Reducing Pathological Stress Effects and Increasing Pilot Performance During Unexpected In-Flight Events.

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REDUCING PATHOLOGICAL STRESS EFFECTS AND INCREASING PILOT PERFORMANCE DURING UNEXPECTED IN-FLIGHT EVENTS.

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The inherent reliability of the modern aircraft means pilots rarely experience actual emergencies, or novel, unexpected events. When events do occur, increased arousal levels may have pathological effects on pilots’ abilities to deal optimally with the situation, leading to increased likelihood of undesired aircraft states. Amygdala based appraisals of unexpected events may cause over-arousal through lack of expectation, lack of previous experience of such events (either directly or vicariously), and through poor individual perceptions of the ability to handle such events. Routine discussion of novel or emergency events widens pilots’ event knowledge database and raises expectation of event occurrence. Individual perception of efficacy in such events is heightened through increased and more readily accessible knowledge, allowing more positive appraisals, which reduces arousal level and improves performance. A pilot study using scenario based discussion at a New Zealand Airline showed very positive perceptions of utility and efficacy and will be discussed.

The ubiquitous reliability of the modern aircraft has added substantial improvements to air safety. However, as a result the average pilot rarely experiences real emergencies, or novel, unexpected events. While simulator training allows exposure to such events, this happens rarely, perhaps only four days per year, with prolonged periods of routine operations out on the line, the norm. While older pilots may remember the days when engine failures were not uncommon, the airline pilot of today could go through the remainder of their career with some statistical surety of never experiencing a major powerplant failure. Engine reliability is such that the prevalence of other systems failures or automation related issues are more commonly cited in modern aircraft incident and accident statistics. Accidents such as the Air France Flight 447 loss of control over the Atlantic (BEA, 2009), the Turkish Airlines Flight 1951 loss of control on approach at Amsterdam (The Dutch Safety Board, 2010), and the Qantas A330 incident off Western Australia involving a loss of control inflight (ATSB, 2008) are typical recent examples where unexpected events resulted in accidents or undesired aircraft states.

When actual events do occur, increased arousal levels may have pathological effects on pilots’ abilities to deal optimally with the situation, leading to an increased likelihood of undesired aircraft states. Over-arousal or acute stress has been strongly associated with reduced performance (Stokes and Kite, 1994) with Amygdala based appraisals of unexpected events at times causing over-arousal through lack of expectation, lack of previous experience of such events (either directly or vicariously), and through poor individual perceptions of the ability to handle such events. Anything which can be done therefore to reduce stress levels during critical events is likely to engender positive effects on performance.

Routine discussion in the briefing room or the aircraft of novel or emergency events has several benefits during subsequent critical incidents. As well as widening pilots’ event knowledge database, it raises expectation of event occurrence. Individual perception of self-efficacy in such events is heightened through increased and more readily accessible knowledge, allowing more challenging, rather than threatening appraisals, and therefore reducing arousal level. A pilot study
using scenario based discussion at a New Zealand Airline in 2010 showed very positive perceptions of utility and self-efficacy amongst the Pilots who participated.

**Discussion**

Substantial data exists (e.g., Boeing, 2010) which suggests that the reliability of modern aircraft, coupled with increased flight path awareness tools such as Enhanced Ground Proximity Warning Systems (EGPWS), Vertical Situation Displays (VSD), Head Up Displays (HUD), and Electronic Flight Bags (EFB), have greatly reduced the number of Controlled Flight Into Terrain (CFIT) accidents over the last few decades. Coupled with ubiquitous reliability in modern aircraft engines and improved systems, the trend in flight safety is continuing to improve. Regardless of these tools and equipment, aircraft still continue to have accidents, with the predominance in the statistics suggesting that in-flight loss of control is now the most common cause (Boeing, 2010).

Of these accidents, humans have continued over the evolution of aviation, to contribute around 70-80% to contributory causes (O’Hare, Wiggins, Batt, & Morrison, 1994; Wiegmann and Shappell, 1999; Yacavone, 1993) and while the technology has morphed over the generations, so too has the nature of the human contribution. Typical areas of concern in modern aircraft generally include automation management, loss of situational awareness, poor judgement and decision making, vigilance issues, complacency, spatial disorientation, and physical factors. While these issues have always been contributory, the very nature of the modern airliner, with its automation, reliability, and endurance, has made some of these more of an issue than was previously the case.

The level of pilot performance during unexpected, novel, or emergency events varies widely. In some, well-documented cases, such as those on American Airlines Flight 1592 which ditched in the Hudson River in New York (NTSB, 2009), the British Airways Flight 009 which lost all four engines in a volcanic ash encounter in Indonesia (UK AAIB, 1982), or those on United Airlines Flight 811 which made an emergency landing following a cargo door failure (NTSB, 1992), the pilots performed exceptionally well, both individually and as a crew. In other cases however, pilot performance has been badly affected by startle and/or acute stress effects resulting in undesirable aircraft states or even accidents. Recent examples include the Turkish Airlines Flight 1951 accident at Amsterdam (The Dutch Safety Board, 2009), and the Air France Flight 447 which crashed in the Atlantic, where the pilots failed to recover from what appear to be fairly recoverable situations following unexpected events.

Stress and under-performance are likely where pilots have never considered how to deal with a situation before (Hancock & Szalma, 2008). Generating a solution to a problem and putting into effect a strategy for dealing with it are much harder from scratch, particularly under the effects of acute stress. Having a stored plan for dealing with a range of novel events, allows individuals to simply recall these strategies and apply them to the situation at hand; a much simpler task under stress. These “cognitive pre-plans” may simply be management strategies which can be applied to a number of conceivable events.

Startle is a phenomenon which affects all humans and most animals, and varies in its intensity depending on individual susceptibility and expectation levels (Muto and Wierville, 1982; Warrick, Kibler & Topmiller, 1965). Research has shown that startle can affect information processing for up to 30 seconds (Thackray, 1988; Vlasak, 1969; Woodhead 1959, 1969), which in a dynamic, complex situation such as an unexpected novel or emergency event, can have substantial effects on situation outcome. It is likely that these effects are generated not from the initial involuntary startle reflex effects (such as eyelink and aversive movement), but rather from an amygdala based activation of the sympathetic nervous system which may accompany it, which
is epitomised by the “fight or flight” reaction (Canon, 1929). Unfortunately there is little that can be done to overcome these phenomena other than to raise expectation levels through conditioning (Roberts, 2003), and greater exposure to such events which creates “previous experience” and a sense of self-efficacy which will reduce sympathetic nervous system arousal levels.

Acute stress caused by over-arousal can have significant effects on situation outcome, with emotion-focused coping mechanisms such as freezing or denial having potentially disastrous consequences. Stress occurs when individuals appraise a situation as potentially harmful and that they are insufficiently equipped to deal with it. Primary appraisal is the amygdala based assessment process which determines whether a stimulus is benign/positive or involves loss, harm, threat or challenge. Secondary appraisal determines the best method of coping with threats and is generally dealt with in two ways: problem-focused coping, in which the individual deals with the problem, and emotion-focused coping which simply changes the individual’s relationship to the problem (Lazarus & Folkman, 1984; Monat & Lazarus, 1991). Of these, emotion-focused coping may use problematic methods such as freezing or denial, and will likely therefore have negative implications for situation outcome. The following diagram is proposed to show the relationship between appraisal and information processing:

Figure 1. A Conceptual Model of Appraisal and Information Processing
(Martin, Murray & Bates, 2010)
A pilot study was carried out in 2010 at a New Zealand based international airline (Martin, Murray & Bates, in press). The project was entitled “What would you do if....?” and involved ten weeks of trial followed by a short survey. During the trial pilots were encouraged to spend a few minutes enroute each day discussing novel events and emergencies, considering how they would handle the aircraft, what they would do in terms of diversions, checklists and communications, and what best resources to utilise to deal with the problem. Following the trial a survey was conducted which analysed the sense of utility and self-efficacy for novel events which pilots developed during the trial. The following graphs show some of the significant results:

**Question 4:** Do you think that these discussions have raised your expectation level for surprise events?

![Graph showing responses to Question 4](image)

**Question 6:** As a result of these discussions do you think that you would be better prepared to handle one of these novel or emergency events if it happened unexpectedly?

![Graph showing responses to Question 6](image)

(Martin, Murray & Bates, 2011)

**Conclusion**

Reduced expectation of failure and conditioned over-confidence in aircraft reliability are realistic consequences of ubiquitous normality in the sophisticated and failure-tolerant aircraft becoming more and more prevalent in airline operations. This lack of expectation, coupled with an enduring emphasis on traditional failures during training and checking, are having negative effects on situation outcomes during unexpected novel or emergency events.
Pathological stress effects such as denial and freezing, coupled with over-arousal associated with startle or surprise, can be mitigated to some extent by greater levels of expectation, and greater pilot self-efficacy for the handling of such events. This expectation and efficacy can be improved by organisational and personal interventions which would encourage pilots to discuss novel and emergency events during quiet periods enroute, as a means of developing “cognitive pre-plans” for dealing with such events. The traditional “What would you do if .... happened?” has commonly been used in military transport operations and in airline command training, but has been under-utilised in normal line operations. Discussion of novel events allows pilots to form a plan for what they would do in a given situation, free of stress and startle effects, which they can then store as a series of related processes and strategies for some time in the future. Regular revisiting of these strategies allows for consolidation in long-term memory and associations with a large range of situations. This in turn allows these strategies to be utilised from memory in the event of a novel incident, either directly, or through association with some previously considered and similar event. Strong memories in the long-term memory are comparatively more resilient to stress effects, and the greater the depth and breadth of previous event “pre-plans” therefore, the more seamless utilisation of effective processes and strategies for dealing with such events or similar events.

A pilot study at a New Zealand based international airline found that pilots who participated in scenario discussions of novel events generally had raised levels of expectation and a greater sense of self-efficacy for dealing with such events. A willingness to continue with scenario discussions beyond the study indicates the sense of utility of the discussions which was evident amongst participants.

As evidence based training starts to become more widespread and an acknowledgement of changing needs to deal with real world failures in aircraft becomes recognised, the use of scenario based discussions to bolster the capabilities of pilots in dealing with unexpected novel and emergency events would seem to be complementary. Further research is warranted.

References


