that provided the overarching objective of error management, later re-named TEM, that was believed to provide the best possible support for pilots in managing everyday threats and errors (Merritt & Klinect, 2006).

Development of TEM was a by-product of LOSA and was developed to capture the full operational complexity of a flight (Merritt & Klinect, 2006). Since the first full TEM-based LOSA in 1996, the concept has attracted strong interest from airlines, regulatory authorities and academia, and the benefits of such training have been widely witnessed (Merritt & Klinect, 2006). Consequently, ICAO recommended that TEM training be a licensing requirement for all pilot licences and it also became a requirement for initial and recurrent flight crew training (Maurino, 2005).

Following ICAO's acknowledgement of the need for TEM principles to be embedded within all pilot training, CASA amended the Day Visual Flight Rules (VFR) syllabus on 1 March 2008 to reflect this initiative (CASA, 2008). In addition, CASA (2008) mandated that TEM be formally assessed on flight tests for the General Flying Progress Test (GFPT), Private Pilot Licence (PPL), Commercial Pilot Licence (CPL) and Airline Pilot Licence (ATPL) from 1 July 2009.

It has been more than four years since TEM training was introduced to notionally increase aviation safety, thus it is timely to explore how the requirement for TEM training is currently being addressed and it is regarded among pilots in Australian general aviation.

Method

Design overview

The primary purpose of this study was to collect information on how the requirement for TEM training was being addressed in Australia and to gather general consensus on the benefits and effectiveness of TEM training in an exploratory manner. In order to collect the required data, a survey was devised. The survey contained several common questions (presented in table 1) for all participants as well as few group-specific questions (e.g., question presented in table 3).

Participants

A total of 63 participants completed the survey. However, four surveyees failed to indicate their consent, so only responses from 59 participants were analysed for this study. These general aviation pilots comprised 26 trainee pilots working towards a PPL or higher licence, five private/recreational pilots, 21 trainers (e.g., flight /ground instructors) and seven other pilots (i.e., pilots who do not fall in other groups such as a charter pilot).

Materials

Although no separate headings were used, the survey comprised three parts. The first part aimed to categorise the general aviation pilots into four categories (i.e., trainee pilots, private pilots, trainer pilots and other pilots such as charter pilots). The second part aimed to gain insights into how TEM training was delivered. The third part aimed to gather how the benefits and effectiveness of TEM training were regarded among general aviation pilots. This part contained several common questions as well as group-specific questions. Six common questions are presented in table 1. The last

question of the survey was open-ended type, giving the participants an opportunity to share their opinions on TEM training.

• I feel that the number of accidents/incidents has reduced in my organisation after TEM training was introduced
• I feel TEM training has improved overall aviation safety in general aviation
• I feel appropriate use of TEM training improves my technical skills (i.e., aircraft handling skills)
• I feel appropriate use of TEM training improves my non-technical skills such as situational awareness and decision making
• I feel CASA produces adequate training and guidance materials for TEM training for general aviation
• I feel the benefit of TEM training is over-rated

Table 1. Six common questions

The survey questions in the third part had six response options: strongly agree; agree; neither agree nor disagree; disagree; strongly disagree and unsure. For the purpose of statistical analysis, numerical values of 'Strongly disagree' = 1, 'Disagree' = 2, 'Neither agree nor disagree' and 'Unsure' = 3, 'Agree' = 4 and 'Strongly agree' = 5 were assigned to each of the potential responses.

Results and Discussion

SPSS (version 20) was used with the level of significance, alpha, set to be $p<.05$ for all statistical analyses.

A descriptive statistic in Table 2 below indicated that with the exception of two questions (i.e., TEM improves non-technical skill and TEM is overrated) the responses to the rest of the common questions fell within a 'neutral' range which suggested that the participants did not strongly feel TEM training improved safety in general aviation. This finding was consistent with Irwin's (1991) finding that a gradual decay in positive attitudes to CRM over time was noted (cited in O'Connor, Flin & Fletcher, 2002). This is rather alarming as the results from two surveys (i.e., a post-training survey and a follow-up survey) conducted by ATSB (2009) suggested that approximately 87 per cent (181 out of 209 participants) either agreed or strongly agreed that TEM would improve safety in their organisation. A similar trend was also observed when the follow-up survey was conducted where approximately 90% (65 out of 72) either agreed or strongly agreed that the use of TEM principles would improve safety.

An encouraging finding was that the participants felt TEM training improved their non-technical skills. This result was somewhat expected as TEM principles were widely known as improving non-technical skills (e.g., decision making). Findings also suggested that the participants would like to see more guidance materials on TEM training.

Questions	Mean	Std. Deviation	Total (N)
I feel that the number of accidents/incidents has reduced in my organisation after TEM training was introduced	3.58	.72	59
I feel TEM training has improved overall aviation safety in general aviation	3.86	.71	59
I feel appropriate use of TEM training improves my technical skills (i.e., aircraft handling skills)	3.58	.97	59
I feel appropriate use of TEM training improves my non-technical skills such as situational awareness and decision making	4.2	.89	59
I feel CASA produces adequate training and guidance materials for TEM training for general aviation	3.44	1.25	59
I feel the benefit of TEM training is over-rated	2.42	1.13	59

Table 2. Descriptive statistics on responses to common questions.

In addition to common questions above, a trainer-specific (i.e., flight instructor) question was asked and the majority agreed that incorporation of TEM had improved the way that airmanship was taught. This finding suggested that the majority of trainers did not consider the TEM training being a mere replacement of a traditional airmanship or a way of re-labelling airmanship. This is considered to be a positive finding as a positive perception of this training has a stronger likelihood of a better transfer of training to trainees.

Binomial Test

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
I feel incorporation of TEM has improved the way that airmanship is taught	Group 1	<= 3	5	.24	.50	.027
	Group 2	> 3	16	.76		
	Total		21	1.00		

Table 3. Instructor specific question.

Limitation and Conclusion

A major limitation of this study was the small sample size, particularly the private pilot group, resulting in statistical weakening of the generalisability of the findings. It was clearly identified from the literature review that private pilots flying a fixed wing aeroplane in general aviation were the weakest end of the safety chain, deserving immediate attention. Thus greater sample size for the private pilot group would have yielded a better understanding of how TEM training was regarded, which in turn would provide a direction leading to translation of the positive impact of TEM to the weakest link.

In conclusion, overall results from this pilot study indicated a variable uptake of TEM principles and differing opinions as to its effectiveness hence a further study should be conducted on a larger scale to ascertain how TEM training is regarded and whether a positive effect of TEM training can be determined within Australian general aviation.

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