THE RELATIONSHIP BETWEEN NON-TECHNICAL SKILLS AND RESILIENCE

Associate Professor Wayne Martin BAvMan, MAvMgmt, MBus, PhD, FRAeS



BE WHAT YOU WANT TO BE cqu.edu.au

CRICOS Provider Code: 00219C PRJ-14042

Dr Wayne Martin Adjunct Associate Professor of Aviation, CQU

Post-doctoral researcher in Human Factors Supervisor to 9 PhD students (USQ/CQU) Convenor of the PACDEFF CRM and Aviation Human Factors Conference 40 years & 20,000 hours total flying experience (10 years Military) B777 Pilot with Virgin Australia (15 years) B777 Simulator Instructor (& B737-MCC)









Topics

- Introduction
- Resilience
- TEM and Resilience
- Consequences of Resilience Failures
- Becoming More Resilient
- The Nature of Startle and Surprise
- Using Our Non-technical Skills to Improve Resilience
- Conclusion



BEWHAT YOU WANT TO B



Resilience

Over the last decade or so there have been a number of aircraft accidents where the pilots appear to have been presented with an unexpected critical event, which was subsequently mishandled by the crew.

In some of these accidents inappropriate crew actions actually exacerbated the situation.

Recent literature has often cited these crew shortcomings as 'A LACK OF RESILIENCE', a convenient and non-descript term.







Resilience

Resilience implies [being] prepared ... and [being] prepared to be unprepared (Pariés, 2012).

The traditional interpretation of the term *resilience* has widespread strategic applications across a number of domains.

Agriculture may use the term to describe crops which are *resilient* to drought or pests.

Medicine may describe it in terms of patients who were *resilient* to infection, or diseases which were *resilient* to treatment.

Businesses may use the term to describe *resilience* to economic downturns.









Strategic and Tactical Resilience

While *resilience* is often used as a strategic term, including in aviation, a number of aircraft accidents over the last few years have also demonstrated a need for *tactical* resilience, and the industry is slowly starting to move towards training strategies which will make personnel across the aviation system more resilient to unexpected adversity.

Evidence Based Training (EBT) is one of the processes becoming more widely used to facilitate this development of resilience.







The Curse of Ubiquitous Normalcy

Fifty years ago, aircraft reliability was such that pilots were regularly exposed to non-normal events. Engine failures, system failures, navigation challenges and a myriad of other aircraft-related challenges meant that there was a continually high level of suspicion and expectation for failure amongst pilots.

Contrast that against current technology and pilots who are flying aircraft whose engines have a mean time between failure of literally hundreds of thousands of hours, could statistically at least, expect to fly for dozens of careers and never experience an actual engine failure.

This ubiquitous ultra-reliability lends itself to a *conditioned expectation for normalcy,* which, while certainly unwitting, has regularly exposed a lack of adaptability and resilience, even amongst very experienced pilots, when things have gone awry.





Is Resilience Just Threat and Error Management?

There have been questions raised about the recent emphasis on the term *resilience* within aviation (e.g., Jarvis, 2017), and especially with regards to comparisons with existing constructs such as Threat and Error Management (TEM).

The underlying premise of TEM is that in order to manage risk, crews should avoid, mitigate and manage the threats and errors which abound. Helmreich et. al. (1999) suggest that risk emanates from both expected and unexpected threats, and that CRM behaviours are the last line of defence against such threats.



BEWHAT YOU WANT TO BE



Is Resilience Just Threat and Error Management?

When examining TEM for comparisons with resilience, it is easy to identify comparable goals in terms of *strategic* resilience. In this construct, pilots and other crew members are prepared, and have an expectation for, eventualities (threats or errors).

This could be termed resilient behaviour, because the very act of being prepared makes someone less likely to be put in a position where they will have to recover from an undesired state. This equates to the *avoid* and *mitigate* parts of threat and error management.

There is also a *tactical* side to resilience, where crew members react to events happening in real time. When such events have potentially negative consequences, resilient behaviour allows the crew member to recover to a safe state. This could be considered analogous to the *manage* stage of TEM.



BEWHAT YOU WANT TO BI



Is Resilience Just Threat and Error Management?

It is clear that there are similarities between TEM and resilience, and there are likely elements of crossover between the two concepts, however resilience has much wider and more diverse applications.

Resilient behaviour can be characterised by an ability to resist impairment from adverse circumstances, or to at least recover from such circumstances.

It also has applications at an individual level, a team level, an organisational level, and even at a systemic level, whereas TEM is predominantly a flight crew application.

Fror resi	n threat and erro lience	or management (TEM) to
Article · J	anuary 2006	
CITATIONS		READS
12		1,214
2 authors	, including:	
	Sidney W A Dekker	
	Griffith University	
	71 PUBLICATIONS 1,802 CITATIONS	
	SEE PROFILE	
	dee Phonee	

BEWHAT YOU WANT TO B



The Consequences of Resilience Failures

Aircraft accident data is full of examples of non-resilient pilot behaviours. In fact, almost all accidents which were human-centric in causality, could conceivably be classified as lacking in pilot resilience, because the pilots involved failed to recover from adverse circumstances.

In a lot of those cases, the circumstances which arose may even have been predictable, and/or entirely preventable, so the strategic resilience behaviours which could have prevented the undesired state, were either missing, or at least deficient.



BEWHAT YOU WANT TO B



The Consequences of Resilience Failures

Likewise, the tactical resilience which would have enabled pilots to recover from adverse circumstances has been noticeably absent at times. The inability to apply previously learned skills and knowledge to both novel and to well-known adverse events, has illustrated a possible shortcoming in the modern pilot's arsenal.

Whether this is a trend which is borne from increasing complexity and sophistication in modern aircraft, which more than ever, removes pilots from the loop in system awareness, or whether the ubiquitous reliability reduces expectation for adverse events to a point where pilots become complacent, is not always clear.

However, both of these issues have been identified as problematic, and will likely only become more so in the future, as older generation aircraft are phased out, and even further technological advances are made.



BEWHAT YOU WAN



Becoming More Resilient

How then, can pilots be more resilient, and avoid accidents such as AF 447 or Colgan Air 3407?

When considering strategic resilience, there are a number of ways that pilots can address this. They can be well rested, be free of additional lifestyle stressors, be technically competent in their role, ideally have previous experience to relate to, and have a high level of knowledge about their aircraft, their standard operating procedures (SOP's), and their non-normal procedures.

While the crew of AF 447 may not have been impaired by fatigue or lifestyle stress, they clearly lacked sufficient technical knowledge to assimilate and comprehend the cues that were available to them. Whether other pilots in the same situation would have been equally confused is of course unknown, however the lack of understanding of highly complex and sophisticated aircraft is a problem that is perhaps more widespread than we would like it to be.





Becoming More Resilient

Breakdowns in strategic resilience also come about by poor judgement and decision making. Sound naturalistic decision making comes from sound situational awareness, and experience, but also requires a high level of knowledge, which can be used as a basis for making informed, quality decisions.

Reactive, or tactical resilience is also borne from sound CRM skills. It is unclear how many unexpected critical events have resulted in disaster, which could have been saved by sound leadership and teamwork, by effective communication skills, by sound situational awareness and decision making, and by effective task assignment and execution (workload management), but it is likely to have been a substantial number.







Startle

Startle research has shown than an extensive and elaborate reaction occurs throughout the body, particularly when the startle occurs in conjunction with a conditioned stimulus that has been associated with some fearful or threatening experience.

Fear conditioning studies have shown that when startle is experienced in the presence of threat, or perceived threat, then the severity of the startle is greatly exacerbated, creating a reaction generally known as fear-potentiated startle.

This enhanced reaction, which involves the arousal of stress circuits within the body, extends well beyond the simple reflex reaction and engenders significant changes in the nervous system, endocrine system, and the workings of the brain.



BEWHAT YOU WAN



Surprise

'An unexpected event that violates a pilot's expectations and can affect the mental processes used to respond to the event' (FAA, 2015)

Surprise is a relatively common phenomenon, which occurs when something occurs which is outside the expectation set of the pilot(s) concerned.

This surprise element can temporarily destroy the situational awareness mental model which pilots maintain, as they try to integrate this new sensory information into a new mental model of what is going on.

This process can be relatively quick, as the new cues are easily understood and integrated, or it may take some considerable time to make sense of.



BEWHAT YOU WANT



Surprise

Lanir (1986) makes a distinction between situational surprise and fundamental surprise.

Situational Surprise: A surprise that can be fitted into our current frame of understanding. While unexpected it is conceivable.

Fundamental Surprise: A surprise that challenges our basic assumptions of the situation and requires a new frame.





BEWHAT YOU WANT TO BE



Sensemaking

nversity

One of the common outcomes of both startle and surprise can be the requirement to re-evaluate the situation to 'make sense' of this new information or stimulus.

During this 'sensemaking' process, new information must be integrated into our previous understanding and expectations before we can regain situational awareness.

This process may occur with both startle and surprise when there is also some highly salient distraction or confusing and ambiguous cues.

This sensemaking process may be very quick for 'false alarm' startles or situational surprises, or quite lengthy where fear potentiated startle or fundamental surprise occurs.

During this period of sense making, where new information is trying to be comprehended and integrated, the pilots are vulnerable to breakdowns in situational awareness, and decision making, and therefore require some level of resilience to ensure the aircraft does not enter an undesired state.





Within the crew environment, considerable work has been done over the last 40 odd years to build capabilities into crew members, which equipped them to not only be technically competent, but also competent in their non-technical skills (NTS).

These non-technical skills are at the heart of effective crew resource management and include elements such as leadership, teamwork, communication, situational awareness, decision-making, workload management, stress management, fatigue management, and a number of others.

CRM, NTS and Human Factors programs across most of the world have generally received strong support, and are recognised by the International Civil Aviation Organisation (ICAO) and other regulatory organisations as an intrinsic part of the battle to improve aviation safety.





Situational Awareness

niversity

Situational awareness (SA) has been described in various ways, but is commonly conceived as a three-step process: perception of environmental cues; comprehension of their meaning; and projection of the implications of this information into the future (Endsley, 1995). While resilience is not necessarily a direct result of SA, it could be argued that strategic resilience, where adversity is anticipated and prepared for, is dependent on SA.

Hollnagel et, al., (2011) describe a form of strategic resilience where people have a readiness to respond to eventualities. They accomplish this by being situationally aware. This means that they have a fundamental understanding of what is going on around them at the moment, and also have an expectation for what is *likely* to happen in the future, and an expectation for what *could* happen in the future.

Hollnagel et al., (2011) further describe four cornerstones of resilience: anticipating, monitoring, responding, and learning. These would go hand in hand with Endsley's (1995) interpretation of situational awareness, given that the learning function is more allied to future states of SA.



"Say ... what's a mountain goat doing way up here in a cloud bank?"

BEWHAT YOU WANT TO BE



Decision-making

Sound decision-making, particularly in complex, high risk environments such as aviation, is a strong contributor to resilience, both at a strategic level, and in a recovery period following an adverse critical event. Conversely, resilience could be considered a fundamental requirement when crews are required to make rapid, accurate, safety-critical decisions under stress, such as during an aircraft emergency.

One of the significant factors affecting decision-making, and therefore resilience in aviation, is uncertainty. Decisions are relatively simple when situations are readily assessed, and there are a limited number of decision options, with clearly associated levels of risk. However, real-world decision making, particularly during complex safety-critical events, does not always enjoy the benefit of being predictable, or easily understood, which can impact on recovery efforts. While the ideal answer would be that pilots were more "resilient," and therefore better equipped to deal with such events, regrettably such resilience is often tested during novel, safety-critical events.



BEWHAT YOU WANT TO BE



Decision-making

A resilient flight crew could be considered to be a crew who made decisions commensurate with risk, who were prepared technically for any eventuality, and had on hand a range of pre-considered decision options which could be adapted to suit a range of both known, and novel circumstances.

Such crews could be considered to be strategically resilient (i.e., prepared for most eventualities), and tactically resilient (i.e., able to respond with appropriate decisions following an unexpected critical event).

Research has shown that greater exposure to decision-making tasks, and also to novel, unexpected events, can improve future decision-making during such events through the development of decision strategies, and a wider breadth of experience to base such decisions on.

This is one of the premises of EBT and is likely to become more prevalent in the future.



BEWHAT YOU WANT TO BI



Communication

One of the common themes in organisational resilience literature is the need for strong, clear and effective communication skills. These same requirements apply equally to flight and cabin crews in times of adversity

One of the common occurrences under periods of acute stress is a breakdown in communication, sometimes to the point where it stops entirely, or is at least stilted. Contrast this to the measured, clear communication styles exhibited by Captains Haines and Sullenberger in the United 232 and US Airways 1549 accidents respectively, and it becomes clear what the ideal communication style is under immense adversity.





Communication

Communication is an enabling skill for effective situational awareness and for decision-making, and therefore forms an equally important role in strategic resilience as it does in tactical resilience.

It is often the basis of a shared mental model which is an effective tool for TEM.

Shared mental models can be hard to restore in the initial aftermath of an adverse critical event, particularly where it involves surprise or startle, and therefore ensuring a communication stream which announces the most critical information, will ensure all crew are focussed appropriately and as a team.



BEWHAT YOU WAN



Workload Management

Task management is a critical skill, particularly under periods of high workload. Effective workload management has a very significant role in preventive, or strategic resilience by reducing the chances that crew members will be distracted by tasks and thereby creating a window for an adverse event to develop.

It is also a tactical resilience skill, allowing crew members to focus on the critical tasks following an adverse non-normal event. The old adage of *Aviate – Navigate – Communicate* is a prioritisation tool which is particularly effective in non-normal situations, and lends itself to resilient behaviour. While there may be a number of attention getters during a critical situation, the onus must always be on flying the aircraft and managing the flight path. This has not been well done in a myriad of cases which ended in negative outcomes.

Workload Excess Workload can result in human performance issues such as: Slower task performance · Errors such as slips, lapses and mistakes Under-load can result in: Boredom Loss of situation awareness reduced alertness

BEWHAT YOU WANT TO BE



Stress Management

niversity

Significant stress has largely negative effects on information processing. While a moderate level of arousal is useful for keeping focus and vigilance, the impairment effects of acute stress during emergencies or conditions of threat, can have a serious impact on the resilience of crews.

Prior to critical events, high levels of stress can cause decreased or narrowed attention, poor concentration, or concentration on task irrelevant issues; a less resilient state because of the impaired awareness.

During and immediately following a critical event, stressed crew members suffer from all of the same issues, but often at a much more heightened level. The results of this can be impairment beyond the point of being able to contribute meaningfully, including episodes of freezing. While these are rare, the impairment effects of stress are likely to be exacerbated during conditions of threat, reducing both individual resilience, and therefore overall team resilience.





Stress Management

There are a number of techniques for remediating the effects of stress. Most of these are lifestyle based and involve psychological or actual means of either reframing stressors, or removing them completely.

Such techniques include social support, counselling, exercise, yoga, meditation, improved diet, and reduction of relationship or financial stressors. Such efforts could be considered strategic resilience, designed to alleviate the stress which predisposes crew members to poor performance during stressful events.

Following critical events, where stress levels may spike, the effects of deliberate breathing have been shown to improve recovery time. Earlier recovery will likely aid resilience as more working memory capacity is freed up.



BEWHAT YOU WAI



Fatigue Management

Fatigue is an insidious impairment, which is receiving much attention worldwide. While ICAO has published guidelines (ICAO, 2016), individual regulators are quite varied in the way they apply those guidelines.

There is also a move towards Fatigue Risk Management Systems, which allow mature operators some leeway to manage their risk exposure based on evidence from their own operation.

The effects of fatigue on crew members has been relatively well studied however there is still further room for scientific rigour in establishing contemporary empirical bases for fatigue rules across a diverse and complex industry.



BEWHAT YOU WAN



Fatigue Management

At an individual level, fatigue often manifests itself as a reduction in concentration, vigilance, attentional span and teamwork. It also adversely impacts on complex mental tasks, such as those that would be required during novel critical events

Fatigue is therefore likely to have a significant impact on an individual's resilience, both strategically and tactically. Where the situation encountered calls for exemplary teamwork, leadership and higher order thinking skills for successful resolution, then the resilience of the team could also be affected.

Managing fatigue through appropriate pre-duty rest, through in-flight naps (where appropriate), and through the appropriate use of caffeine, can enhance individual and therefore team resilience.





Conclusion



The Resilience Continuum



BEWHAT YOU WAN

Resilience is a term which has become widely used, particularly at an individual level and at an organisational or systemic level. It is however rarely discussed at a small team level, such as happens every day in the aviation industry.

While the tactical resilience which saves the day is essential, there is also a strong case for CRM skills to be used as a defensive, more strategic tool, utilising this array of abilities and behaviours to be on top of the TEM challenge, and to avoid situations which would require a recovery using tactical resilience.

Training pilots in the future to be resilient will continue to focus on CRM and Non-technical skill development, in both normal and non-normal situations. It will also focus on exposure to unexpected critical events, in a constructive, learning environment. Better resilience will also be borne from raising the expectation levels for critical events, a battle which will not be easy as aircraft become ever more automated, sophisticated, and reliable.



Questions?



