Same skies, different flight plans? Human factors and safety management experiences from Australian small aircraft flight operations

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Abstract

Human factors evidence has been incorporated into large aircraft operations since the 1970's and is now regarded as part of standard procedure. Airline transport data indicate that air travel remains the safest form of transport. However there are two tiers of flight operations, large and small aircraft, and there may be some important differences between these two groups, and also within the small aircraft sector itself. This paper is an overview of data collected from 426 Australian small aircraft pilots in September-October 2008. Pilots were asked about knowledge, beliefs and actions regarding incoming human factors based regulations. Differences in pilot responses are evaluated and implications for introducing and supporting operational changes are considered.

1 Introduction

1.1 Historical Background and Current Implications

Aviation has advanced a long way in a relatively short timeframe. Given the complexity of modern aircraft and associated operations, it is easy to lose sight of the relative youth of this form of transport. Powered aviation may have begun as an experiment in creating flight with the use of basic tools, equipment and engineering skills, but it has rapidly developed into a vital part of global transport systems, along with an associated rapid expansion of sciences such as engineering, aeronautics, computing, avionics, and human performance. The study of human performance itself is relatively new and, even after 40 years, still has some way to go in catching up with all facets of air transport.

The rate of change from experimental, free form flight to highly regulated, complex systems is astonishing, and each stage has had enduring implications for subsequent generations, including modern day operations. Powered flight was first demonstrated by the Wright brothers in the USA, in December 1903. Early flight relied heavily on basic engineering knowledge and skills, mainly mathematics, physics and basic aerodynamics. It would be safe to say that little, if any, consideration was given to human abilities or skills, other than possibly those associated with adventurous and pioneering spirits. 'Barnstorming' and other

forms of unregulated flight were popular pastimes in the 1920's and 1930's. Aviation transport and tighter flight regulations took on increasingly greater importance during political conflicts and war. Aircraft design and usage benefited from enhanced research and development during those years. Postwar, during the 1950's, air travel became a fashionable luxury and also a preferred faster alternative to long distance sea travel. In recent times, commercial and military aircraft design and technology have developed into highly advanced and complex systems. Now, just over 100 years later, complex commercial and military aircraft operate in multiple high risk environments on a daily basis. At the same time there is also an increasing turning to (or perhaps 'returning' to) the skies, by adventurous aviators wishing to fly in basic small aircraft.

The 100 year overview mentioned here is not irrelevant to the consideration of how aviation safety culture and practices can be viewed at this time. Indeed, it is important to understand the effects of preceding decades on the development and application of current flight safety management.

Current beliefs, decisions and regulations are all in part influenced by a variety of 'subject matter experts', many of whom derive their experience from earlier aviation eras. For example, there are currently a large number of 50 and 60 year-old commercial pilots, originally trained as single cockpit military pilots, well prior to the advent of 'human factors' concepts and training inputs. Similarly there are many older 'recreational' pilots who learned to fly by wire 30, 40 or even 50 years ago, and who have little time for the current views of flight training. Flying instructors, themselves often 'older' pilots, many of whom learned to fly decades ago, may also pass on to their students particular beliefs and possible biases originating from earlier times.

At the same time there are large numbers of emerging younger and 'middle age' professional pilots who have 'always' known about the need for human factors' knowledge and skills, given that they began training within the last 10-20 years. In addition, there will soon be a group of multicrew pilots licensed to fly on large commercial flight decks, who are no longer required to have any basic flight training and may never have flown solo command of a small aircraft. Finally, there are exponentially increasing numbers of 'recreational pilots' who do not have the long experiential background of some of their peers and who also may not have access to, or appreciate, the role of human factors knowledge in safety culture and management. All of these pilots now share similar skies and in particular they share higher risk areas such as aerodrome approaches, circuits and landing areas.

As part of a worldwide effort to increase overall safety management and to reduce the effects of some of the differential experiences mentioned above, regulators are beginning to harmonise flight operations at all levels, particularly with respect to human factors based information. That is, the 'way that flying is done' will ultimately be more consistent, reliable and predictable across all areas and regions.

Achieving this type of harmonisation, and changing past practices and enduring beliefs along the way, may not be as straightforward as it seems. Human performance in high risk environments may not just be a matter of updating or mandating safety regulations and then advertising the changes.

1.2 Research Background

1.2.1 Emergence of Human Factors as a Working Concept

A long held notion, that aviation operations were primarily based on mechanical and engineering knowledge and expertise, endured for decades, until the 1970's, when questions were asked about the root causes of aviation accidents and incidents occurring in large commercial operations at the time. New research established the now iconic finding that over 70% of negative aviation events were due to some form of human error and the term 'human factors' came into being. Subsequently, the initial concept of 'human factors' developed into a large body of well-researched knowledge encompassing a range of human performance related ideas, including crew resource management, and threat and error management. Mature human factors concepts have now been incorporated into the standard operating procedures and manuals of military and commercial operations and are commonplace, not only in aviation, but also in other high risk ventures. However, these notions and outcomes are mostly associated with large aircraft operations. This paper presents data that suggests there may be a significant gap between the knowledge, beliefs and practices of 'large' and 'small' aircraft aviators, and also within the small aircraft sector itself, with implications for associated issues of safety culture and safety management.

The International Civil Aviation Organisation (ICAO) identified a range of safety behaviours deriving from extensive human factors research over the past four decades. Australia, with its 'enviable safety record' and 'a well-earned international reputation as global leaders' (National Aviation White Paper, 2009), has also been a proactive participant in ICAO for many years, and for a time led the way in developing some of the practical applications which now underpin current safety management planning. ICAO has since incorporated the human factors findings and practical applications into a series of Standard and Recommended Practices (SARPs), and member countries are now obliged to implement and adapt to local environments, including small aircraft operations.

Pilots at all levels need to be aware of, and to rely on, published aviation regulations and recommendations. While aviation rules have the status of federal law and must be followed, aviation 'recommendations', in the form of Civil Aviation Advisory Publications (CAAPs), are non punitive and unenforceable guidelines. They are designed to inform aviators of the desired benchmarks of particular safety issues, and as a means of assisting pilots to better understand the nature of current safety planning, and to upgrade their own safety practices within their own operations. Nevertheless, it is not known how extensively the CAAPs are used and how effectively they contribute to safety culture or safety management. This may be an area in need of further consideration in general aviation operations. CAAPs may also offer, with modifications, another avenue of assisting 'non licensed' small aircraft operations.

A new era in Australian aviation governance and operations was recently declared by the Federal Government through its National Aviation Policy White Paper (Dec, 2009), including statements of core responsibilities for Federal transport agencies such as CASA. After nearly a decade of restructuring and rebuilding, CASA's two main areas of responsibility were affirmed and strengthened. Specifically, CASA maintains primary responsibility for a) the upgrading, monitoring and maintaining of Australian aviation rules, regulations and recommendations, and b) the provision of nation-wide safety education and training associated with new rules, recommendations and safety management strategies.

It could be argued that there is also a new era getting underway in aviation activities in Australia airspace. There is now greater diversity of aviation operations within shared airspace than ever before, and this diversity is influenced largely by increasingly greater numbers of small aircraft operations (CoA, 2010; GAASILG, 2007; BTRE, 2005). Within the past 10 years, individual aviation interest groups in Australia lobbied for, and finally achieved, greater self-management rights, including training and 'licensing' (certification) capacity. For example, RAA-Australia has, at the time of writing, over 10,000 members and is empowered to train and certify recreational aircraft pilots. There are also increasing numbers of other small aircraft in shared skies, such as light sports aircraft, hang gliders,

motorised hang gliders, gyrocopters, paragliders, balloons, and others. The performance capabilities of these disparate aircraft may vary significantly. It is often the case that very small 'recreational' aircraft, requiring a 'pilot certificate' only, may have greater engine performance and capacity than 'traditional' VH registered fixed wing aircraft such as an older Cessna 150, for which a 'traditional' pilot's licence is still mandatory. The differences in training and assessment between large and small aircraft operations has always been evident and of themselves may be of some concern with respect to current best practice in human factors training and safety culture awareness. There are also increasingly greater differences between groups within the small aircraft sector itself, along with possible gaps of safety culture awareness and practices and with different mindsets for planning flights (i.e., different 'flight plans').

1.2.2 Pilot Knowledge, Beliefs and Actions

It is generally accepted that the overall purpose of amendments of regulations or recommendations in any industry is to modify operator behaviour towards some form of desired 'best practice'. Yet mandating 'behaviour change by regulation and recommendation' may not necessarily enhance positive attitudes nor safety consciousness or behaviours. Conversely, such changes could lead to resistance or avoidance, and jeopardise desired best practice and safety culture outcomes. This may particularly be the case with operators who are very experienced in their field and/or who do not trust processes which seek to change 'the way things are done'.

Augmenting behaviour change in desirable and predictable ways has been the subject of much study over a number of years. Fishbein and Ajzen began a famous line of enquiry in this area in 1975 which has since been updated and continues to have viability in a number of contemporary settings. In its simplest form, Fishbein and Ajzen's theory showed that attitudes were important predictors of intentions, which in turn predicted behaviour. That is, individuals need to be convinced first, and would consider changing their behaviour second. Ajzen went on to develop his Theory of Planned Behaviour (2006) which explains how understanding the nature of subjective beliefs can influence behavioural changes. Aviation regulators are in effect requiring that pilots modify or upgrade their safety behaviours. Merely providing 'required knowledge' and expecting compliance by pilots does not take into account established evidence of the conditions required to best support attitude and linked behaviour change. There may be some benefit to pilots, trainers and regulators in reviewing the issues underlying behavioural change theory and practical change management.

1.2.3 Pilot Trust

Trust can also be demonstrated to be an important component of safety. Trust has been defined in a number of ways including 'the willingness of a party to be vulnerable to the actions of another party, based on the expectation that the other will perform a particular action (that is) important to the trustor, irrespective of the ability to monitor or control that other party' (Mayer, Davis & Schoorman, 1995). The relevance of trust in making changes to perceived 'tried and true' aviation operations is evident and this may help explain the nature of pilot resistance often seen when rules or procedural changes are mooted or implemented.

Research on trust indicates that level of trust often has subtle, widespread and important implications in a range of environments. O'Neill (2002) considered the notion of diminishing levels of trust (distrust) by ordinary people in 'usually trustworthy' institutions such as government and public services. Hudson (2001) believes that there are two key elements which will predict response style with respect to creating a comprehensive safety culture: the degree to which individuals are informed about the need for change, and the extent to which they trust the change process. These core ideas form part of Hudson's 'winning hearts and minds' concept. Fletcher et al (2003) found that judgments made by one team member of

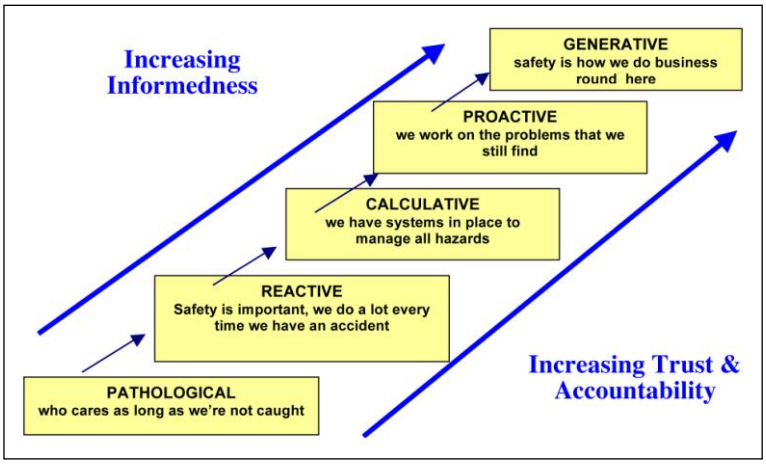
another's competence (trusting their ability) was important for team performance in high risk environments such as operating theatres, where people may have not worked together as a team before. This may also apply in a range of aviation settings including pilot-air traffic controller and pilot-pilot communications in circuits and at aerodromes. Flin (2004) makes the point that it is not always easy to assess levels of trust, for example, does *not* selecting Trust options in a survey equate to actual 'distrust'. Further work may need to be done with respect to understanding trust in aviation applications and settings.

1.2.4 Safety Culture

Hudson (2001a, 2001b, 2006) maintains that enhancing safety culture depends on working with two main variables, levels of information and trust. These elements can be demonstrated to be connected with issues such as pilot knowledge, beliefs and trust.

Building a safety culture also requires making organisational changes so that individuals and systems are both in harmony as change progresses. Sometimes such changes cost time, money or both. 'Change-ability' depends on the resources available to a group and the willingness and capacity to work with change. Hudson argues that the 'level' of safety culture can be shown by changes in behaviour and activity levels, for example, whether organisations pre-empt changes and willingly engage with them and 'get ahead of the game' or whether they take a wait and see approach, Hudson's five-stage safety culture model is shown below (see Figure 1).

Figure 1. The Evolution of Safety Culture (Hudson, 2001)



2 Method

The time frame of this research is an important aspect of the project. Specifically, data collection was deliberately chosen to coincide with a time of transition in Australian aviation governance and associated safety management, and with concurrent changes in worldwide 'nontechnical' rules and notions.

This research project was in effect a snapshot of small aircraft pilot understandings at a time of major change at both local and international levels. The project explored small aircraft

pilot knowledge, beliefs, trust and behaviours with respect to human factors issues in new and incoming regulations and recommendations.

Pilot learning styles were also investigated, with a view to informing the development of future training and assessment activities. Enhancing trust and positive attitudes to human factors' topics and concepts are important considerations in current views of aviation safety culture and safety management.

For the purposes of this project, the term 'small aircraft' is defined as including all aircraft which have no more than 5700kg MTOW (FAA, 2010)[1]. Radio controlled and unmanned aircraft have been excluded from this project, although they are also covered by small aircraft category regulations. Small aircraft pilots may vary in their training and licensing arrangements according to aircraft type/usage.

An online survey was made available in September – October 2008 to all pilots operating small aircraft, aged 18 years and older. Participants were invited to join the survey via an advertisement placed in Flight Safety Australia magazine (mailed out by CASA to all licensed current pilots), and also via an online aeroclub email list with approximately 7000 subscribers. Emailed invitations were also sent to individual aviation interest group committees (e.g., hang gliders, balloonists, and other recreational aircraft groups).

The survey consisted of four sections: Parts A-D. Part A collected basic demographic information such as pilot age, experience, flying hours. Part B investigated pilot knowledge, beliefs, and actions with regard to human factors issues and associated aviation rules and regulations. Pilots were also asked about their levels of trust in current changes in aviation procedures, education and training, and their perceptions of the usefulness of ongoing safety management changes. Responses were mainly quantitative in nature, although there were also a few options for pilots to make their own comments about the survey questions and their content.

Parts C and D asked pilots to complete two formal learning questionnaires, the Pilot Learning Process Questionnaire (PLPQ) and Kolb's Learning Style Inventory (KLSI). Results from Parts C and D are reported elsewhere.

[1] It's worth noting that, although small aircraft have been defined in this project in the simplest of terms, the general concept of 'small aircraft' has a variety of definitions and subcategories, depending on which aspect of aviation is being considered, eg flight operations (RPT, commercial, charter with passengers or with cargo, recreational), licensing, maintenance or wake turbulence effects (ICAO, 2010). Some aspects of these definitions are in flux and being updated, or have changed over the past few years, as aviation operations change and broaden. For example, CASA is currently establishing definitions and criteria for its aviation dictionary and also for Part 42 Manual of Standards and proposed Part 135 (CASA, 2010), where MTOW can vary from 5700 kg to 8640 kg MTOW respectively. Meanwhile, the FAA has included very light jets in the small plane category (FAA, 2010). 'Small aircraft' are variously referred to as small airplanes, low capacity aircraft, or are included in subcategories such general aviation (BITRE, 2008), recreational aviation, or as part of aviation interest groups such as lighter-than-air aircraft, powered hanggliders, gyrocopters, and other small aircraft categories. In any case, there are many types of small aircraft, operating in a range of circumstances, in increasingly shared airspace with large aircraft operations and each other.

3 Results and Discussion

3.1 Respondents

Four hundred and twenty nine pilots from all states in Australia replied to the survey. Pilot age ranged from 18 to 78 years and pilot experience ranged from 1 hour to in excess of 40,000 hours. All pilots completed Part A. About 60% of pilots then went on to complete Part B, and fewer again completed Parts C and D.

The majority of pilots who participated in the survey identified themselves as fixed-wing VH registered aircraft pilots. About 30% of the fixed wing VH-registered aircraft pilots also identified themselves as having 'large aircraft' experience (e.g., commuter flights, Boeing 737 and military experience. These pilots are necessarily already involved with human factors knowledge, training and updates in their professional aviation careers, and their knowledge, beliefs and actions are captured in the results.

There were also several 'recreational' pilots, some balloonists, and a few helicopter, glider, hang glider, motorised hang glider, and gyrocopter pilots. There were sufficient fixed-wing pilots to meet sample size criteria but not enough pilots in other categories, so all responses were grouped and reported together.

3.2 Pilot Knowledge

A total of 261 pilots responded to questions about their knowledge of current and incoming human factors based rules and recommendations. The majority of respondents reported an overall lack of awareness of incoming human factors based regulations and recommendations. There were five subcategories of human factors knowledge: Human Factors/Human Performance (HF/HP), Crew Resource Management (CRM), Threat and Error Management (TEM), Safety Culture (SC), and Safety Management Systems (SMS). Yes responses were low across all categories: Yes responses accounted for about 32% awareness (HF/HP), ranging down to 13% (CRM). The majority of respondents selected Don't Know/Unsure. The data suggests that pilots were not actively disagreeing with any statements, rather that some (few) pilots were indicating a definite positive response, and that most pilots indicating uncertainty or actual lack of knowledge.

3.3 Pilot Actions

Fewer than 14% of a total of 253 respondents indicated that they attended any formal aviation courses within the previous 12 months. This is a very low level of active participation on formal presentations. There may be a number of reasons for this, including regional access, geographical isolation, day or time of presentations.

A greater number of respondents (34%) reported making efforts to update their knowledge, for example, by reading CASA or other aviation and safety material. It seems that pilots may be responsive to education and information options that can be accessed from their home or local area. Increasing easy access, web-based learning options and information may be one way to address this need.

3.4 Pilot Beliefs

All pilots reported a belief that they themselves were more active in implementing current aviation requirements than was their club or interest group. Pilots may hold, or need to hold, a belief that they understand and act on current regulations. Despite pilot perceptions, this may not always be the case, even with well-meaning and experienced pilots, given the large amount of information of which they need to be aware.

However, when asked about their perceptions of preparedness for incoming new regulations and recommendations, all pilots indicated a belief that they were less prepared for these than they believed their club or interest group to be. In effect, pilots indicated an expectation and trust that the 'authorities' would have the knowledge and be ready to act on it when needed.

Pilots were also asked their opinions about training and education, in particular whether there was sufficient human factors based training, whether it was useful, and who should provide this. About 39% of a total of 243 pilots agreed that there was sufficient training and the rest were mainly 'unsure' or 'didn't know'. This may indicate some possible issues with accessibility or 'reach' of course announcements and advertising. Slightly more pilots (44%) reported a belief that the training was useful. It seems likely that pilots may appreciate what is on offer when they have knowledge of and access to courses.

When asked about training providers, pilots indicated strong preferences for 'traditional' training providers: flying schools (90%), club or aviation group (78%), CASA (76%) and CEO/CFI (64%). The nature of training was not specified (i.e., ground or flight training) and this accounted for some of the variation within responses. There may also be a bias towards 'traditional' training, given that the majority of respondents in the survey were fixed wing VH registered aircraft pilots. This may be an area worth exploring with other small aircraft interest groups.

3.5 Trust

Pilots were asked about their trust in regulators and other pilots. In response to the question of whether regulators know what they are doing with respect to proposing and implementing human factors' based requirement, 21% of 244 respondents indicated trust in the regulators, while the majority of pilots were 'unsure' or 'didn't know'. More specifically, about 43% of pilots trusted that regulators had sufficient evidence, 35% that regulators had sufficient knowledge and 34% that regulators had sufficient expertise, with which to implement change. Again, the majority of respondents indicated a lack of knowledge or uncertainty, rather than actual disagreement or lack of confidence.

With respect to trust of other pilots, 38% of pilots indicated an active trust in other pilots' levels of knowledge of human factors related regulations and recommendations. Similarly, about 39% of pilots indicated their trust that other pilots actively implemented those regulations and recommendations. As in previous questions, the majority of pilots were unsure or didn't know, rather than actively distrusting other pilots. Although, with respect to the issue of trust, being unsure or not knowing may be a form of 'distrust'.

Finally pilots were asked to indicate their beliefs about whether small aircraft safety would increase as a consequence of incoming new rules and recommendations. Twenty five percent of 246 respondents actively agreed that safety would be enhanced and the remainder were unsure or didn't know.

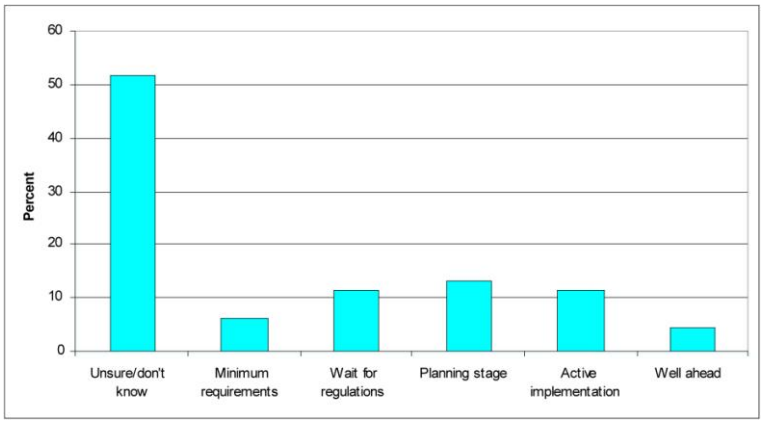
3.6 Safety Culture

Pilots were asked to indicate their perceptions of overall readiness of their organization, club or aviation interest group in preparing for incoming 'nontechnical' (human factors' based) safety culture and safety management regulations. Survey questions were similar in style, although not the same as, the notions within each stage of Hudson's model, and the response options were listed out of 'evolutionary' sequence. Specifically the survey stages ranged from 'will do the minimum required', 'wait until regulations are law', 'things are at the initial planning stage', 'there is active engagement with proposed implementation', 'planning

and implementation are well ahead of schedule', and 'don't really know, not much seems to be happening'.

Fifty two percent of 250 respondents indicated that they 'didn't know' about their aviation organization's preparation and planning regarding incoming regulations and recommendations. Forty eight percent of respondents had definite opinions about the state of organisational readiness for incoming regulations: 18% believed that their organisation was not proactive and that it would maintain minimum mandatory requirements, or that it would wait and see, 13.6% believed their organisation to be at the planning stage, and 16.2% believed their organisation to be actively engaged with changes, or were well ahead (doing more than was recommended or required) (See Fig 2).

Figure 2. Percentage of respondents reporting awareness of incoming regulations and requirements (n = 250)



It is worth remembering that these data were collected during a 'transition phase', at a time when CASA governance was being restructured, and at a time when several new rules and recommendations were being announced and introduced. It is possible (and hoped) that data collected at a later date could show greater awareness and positive activity in these areas.

Although these results tend to suggest that pilots had a low level of awareness of incoming rules and associated change management practices, it is also possible that pilots were unaware of actual incoming rules per se, or did not respond well to the question format as presented to them. Further work with pilots and their responses to incoming changes would be helpful in developing clearer processes for positive change management strategies.

3.7 What Pilots Said

While most of the questions required responses on a Likert style scale (3, 4 or 5 options, depending on the question), pilots were also offered the option of making their own written comments at several points throughout the survey. At one point, pilots were asked to give their opinions about the readiness of their club or group's actual preparedness for incoming rules and recommendations. Fifty five pilots offered comments, including statements that they were not connected with any group at all (n = 11), had not heard about the items under discussion (n = 6), believed that CRM or TEM were not relevant to single pilot operations (n = 8), as well as some positive opinions and many negative and strong negative opinions.

The negative opinions were in the majority (n = 22) and included comments such:

> 'my local flying club is not interested at all, some actually like to flaunt and defy rules'

‘these rules are knee-jerk reactions and are introduced retrospectively, so they are hard to take seriously . . current instructors are less experienced than old war horses post WW2’

‘I’m not confident that the rule makers know much about flying aeroplanes’

‘it would seem that the current plan within government is for monetary gain above all else’

‘aeroclub does not have any specific programs, basically all is left to the individual’

‘I have been flying and training pilots for 39 years and we need no extra regulations – time to butt out!’

‘the new regs are totally irrelevant to ballooning and aviation as a whole – this is all because truckers are having crashes and is in no way relevant’

There were also several positive comments, including:

‘the helicopter fraternity communicates quite well on safety and human resource issues . . . ‘

‘we have a well established flying school and I have no doubt they are prepared’

‘RAA-Aus has started to implement training in these areas as mandatory for all members, can be completed online or in class’

‘CASA’s field safety advisors are a great place to start in assisting as new rules are introduced’

This sample of responses highlights some of the common themes of comments often heard in hangars or aerodromes, such as generational issues (*it was better in the old days*), information dissemination issues (*have no knowledge*, *not connected to an aviation organisation*), and trust or scepticism (*overgovernance*, *increasing charges/money*, *who makes these rules and why?!*).

There were other comments in this section and in other parts of the survey, such as the ways in which pilots choose to learn new information, the type of information they find helpful, and preferred update options. Strong preferences were shown, for example, for CASA workshops and educational input. Taken together, these open-ended comments provide very useful insights into the specific knowledge, beliefs and actions seen within this respondent group, as well suggesting new ways of working with these issues, particularly when it comes to introducing new information into an ‘experienced’ aviation population. These comments are elaborated elsewhere, along with suggestions for information dissemination and training (Kabi, 2010).

4 General Discussion

The current research is useful in helping to define areas of interest for further work. The results highlight the need to consider different methods of accessing smaller aviation interest groups, ways in which information might be gathered, and ways of working towards increasing information dissemination, trust and support.

Trust has been shown here to be a relevant factor in initiating and maintaining active engagement with acquiring new information and with change management. More work needs to be done in relation to engaging small aviation interest groups in the processes of

deciding the ways in which human factors knowledge can enhance safety culture and safety management in their own sector, and the ways in which to disseminate and implement that information. More work also needs to be done in developing stronger, more positive relationships between regulators, trainers and aviation interest groups.

The quantitative data serve as a starting point in understanding the nature of the attitudes and beliefs which may drive some of the behaviours associated with engaging with new information and aviation procedures and practices. The qualitative data (i.e., the pilot's responses to open ended questions) help to enrich the quantitative information obtained in the Likert-scale questions and provide useful information for tailoring future education and training options.

The rate and amount of change occurring within the small aircraft sector could be seen to be disproportionate to that which occurred in 'parallel' circumstances in the large aircraft sector. That is, pilot resistance to the introduction of human issues was very pronounced in the 1970s, but incremental change over a long period of time has seen much greater acceptance of nontechnical aspects and their incorporation to standard operations. This has not been the case with small aircraft operations in general, and particularly not with 'recreational sport aircraft'. The 'buy in' of small aircraft pilots to adopt nontechnical concepts is arguably greater, and occurring at a faster rate, with less organisational support, than was asked of their 'bigger' cousins. In addition, the governance within aviation interest groups may be less rigorous than in more formal organizations. Local clubs are usually run by elected committees, which may be prone to 'popularity' or 'availability' of members, especially in rural or isolated areas. There may also be issues with information dissemination, access and training. Small aviation interest groups could benefit from partnered mentoring and support, and that this may assist at both committee and ordinary membership level. Further work regarding these issues may assist the enhancement of safety culture within small aircraft subgroups.

There are some limitations to the research design and findings. The invitation to participate in the survey was not accepted by a sufficient number of pilots in specific aviation interest groups to allow comparison of pilot responses between interest groups. The results are, therefore, representative of only one sector of small aircraft aviation, predominantly pilots of fixed wing VH-registered aircraft. These pilots are also the most likely to have some prior or ongoing contact with human factors and nontechnical issues and training. Due to the low response rates, there was insufficient data to provide further insights into other aviation interest groups, such as recreational, weightshift, or other small aircraft, and in relation to pilot responses to changes occurring within their aviation subgroup.

The survey format and question style were seen to be problematic by some respondents, as evidenced by some pilots' comments and also by the numbers of pilots exiting the survey prior to completion of survey subsection/s. In contrast, there were respondents who clearly had no problems with answering the questions or coping with the question format. Lack of familiarity with question content and format may partly explain some of the negative comments. The format used is not typically seen in aviation documents and this may be a factor worth considering in any future work with this population. But that is not to say that surveys need to replicate 'typical' aviation surveys, only that a slightly different approach be developed. Suggestions for change, and higher response rates, could perhaps be derived from focus groups and short planning surveys or interviews and also 'road tested'.

Overall, it seems likely that ongoing changes in aviation safety culture may be more problematic within the small aircraft sector when compared to the large aircraft sector. Further work regarding the nature of the 'subcultures' of smaller aviation interest groups may prove helpful in determining their strengths and weaknesses and also assist in developing

some supports and waypoints for safety culture enhancement. Such assistance would also include tailored information dissemination and education and training options.

Conclusion

Important safety changes are currently being implemented in Australian and worldwide small aircraft operations. Safety management and change management across a large 'single focus' and multi-location industry, such as aviation, is a complex process. There are many different aviation subgroups, located in diverse geographical and physical environments, each having similar yet at the same time significantly different operational needs and practices. This is particularly the case within the small aircraft sector, where aviation operations have not matched the progress in nontechnical procedures seen in large aircraft operations. Changes in small aircraft operations also generate problems specific to the sector, such as critical time and cost offsets, very limited staff to cover a multitude of activities, and regional and geographic challenges such as distance and access to resources.

The results of the present study suggest that that pilots' knowledge, beliefs and trust may be useful predictors of the ways in which pilots engage with new information and procedures, and that 'one size' might not fit all. The results also suggest that information dissemination, training and education should be tailored in ways that offer increased support to pilots and sustainable uptake of safety information and culture.

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