ISSUE 121

focus

ON COMMERCIAL AVIATION SAFETY

SUMMER 22

The official publication of the United Kingdom Flight Safety Committee

ISSN 1355-1523

Contents

The Official Publication of THE UNITED KINGDOM FLIGHT SAFETY COMMITTEE ISSN: 1355-1523 SUMMER 2022

FOCUS is a quarterly subscription journal devoted to the promotion of best practises in aviation safety. It includes articles, either original or reprinted from other sources, related to safety issues throughout all areas of air transport operations. Besides providing information on safety related matters, **FOCUS** aims to promote debate and improve networking within the industry. It must be emphasised that **FOCUS** is not intended as a substitute for regulatory information or company publications and procedures.

Editorial Office:
Unit C2b, Fairoaks Airport, Chobham, Woking, Surrey, GU24 8HU
Tel: 01276 855193 Fax: 01276 855195
e-mail: admin@ukfsc.co.uk
Web Site: www.ukfsc.co.uk
Office Hours: 0900 - 1630 Monday - Friday

Advertisement Sales Office:
UKFSC
Unit C2b, Fairoaks Airport, Chobham, Woking, Surrey, GU24 8HU
Tel: 01276 855193 Fax: 01276 855195
email: admin@ukfsc.co.uk
Web Site: www.ukfsc.co.uk
Office Hours: 0900 - 1630 Monday - Friday

Printed by:
Woking Print & Publicity Ltd
The Print Works, St. Johns Lye, St. Johns, Woking, Surrey, GU21 1RS
Tel: 01483 884884 Fax: 01483 884880
e-mail: sales@wokingprint.com
Web: www.wokingprint.com

Front Cover Picture: 9H-LFS of Maleth Aero / FlightService (MLT / DB) during the climb out. FlightService have been conducting cargo operations across the globe using a fleet of cabin-cargo modified A330s such as 9H-LFS. FlightService are now converting the majority of the fleet back to passenger configuration for ACMI operations and some tails will be modified to the new Bulk-Cabin Cargo freighter configuration.

Notice to subscribers – General Data Protection Regulations

UKFSC retains contact details for individual FOCUS subscribers for the purposes of distributing the magazine; no other data is held. All personal data will be destroyed when we are notified that a subscription has ended.

focus ON COMMERCIAL AVIATION SAFETY

'Temperatures and Pressures'

by Dai Whittingham, Chief Executive UKFSC

In the last few months, we have seen the industry's attempts to recover baulked by the lack of manpower in some critical areas, with delays, disruptions and flight cancellations featuring prominently in the news. Much of this was predictable, and indeed this factor was included in non-pandemic safety guidance documents prepared for the Flight Safety Foundation in March 2020[1], but much was not. Unfortunately, it is unreasonable to expect airlines, airport operators and ground handling agents to keep 100% manning to meet 2019 rates when today's activity levels - and therefore revenue - do not support the outlay. That is business, and managers have a duty to keep their businesses afloat.

What we are experiencing now seems to be a perfect storm, where the confounding factors seem to multiply at every turn and where the touch points between the aviation system and the wider economy are having unpredictable effects. (For example, few would have planned on national disruptions to other travel systems such as the railways.) While the industry does its best to deliver a scheduled service, it is clear the travelling public expects better of us. Here we are victims of our own success, as passengers have become very used to flying and arriving. Flying is no longer the privilege it once was, and on-time performance (OTP) is an expectation that many see as a consumer right. And frustrated customers become passengers whose stress levels are elevated before they even board the aircraft, to the point where tempers fray.

Whilst many operators are having difficulty crewing their aircraft, the manpower shortfalls on the ground are having a significant effect. Spare a thought for the airport operators who are being limited by the numbers of people available to work airside or in security. The circumstances are often outside their control - airside working requires a security clearance but that is a government-controlled system also currently beset with delays. You can offer the most attractive jobs on the market, but if it takes 6 months to get a clearance, those jobs will self-evidently remain vacant for the same period, generating more frustration as a result.

People at all levels and in all roles responded to the early furloughs and redundancies by securing alternative employment, though there were pre-pandemic signs that some were leaving the industry for less interesting but slightly more lucrative work elsewhere. Now, when they need to be enticed back, the lurid news headlines (and some reduced salaries) do not help. Anyone who plans on coming back into a customer-facing role and who watches the TV news or reads the tales of lengthy queues and cancelled flights will be expecting conflict, whether that is a reasonable assumption or not, and it will be a disincentive for some. For our frustrated passengers, it is very easy to blame the person stood in front of you, or at least to vent their frustrations – it is not a pleasant experience.

People should be more easily recruited for the less technically skilled roles, but this is not the case for many staff. Ground handling has been especially hard hit, with many pre-pandemic staff having found alternative employment. On top of the lead times to get a new ground handler cleared and trained by their company, many operators are battling with dilution of experience levels. So, when the OTP pressures bite during a turn-round, the team may not be as sharp as you might like. And when you are inexperienced, tasks take longer to perform. Think back to the first time you had to put data into an FMS and how long it took you to get comfortable with doing it. Sadly, all high-end skills are prone to atrophy without regular practice.

There is another dimension in play when staff levels are lower than required. It's called fatigue, and it not just affects those who fly, it's a problem for the whole system. This is because everyone is working at full tilt to try to get the job done, while still trying to rebuild the missing capacity. A perfect storm indeed. The senior managers who had to deal with the effects of the pandemic 2 years ago are still working hard today, and you should not be surprised if they are tired. The same is true of people at every level. And when people are tired, not only do they make mistakes, but they are also vulnerable to 'sense of humour failure'.

There were thousands across the industry who took second or alternative jobs during lockdown, and they were encouraged to do so. Some of those second jobs are still in place. It is up to individuals to manage their own lives, but it is worth bearing in mind that the FTL schemes are supposed to provide you with the opportunity to be properly rested and fit for duty. If your secondary employment commitments impact on this, you perhaps need to think about which one should give way. And if you are running the business, then you also need to ask yourself whether your HR policies are leading your workforce into a trap, as the consequences of poorly managed fatigue can be catastrophic.

A system that is stressed and overloaded is often described as 'running hot'. This is an apt description when you consider it implies a raising in temperature. CHIRP has received many reports over the years from flight crew whose passage through security has been less than smooth, and the concerns expressed have been about distraction rather than claims for special treatment. In the closed container of aviation, an increase in temperature drives an increase in pressure and vice versa; it is a vicious circle.

The problem with pressure is it forces people towards making short-term decisions, and for those directly involved in operating, those short-term decisions can emerge as short cuts and erosion of standards. The SOPS are designed to protect everyone, but the system relies on them being adhered to and pressures push you much closer to hazard boundaries.

So do what you can to relieve pressures when you see them. It requires tolerance and patience, staying positive, allowing time, and being kind. Kindness itself makes no difference to the nature of the task, but it makes real difference in the way you feel about the work. Try being kind to at least one person every day - you will be surprised by the impact on you and them. It is also a function of good leadership, which is something we need more than ever.

[1] COVID-19-Roadmap-V2.pdf (flightsafety.org)

'If you don't take change by the hand, it will take you by the throat'

by Rob Holliday, Chairman UKFSC

You can probably guess who said that.

In aviation, we know all too well about change.

As the pandemic recedes, business is bouncing back with passenger numbers in Europe at 85% of 2019 levels in spite of the oil price being well north of $100 a barrel and airports charging passengers for things that used to be free. At one London airport it now costs £5 for 10 minutes to drop off or pick up a passenger, then £1 a minute.

Operators, airports and aviation service providers are all recruiting to catch up with the resurgent demand for air travel. Driven by what some commentators are calling 'revenge travel' or 'vacation vengeance' where people allegedly get their own back on coronavirus by taking the most extravagant holiday they can afford. The staffing catch up has led to some high profile flight cancellations.

The influx of new staff and the rapid return to full operations brings with it challenges for safety management personnel. Inducting new staff into the safety system and culture, passing on the knowledge, experience and learning from the past. Monitoring the operation, through reporting and data, for any defences that may need improved resilience.

It may seem that we are just returning to normal, but this is in fact a period of change and as such safety management (change management) processes have to kick in to identify hazards manifesting as a result of change.

Change may be internal or external. Internal changes will be similar to past recoveries from economic down turns, but there will be differences and surprises. External supporting aviation infrastructure is also gearing up and going through a process of change that may lead to hazards for an operation.

Replacing safety people and expertise lost during the pandemic adds to the challenge of managing, identifying, understanding and mitigating risk in the upturn.

When recovery from the pandemic is complete, there's more change to manage on the way. The industry is committed net-zero carbon emissions by 2050. 3% of which will be through efficiencies and 65% through sustainable aviation fuels (SAF), 13% from new propulsion technology. All changes to be managed. The remaining 19% will be through carbon offsets and storage. SAF production and use will be increasing year on year from now on, estimated to be 5.2% of the total fuel requirement by 2030.

There is a predicted pilot shortage and already talk of single pilot aeroplanes, starting with a proposal to remove the third pilot from some long haul flights. By the time net-zero carbon emissions is achieved, what will the 2050 generation of aircraft look like? Will it have an alternative fuel or power source, will it be designed for single pilot operations or fully automated with no pilot?

Safety management, safety culture and risk based thinking have all come a long way over the last two decades. Some would say these processes have become embedded in business culture to the extent that a safety department is no longer necessary in the same shape and size as in the past. The evidence is to the contrary.

The question has also been asked, do we have access to enough information today, not to need a safety information exchange. Watching the progress of raising awareness of mental health the promoters talk constantly about starting the conversation. Getting people to talk about their issues. If they don't the problem stays in the shadows. If they do, there's a chance to find a solution and even save a life. The possible solutions that can be revealed through sharing are priceless.

When I talk to pilots and operators, I like to ask what they see as current risk. I always get a different answer. Sometimes I can say that here's a solution that I learned from someone else. I have a very long list of the emerging issues and solutions that have been shared in the UKFSC Safety Information Exchange during the pandemic. It's not possible to solve all your problems in one company, the value of sharing issues and solutions is as fundamental to safety as it is to human development through the medium of telling stories.

There's an answer to the idea that a safety department or an exchange of safety information, or pilots are headed for extinction. The answer is: 'Maybe so sir, but not today'. Thanks Maverick.

Engaging with Emotional Intelligence (EQ)

by A G Arróspide

Emotional Intelligence is the ability to perceive emotions, to access and generate emotions so as to assist thought, to understand emotions so as to promote emotional and intellectual growth (Mayer & Salovey)

Imagine you are called by your boss to replace them in a meeting at short notice to give a presentation to a large group. How will you react to this challenge? Consider your thoughts, feelings and actions. The final action is something you will clearly understand as it is something visible (you will have to be there or not), however will you clearly understand your feelings and thoughts, and how these may impact your actions, i.e. how you perform in the meeting? You may, for example, experience feelings of excitement ("what a great opportunity"), feelings of terror ("I have no idea what is expected in that room"), or a mix of both, of course. Your thoughts will be evaluating the data and you perhaps think that you can do this, or on the contrary ("please not me!").

In 1990 Psychologists Peter Salovey and John Mayer used for the very first time the term Emotional Intelligence (EQ or EI) to describe the ability to manage emotions and use these emotions to guide our behaviors.[1] Later, with the publication of Daniel Goleman's book "Emotional Intelligence: Why it Can Matter More than IQ", the term became more commonly known.

Since then, many companies have begun testing how to integrate EQ into training and how to benefit from its advantages. Research provides evidence that emotionally intelligent leaders are more successful and help others to be part of a successful team. Using EQ in training and organisational change initiatives can also reduce costs associated with turnover, absenteeism, and low performance. This can be especially valuable in today's world of constant change.

What is EQ?

Is there a middle ground where people are real without being hurtful, face the problems without painting everything awful, and access the power and wisdom of emotions? That's what it means to be emotionally intelligent (At the Heart of Leadership, Joshua Freedman)

Emotional Intelligence is the ability to use emotions effectively. It is the ability, capacity and skill to perceive, assess and manage the emotions of oneself, others and groups. It is blending the emotional side and the rational side.

This involves:

- Perceiving or sensing emotions
- Using emotions to assist thought
- Understanding and listening to emotions
- Managing emotions and transforming them

Some people easily connect with others, respond appropriately and maintain composure, even in the face of stresses and challenges. They have great insight into themselves and others, and are proactive and balanced in their approach. These qualities are also learnable, however, and they are valuable both in personal life and at work. EQ skills assist in engaging, influencing, being proactive, caring and building enduring relationships.

The characteristics identified with the foundations of Emotional Intelligence explained by Goleman[2] where he included four domains:

- Self-awareness: being aware of our emotions, strengths, and limits
- Self-management: being able to manage our emotions and make conscious decisions around them. Adapting ourselves to new situations with new ideas, and managing stressful situations or environments
- Social-awareness: being able to sense, care about, and influence other people's feeling and emotions
- Relationship-management: Teamwork and collaboration. Inspirational Leadership. Having the ability and willingness to create and sustain interpersonal relationships.

The case for EQ - Why does it matter in business?

EQ equips people with powerful insights and tools that can be used at work, as well in their personal lives.

In particular, EQ knowledge and training is a practical way to help improve some of the key skills and capabilities businesses require in order to perform successfully, such as:

- Leadership & Teamwork: motivation of teams, flexibility, approachability, assertiveness and delegation skills.
- Communication: clear communication in the team, understanding and listening skills
- Problem Solving & Decision Making: Identifying problems and issues, involving others where needed, reviewing and evaluating outcomes, admitting mistakes and doubts
- Workload management: allocating tasks sensibly, recognising high workloads, taking or making time, dealing with overloads & priorities

Training and Development in EQ

As mentioned before, EQ skills can be learnt. When people know themselves and understand their feelings, they can make better decisions. Because of the benefits an understanding of EQ can bring, an increasing number of organisations are investing in raising awareness of EQ amongst leaders and other staff, and encouraging them to develop and improve their performance using EQ techniques. A typical training and development program may consist of virtual or face to face group awareness sessions, to introduce to the main concepts of Emotional Intelligence. Following on from this, individual sessions with an EQ coach can help staff to dig deeper into their own situations and develop their own plans for using EQ to improve their performance, using concepts and techniques such as emotional literacy, pattern recognition, consequential thinking, navigating emotions, and intrinsic motivation among others.

Emotions drive people. People drive performance

In conclusion, since Emotional Intelligence is all about being 'people smart' - about relating to yourself and others - it is not surprising that EQ plays a very important role in achieving success.

EQ training helps people to:

- Understand the value of emotions in personal and business life
- Improve resilience to manage stress and optimise energy
- Strengthen relationships with practical tools for working with clients and co-workers

[1] Emotional Intelligence. Peter Salovey and John Mayer, Research Article first published 1 March 1990.

[2] "Emotional Intelligence: Why it Can Matter More than IQ". Daniel Goleman, Bloomsbury Publishing, 1996

Ana Gloria Arróspide is an Integrative Counsellor and Coach. She is a qualified EQ Assessor with the Six Seconds method. *www.inspiriacounselling.com*

Wellbeing, Culture and the need for a Psychologically Safe Environment

by Capt. Paul Reuter

Organisations will need to develop cultures where people feel psychologically safe to speak up about matters relating to wellbeing, says Captain Paul Reuter.

'Wellbeing' is one of these buzzwords that regularly pops up, and sneaks into every other presentation or lecture. For me, as a non-native English speaker, 'wellbeing' evokes saunas and yoga retreats, probably because I equate it with 'wellness'. And I have the suspicion that this is true for a number of highlevel aviation executives when they are confronted with 'wellbeing'.

This is a pity because in our dynamic, complex, and hazard-prone aviation environment, the wellbeing of our frontline staff needs to be one of our prime concerns. For all our technological advancement, the human element is still the most resourceful, resilient and surprisingly effective safety 'tool' at our disposal.

The new regulation (EU) 2018/1042 relating to pilot and peer support programmes is the latest acknowledgement that we need to find ways to deal with staff wellbeing (or lack of wellbeing) and allow people to be properly cared for and reintegrated safely into their workplace. The effectiveness of these support programmes hinges on the willingness of the organisations that need to implement them to go beyond simple regulatory compliance, and create an environment where these programmes will be seen as being credible and will work.

The best definition of such an environment that I have found is by James Comey, former head of the FBI:

"(...) is about understanding the truth about humans and our need for meaning. It is about building workplaces where standards are high and fear is low. Those are the kind of cultures where people will feel comfortable speaking the truth to others as they seek excellence in themselves and the people around them."

If we want to take wellbeing for frontline staff seriously, we will need to look beyond the odd presentation, nutritional programme, or well-meant motivational slogan. Organisations will need to develop cultures where people feel psychologically safe to speak up about matters relating to wellbeing, while embracing and understanding their responsibilities. Organisations will need to foster a climate where staff *"feel safe enough to take interpersonal risk by speaking up and sharing concerns, questions or ideas"*, according to Amy Edmondson (2018), leading to opportunities for both for the organisation and individuals.

This sort of environment is likely to foster safety-conscious behaviour, motivation and a sense of purpose, benefiting safety and other goals. Indeed, Kotter and Heskett (2008) provide data to show that organisations that have a culture adapted to their context and needs tend to perform much better than organisations that don't. Outside of aviation, many organisations have benefited from creating environments that foster staff engagement and wellbeing.

In aviation, we have had for a number of years many of the building blocks to create such a culture and environment, including crew resource management, just culture, human factors research and now peer support, just to name a few.

Unfortunately, organisations have rarely seen beyond these 'silos of knowledge' and have often failed to use the tools at their disposal to build a culture that merges all of these elements so that 'being well' and 'performing well' are two sides of the same coin. Additionally, there can be ambiguity between an organisation's professed values and culture and the underlying business practices that the organisation encourages.

In such cultures, it is difficult for both line managers and front-line staff to understand clearly what is really expected of them. This can lead to impairment not only of the quality of performance but also to wellbeing issues, including stress and mental health problems.

For safety-critical staff, such as pilots or controllers, the only fallback may be a set of core professional values, which help to navigate a sea of ambiguous or contradictory expectations at an organisational level. It might also fall to professional associations to reinforce a credible professional ethos and create more psychological safety within a group of professionals.

By encouraging candid questions and sharing doubts and concerns within a team or a crew, individuals and groups may create an atmosphere of trust and respect that will help a team function effectively, even in a disruptive or divisive environment.

Ultimately however, it should fall to organisations to define clear and credible values and to communicate them both internally and externally. Commitment to these values needs to be visible, coherent and felt in all aspects of the organisation, whether operations, training, communications or hiring practices. Both executive management and line managers need to understand the importance of 'talking the talk and walking the walk' every day, especially so on the 'bad days'.

In an environment where the economic, environmental and safety challenges will grow, we as an industry will be challenged to foster such a culture with wellbeing being woven into everything that we do, not a regulatory add-on. This is our duty of care, not only to our front-line staff but also to the travelling public.

References

Comey, J. (2018). *A higher loyalty: truth, lies and leadership*. Flatiron Books.

Edmondson, A. C. (2018). *The fearless organization*. Wiley.

Kotter, J. P. & Heskett, J. L. (2008). *Corporate culture and performance*. Free Press.

Paul Reuter is a Captain Boeing 737NG for Luxair, and President of the European Pilot Peer Support Initiative. He is a former president of Luxembourg's Airline Pilot Association, former Technical Director of the European Cockpit Association, and former Chairman of ECA's Safety Strategy Task Force. Paul is an IFALPA Accredited Accident Investigator.

Reprinted with kind permission of EUROCONTROL HindSight 33, Winter 2021/22

Human Performance In The Spotlight: Distributed Situation Awareness

by Paul Salmon

In this series, human performance issues are addressed by leading researchers and practitioners in the field. Paul Salmon gives some insights into distributed situation awareness and implications for digitalisation.

What is situation awareness?

At a simple level, situation awareness (SA) is the term used in Human Factors to describe the awareness that people have of 'what is going on' around them while performing dynamic tasks. The concept first emerged in aviation during the First World War and has gone on to become one of the most studied and debated topics in Human Factors. Though the initial focus was on the awareness held by individuals, this has now expanded to consider the SA of teams, organisations, and even entire sociotechnical systems. The relationship between SA and performance is complex, however, and it is widely acknowledged that SA is a critical consideration when designing work and work systems. It is especially pertinent to consider SA when designing and introducing advanced automation.

What is distributed situation awareness?

The idea behind distributed situation awareness (DSA) is that, in sociotechnical systems, no one person or 'agent' has all of the awareness required for the system to function effectively.

Can different agents have the same awareness of a situation?

Our research has demonstrated that different agents have different views on a situation, even when they have access to the same information. Each agents' SA is influenced by their goals, the tasks they are performing, and their experience of similar situations. The fact that different agents have different SA has implications for system design. Rather than attempt to achieve 'shared SA' where all agents have the same awareness of a situation, we have found that 'compatible SA' is more appropriate. This is achieved when different agents' SA connects to give the overall system the big picture. Achieving compatible SA involves acknowledging that individuals have different views on a situation and identifying who needs what information, when, and in what format. Incompatibilities can lead to suboptimal DSA where there are gaps in the SA required for effective performance.

What is the role of technology in optimising distributed situation awareness?

An interesting feature of DSA is that it explicitly considers the SA held by technological agents as well as that held by human agents. The idea that nonhuman agents could be situationally aware was controversial at first but has since become highly relevant given advances such as artificial intelligence. As such agents gather, interpret, and share information, they play a critical role in ensuring that a system can generate the DSA required for safe and efficient performance. Unfortunately, what we are seeing many areas is a failure to consider the important role that technological agents play in DSA.

What is important to consider when designing and introducing advanced technologies?

With advanced technologies such as automation, we need to consider not only human agents' SA but also the SA held by automation and how it shares SA-related information with humans and other technologies and vice versa. We have seen many recent incidents in aviation and road transport for example whereby advanced automation has either not been aware of something it needed to be, or where automation has not communicated critical information to human agents. This is not because the automation failed, rather it is because designers have not fully considered what the automation needs to know or what SA-related information the automation needs to pass to human operators. As a result, we are seeing breakdowns in DSA which in turn can lead to catastrophe.

It is important then when designing advanced technologies to consider the SA requirements of both human and non-human agents. What does the advanced technology need to be aware of for the system to function effectively? Then designers need to ensure that the automation can gather and understand the information required to fulfil these SA requirements.

The sharing of information between human and non-human agents is also important to consider. We label this sharing of awareness as 'SA transactions' and have found many instances where these transactions are inadequate, erroneous, or do not occur at all, resulting in suboptimal DSA. For example, in a recent automated vehicle collision, the automation did not inform the vehicle operator of an obstacle that it had detected in the road ahead. So it is critical to consider what information needs to be exchanged, when, and how non-human agents will exchange SA-related information with human agents.

A final consideration is how to ensure that human agents understand what non-human agents are aware of. Without this, it can be difficult for human agents to understand why automation is behaving in a certain manner, or why it has taken a particular course of action.

What happens when systems 'lose' DSA?

As DSA degrades the risk of system failure is heightened. Recent high-profile examples of incidents involving DSA failure include the Air France 447 collision and the Arizona Uber-Volvo test vehicle collision. When investigating and responding to such incidents it is important to maintain a systems perspective. It can be tempting to seek to identify the individual agent who 'lost SA'. However, as the SA required for effective performance is not something that can be held by one individual alone, it cannot be lost by one individual alone. Hence, the most appropriate view to take is that systems lose SA and not the individuals working within them. Accident investigators should examine the overall system to determine why DSA failed, not who lost it. In our experiences, DSA failures most often involve failures in the exchange of SA-related information between human and non-human agents.

Paul M. Salmon is a professor in Human Factors and is the director of the Centre for Human Factors and Sociotechnical Systems at the University of the Sunshine Coast. Paul has over 20 years' experience of applied Human Factors and safety research in areas such as transport, defence, sport and outdoor recreation, healthcare, workplace safety, and cybersecurity.

Reprinted with kind permission of EUROCONTROL HindSight 33, Winter 2021/22

A Regulator's Perspective on Digitalisation and Human Performance

by Kathryn Jones and Anna Vereker

When it comes to digitalisation, it can be hard to know what regulators expect. In this article, Kathryn Jones and Anna Vereker give a regulatory perspective on digitalisation to support human operators.

It is tempting to think that regulators should have an advanced understanding of the impact of the various technological advances in aviation. The reality is that we share this knowledge journey with the industry. As ICAO's *Human Performance Manual for Regulators* (Doc.10151) states, our role is *"to make it easy for people in the aviation system to do the right thing and avoid negative consequences"*. We need to develop our regulatory approach with support for the person in mind. This is at all levels of regulatory influence, from State Safety Programmes and options for regulatory intervention, to the changes in oversight driven by the demands of technological advancement.

This rapid change in the use of technology is not restricted to aviation; we are all impacted at a societal level by digital transformation. For many of us, digital assistants on smartphones have much reduced the need to make difficult mental calculations, remember phone numbers, or even use a map. It – in theory at least – frees up brain functionality for other more interesting or more useful things. This process of handing off less interesting tasks to a digital assistant is a common theme in aviation too. Most commercial aircraft now have a digital suite which augments the capabilities of the human pilots, as well as air traffic control systems, flight operations scheduling, and many other functions.

How technology changes the nature of work

One of the five core human performance principles recently published in ICAO's Doc.10151 is that *"people's performance is influenced by working with other people, technology and the environment"* (see HindSight 32). There is recognition that the way we work with technology has changed the way our work looks and feels, and the tasks we undertake. As an aviation regulator, we want to understand how organisations have understood this change, and how they are supporting their people to do their best in their operational context. We want to know that technological tools help people to make the best decisions on the day, and support them with the tasks that we know people are not as good at achieving – for instance remembering to do things in advance (prospective memory) and monitoring tasks.

For digital assistance to be successful, it must be able to provide options within the boundaries of its functionality *and* be easy to understand and use by the people involved. It must cater for changes to peripheral tasks in addition to the 'main' users. It must be able to support people on the day and within the context it will be used. This is an often-forgotten element; just because something can be *designed*, doesn't mean it can be applied *usefully* on the day.

Understanding complexity

We want to ensure that organisations understand how digitalisation affects a complex system. Digitalising one task can have a big impact elsewhere in the system. It may change how an operator understands the system is working, or make the job harder for someone else in another part of the system. Traditional safety analysis methodologies such as barrier and bow-tie models may not be well suited to understanding these sorts of changes in a complex system.

As a regulator, we want to see new methodologies emerge that are better able to deal with systems and complexity. Take the map navigation function on your smartphone: it is not simply a digital version of a paper map. Instead, there is recognition that a person driving a car will have difficulty trying to read a map at the same time as driving – so the map application provides audible directions to help the driver, and is often mounted on the dashboard of a car so that the driver can easily see the map without having to hold the smartphone. However, by not looking at the map before we start our journey, we often lose sight of the bigger picture and can end up driving down unsuitable roads or not knowing how to avoid a closed road. We now have regulations preventing car drivers from holding and using smartphones while driving, recognising that this is unsafe, but we do not require them to have a 'big picture' view so that they manage the different conditions on the day. As aviation regulators we are looking for digitalisation to support human operators to do their best both in using the equipment and understanding the context.

Beyond prescription

As regulators we need to avoid 'solutionising' digital applications. There may be new applications that would be helpful but might be precluded by prescriptive regulations. Instead, we want operators to understand their own systems better, and understand how digitalisation may help their people do their best. As a society, our appetite for increased digitalisation (and automation, including autonomous operations) will change over time, and with increased technological development. We do not want to hamper this development, but we do want to ensure that safety is at the forefront of progress.

In air traffic control, a new type of 'digital' tower is being introduced; this might be an augmented physical tower located at the airport or might be a remote application from another location. Careful consideration has been given to how best to support the human controllers involved in this work, and what sorts of technology will assist them to do their best. It is possible for some cameras to provide more information than a controller would gain from using their eyes in a physical tower, but at the same time there could be several limitations (for example, poor weather occluding a camera). Some of these differences are more obvious than others, and there is an agreement for ongoing monitoring of the effects of digital towers on the human controllers so that any long-term impacts are captured and understood.

For now, the system still relies on a human controller, but in the future, there may be a different interaction of digitalisation and automation that changes this role. We need to ensure that we are mindful of safety impacts, and make best use of human operators, and all their positive capabilities in this situation.

Collecting safety data

Collecting safety data is a core activity in supporting our understanding of the system and in aviation. It has been subject to both digitalisation and in some cases automation. We have air and ground systems that collect data, and help the human operators translate this into meaningful trends. Digitalising mandatory occurrence reporting (MOR) forms has also improved the user experience of submitting these reports and may improve reporting as people find it easier to log them. However, data itself always has limitations in the insights it can provide, and we need to be wary that in making the collection process easier, we must listen out for 'noise' between data points that can provide vital contextual information about safety. Once again, we need the technology to support the people, valuing qualitative information as much as we easily accept quantitative data.

The road ahead

This is a shared road that we are all travelling on, and it will call on all of us to use our experience and knowledge in different ways. Through collaboration and curiosity, we can work together to ensure that we make the best use of the resources available to us and continue to explore ways to prioritise system safety with human factors at the fore.

References

Barshi, I. (2021). Making it easy to do the right thing. *HindSight*, 32, 10-12.

ICAO (2021). *Manual on Human Performance (HP) for Regulators*. Doc 10151. Montréal: International Civil Aviation Organization. https://bit.ly/ICAOHPM

Kathryn Jones led the CAA's Human Factors Programme until March 2022. Now an independent safety consultant, she is a specialist in fatigue management and has a broad range of regulatory HF experience. She is a member of the ICAO Fatigue Management and Human Performance task forces and holds a Master degree in Air Safety Management. She is currently focused on how systems thinking methods can improve our understanding of the influences on people and to support them to their best.

Anna Vereker is a Chartered Occupational Psychologist and EAAP Aviation Psychologist. She has a broad range of experience with aviation human factors, including with the military and air traffic control. She is passionate about encouraging robust consideration of human factors issues in complex systems, and continues to be curious about new methods, research, and ways to influence the industry.

Reprinted with kind permission of EUROCONTROL HindSight 33, Winter 2021/22

"See it, say it, sorted" Why reporting matters and CHIRP's role

by Steve Forward, Director Aviation CHIRP

Reporting systems

Although commercial air transport accident rates are extremely low, they have remained relatively constant over the past few decades and a major challenge for the air transport industry has been to develop effective processes to identify key causal factors that in some circumstances might lead to an accident, before the accident occurs. One element of this has been to improve the quality of feedback from the professional groups involved in air transport operations through not just the reporting of incidents but also the reporting of things that nearly happened (but were averted or didn't develop into a reportable incident) in order to provide additional important information related to contributory causal factors.

The Civil Aviation Authority (CAA) introduced the UK Mandatory Occurrence Reporting (MOR) Scheme in 1976 to: record potentially hazardous incidents, occurrences and defects; permit safety implications to be assessed; and disseminate the associated knowledge to relevant individuals/organisations. But, as the MOR and other similar reporting schemes became mature, it was recognised in the UK and elsewhere that many incidents were still not being reported. More specifically, although investigations revealed that more than 70% of accidents had a human factors element, the actual reporting of human factors related incidents was much lower than this. As an example, although a bit dated now, a study in Australia in 1983/84 revealed that *"only 9% of General Aviation incidents and 3% of regular Public Transport incidents reported by flight crew involved human factors"*. A subsequent survey of the Australian pilot community confirmed that many incidents involving pilot performance were not being reported; the reasons given were:

i. Fear of punitive action being taken against the individual by either the aviation regulatory authorities, their employers, or both. (In most cases the fear of punitive action involved the threat of licence suspension/cancellation, and/or the threat of job loss or demotion).

ii. The perception that publicly admitting they had made a mistake by submitting an incident report on their own performance made them look inferior to their peers. (Possibly because of their rank and seniority structure, this was more often given as a reason for non-reporting by airline aircrew than by general aviation pilots).

iii. Belief or experience that the only visible result of submitting an incident report was an investigation which sometimes brought about negative consequences, but never any positive response.

iv. As a result of the perceptions outlined in (iii), some saw an incident report as just more 'red tape'. (Some felt that they already had to fill out too many irrelevant pieces of paper and that, in many cases, an incident report was just another one).

The first 2 points relate to Just Culture in the way that reports are received both by management and colleagues within an organisation. The third point relates to how strong the Learning Culture is within an organisation, and the last point reflects on an organisation's Reporting Culture and how easy and effective it is to report not just things that have happened but things that nearly happened, or might happen, if corrective actions are not taken.

The contribution of confidential reporting systems

Although mandatory reporting systems make an important contribution to the feedback process, they are less successful in gaining information on human factors related aspects. Confidential human factors reporting systems were introduced to address this. Reports fall into two broad categories; those indicative of an undesirable trend, and those detailing discrete safety-related events, occurrences or issues. It is important to understand that the confidentiality part applies to the identity of the reporter not the information; whenever possible the latter is disseminated as widely as possible, but in a disidentified manner so that the reporter cannot be recognized, and only with the reporter's consent.

A confidential reporting system permits individuals who are working within the aviation system to report safety related matters that they might not report through other 'open' systems. Reporting directly to an organisation that is totally independent of the operational management and regulatory agencies allows reporters to describe the issue in their own words and ensures that reports are received without being filtered in any way. More importantly, the confidential process permits the non-attributable reporting of deficiencies and discrepancies that may result from, or cause, human errors without exposing the reporter or other individuals within the system to critical judgement or the attachment of blame.

On the other side of the coin, for companies and organisations, confidential reports provide a source of non-attributable safety information to safety management and regulatory agencies that otherwise would probably not be available. This type of information often provides organisations with early warning precursor alerts of potential problems, or substantiates other sources of information.

The benefits to be derived from a confidential reporting process are recognised within ICAO Annex 19 'Safety Management' and the associated ICAO Doc 9859 Safety Management Manual which require that *"States shall establish a voluntary safety reporting system to collect safety data and safety information not captured by mandatory safety reporting systems"*. In addition, EU Regulation No 376/2014 (Articles 3, 5 & 16) also requires Member States to safeguard the confidentiality of reporters and makes provision for independent systems for collection and processing of safety information that might not otherwise be captured; the UK has retained this regulation as part of the post-Brexit regulatory suite of documents.

The history of UK CHIRP

The UK **C**onfidential **H**uman **F**actors **I**ncident **R**eporting **P**rogramme, known widely by the acronym CHIRP, was introduced for flight crew members in December 1982 and a review of its first year of operation showed the principal areas of concern in early reports to be fatigue/rostering, poor crew interaction and inappropriate crew actions. Things have moved on in many respects since then with the development of safety management systems (SMS) and crew resource management (CRM) understanding but, with aviation still being a fundamentally human activity for the most part, some themes recur because we humans are ingenious in our ability to thwart attempts to eliminate errors and mistakes. Ever-present commercial pressures to maximise efficiency and resource utilisation also invite margins to be cut to the bone in times of economic uncertainty such as recently experienced during the COVID-19 pandemic.

In 1995, following a review of confidential reporting by the then Guild of Air Pilots and Air Navigators (GAPAN), now the Honourable Company of Air Pilots (HCAP), the CAA accepted a recommendation that CHIRP be restructured as a charitable trust with a full-time Programme Director, funded by the CAA as an independent entity, and with overall management and fiscal responsibilities being held by an independent Board of Trustees. That model continues today but with the single full-time Director Aviation now being replaced by a Secretariat of part-timers comprising Director Aviation (Steve Forward) who deals with all aviation policy, management and engagement activities, as well as dealing with all commercial pilot, ATC and GA issues, and 4 contractors dealing with their own specific areas: Cabin Crew Programme Manager (Jen Curran); Engineering Programme Manager (Phil Young); Drone/UAS Programme Manager (Rupert Dent) and, as of 1st July 2022, Ground Handling & Security Programme Manager (Ernie Carter).

CHIRP's mandate and role

In addition to UK (EU) Regulation No 376/2014, CAA Civil Aviation Publication CAP1180 – the UK State Safety Programme – acknowledges CHIRP as the UK's independent confidential voluntary reporting scheme. CHIRP's vision – our 'guiding star' – is a world in which aviation and maritime safety are continuously improved by the tackling of human factors safety-related issues, underpinned by a strong safety culture. Within this, our mission – the 'what' – is to help improve aviation and maritime safety and build a Just Culture by managing an independent and influential programme for the confidential reporting of human factors-related safety issues. Our desired strategic outcomes – the 'why' – are: better leadership, awareness and attitude towards safety issues; improve safety culture by changing behaviours, so that practices, processes and procedures are as safe as they can be; and safety outcomes identified in CHIRP reports are adopted by regulators, managers and individuals.

With regard to Just Culture, nobody comes to work intending to fail: mistakes & errors are part of the human condition. However, sometimes people should have known better (unprofessional), could have known better (training), or may have intentionally broken the rules with good or bad intentions. These aspects all need to be taken into account when reviewing peoples actions in any incident or event. CHIRP's 4 key principles of operation are:

- VOLUNTARY - Voluntarily submission of reports concerning events related to safety for the purpose of system alerting, understanding and learning
- CONFIDENTIAL - Protection of identity through disidentification of persons, companies, and any other identifying information
- INDEPENDENT - Trusted, unbiased dissemination of safety information and advice
- JUST CULTURE - Non-judgemental safety net for reporting occurrences that might not otherwise be reported

CHIRP's processes

CHIRP operates through the use of 4 volunteer-based Aviation Advisory Boards comprised of members from the principal relevant aviation interests in the UK who provide specialist expertise in the definition and resolution of issues raised in CHIRP reports. The Advisory Boards are titled 'Air Transport '(dealing with all aspects of commercial aviation other than cabin crew) and 'General Aviation', 'Cabin Crew' and 'Drone/UAS' with associated obvious focus for each. The Advisory Boards are panels of peers who have rigour and credibility as experts in their own right. One of the principal roles of the Advisory Boards is to review reports and issues raised through the Programme and to provide counsel on the most appropriate way in which specific issues might be resolved. Report information is formally submitted to the Advisory Boards on a confidential basis and all personal details are removed from reports prior to discussion. The Advisory Boards also review the responses received from third-party organisations to assess the adequacy of any action taken in response to a reported concern. The Advisory Boards are the great strength of the CHIRP process because they provide the breadth and depth of expertise. They also provide the specialist intellectual horsepower and professional credibility to our work. In addition, the Advisory Boards provide feedback to the Trustees on the performance of the Programme.

Broadly speaking the programme is delivered through the following processes:

- Reports are most frequently submitted directly into the CHIRP database via our website/app reporting portal. Reports may also be submitted by telephone or by post using a downloadable form from the website but neither is encouraged because of the additional workload due to the need for manual transcription.
- Following initial submission and triage, the relevant Programme Manager will engage further with the reporter, normally by email, to seek additional information if necessary and to determine their appetite for more widespread engagement and action to be taken.
- Appropriate reports are selected by the secretariat and disidentified prior to dissemination for review by the relevant Advisory Board to obtain their specialist advice, counsel and guidance.
- Once CHIRP has completed its enquiries and interventions where appropriate, a closing response is sent to the reporter. This is usually by email outlining what has been done and advising them, before it occurs, of the intention to publish their report in the relevant FEEDBACK if appropriate. This gives the reporter the opportunity to consent to publication or not. Once published, the report is closed by CHIRP and the reporter's personal details are removed from the CHIRP email system and database so that future confidentiality can be ensured.
- We use the SHELL model[1] within the CHIRP Aviation Secretariat for our analysis, along with the ICAO ADREP[2] taxonomy to look at what Human Factors issues might apply to each report received. This is based on the fuller report that FEEDBACK readers don't get to see because we remove quite a lot that might either be identifiable or pejorative. This means that the published text we release isn't quite all of the story, just the bits that we think are vital and also which the reporter agrees that we can publish. What we publish is therefore by necessity a compromise and we also want to 'tell a story' rather than present a set of rather cold 'factors' that many people won't be that engaged by and might not be supported within the text we include. Our intent being to write it up in a readable and engaging manner so that people will be given cause to think about the issues themselves.

What's the reality of CHIRP's role?

Broadly speaking, CHIRP provides a vital safety net as another route to promote change when all else fails and for collecting reports that would otherwise have gone unwritten with associated safety concerns therefore not being reported. An element of our work involves whistleblowing with discretion and without direct regulator involvement for those who do not want the regulator to know their details. We often act as an 'Agony Aunt' for those who seek our 'wise' counsel and we often provide information and point people to the right sources / contact points for them to resolve their own issues. Depending on the issue and our resource availability, we also champion causes and act as an advocate or the 'conscience' of industry and the regulator where we can.

Our strengths are that we are: independent, external to the regulator and non-mandatory; a trusted brand by industry, regulators and reporters alike; we act as an intermediary buffer with the 'system' for reporters; our Advisory Boards comprise panels of peers with rigour and credibility as experts in their own right; and we have access to the highest levels of the CAA to promote change. That's all well and good, but we recognise that there are things we could do better and our weaknesses are: our overall resources versus case workflow; our limited bandwidth to engage in every worthy cause; our ability to feedback face-to-face with the wider community; the fact that we are reliant on altruistic contributions by Advisory Board members; and that we have no statutory powers so we are reliant on industry and the regulator 'doing the right thing'.

Future prospects for confidential reporting – is there a continuing need?

With the widespread introduction of additional safety processes such as company 'open' reporting schemes, Flight Operations Data Monitoring programmes and Line Operations Safety Audits, it might be questioned whether there is a continuing need for an independent confidential reporting system when other avenues are apparently more readily available. However, the evidence from mature confidential systems is that reporters prefer to raise some safety-related issues on a confidential basis; this is demonstrated by the fact that despite the increased availability of alternative reporting methods, the number of confidential reports submitted per annum has remained essentially the same or increased over the past ten years (the 2 years of COVID-19 hiatus in aviation activities excepted). The key is that an integrated approach is essential to ensure that human performance and environmental information are appropriately and fairly coupled with technical/operational data because although data/event logging provides insights into human actions and 'what happened' it does not inform as to 'why' an event occurred, any pertaining external influences and distractions, or an individual's capabilities and remaining capacity at the time.

More importantly, much of the information contained in confidential reports continues not to be made available through other reporting systems. More specifically, in the last few months CHIRP has received a number of reports about fatigue and FTL management that are indicative of companies trying to maximise schedules with reduced crewing levels and availability. Although we can't publish many of these reports due to confidentiality issues, we do progress those that we can with the appropriate agencies and, in many cases, we have been able to pass on our concerns to the CAA Flight Operations Team to review the circumstances reported. Whilst these individual reports have presented important issues that have attracted specific actions, it's also the aggregated statistics that reveal some key trends of concern.

A few words of caution though, the reports that CHIRP receives represent a fairly small statistical sample and so we should be careful about reading too much into them. Also, CHIRP obviously receives reports that are generally critical of things that have gone wrong and so there is a bias towards negativity that might not reflect the majority experience. Nevertheless, the sun-dial graph shows the top-15 key issues reported to CHIRP by Flight Crew over FY2021/22, with Company Policies and Culture; Duties and Rosters; Commercial/ Management Pressures; and Management Relations well to the fore.

Concerns have focused on FTL/FDP limits being regularly approached; rosters containing successive long-haul duties with minimum rest at destinations or after return to the UK; reduced resources (crew availability); pressures to operate to time schedules despite the additional constraints of COVID procedures; late rosters; and many reports of crews who feel fatigued but do not feel they can report as such due to fear of reprisals. Increased efficiency is a laudable notion that has obvious managerial attraction in keeping down costs as some airlines struggle to survive and remain viable in the immediate post-COVID economic circumstances but there's a trade-off: as James Reason identified in his 'Safety Space' concept; at some point, reducing costs can have a negative impact on safety and this needs to be at the forefront of any change management risk assessment – as the old saw goes, 'if you think safety is expensive, try having an accident…'

All of which has echoes from the past and indicates a continued need for confidential reporting so that regulators and senior management remain attuned to concerns and feedback from those at the coal-face. CHIRP will continue to engage with the CAA and organisations where it can to ensure that your concerns are aired in a confidential, independent and impartial manner. The first option should always be to use the formal ASR/MOR/VOR reporting systems where you feel able to because this will hopefully gain the quickest and most complete response to any concerns. But CHIRP stands ready to assist as best we can those who do not feel able to do so or wish to report concerns about things that 'nearly happened' and might not meet the threshold for formal reporting elsewhere.

[1] The SHELL model stands for **S**oftware, **H**ardware, **E**nvironment, **L**iveware (other people) and **L**iveware (self) and is an HF tool that is used to analyse how people interact with their surroundings in the circumstances by assessing their Liveware (self) interface with the other 4 components.

[2] The ICAO Accident/Incident Data Reporting (ADREP) taxonomy is a glossary of specific human factors issues, concerns and latent failings that relate to aviation activities and which provides a set of definitions and descriptions used during the gathering and reporting of accident/incident data to ICAO.

CHIRP
Confidential Human Factors Incident Reporting Programme

Event Horizon. Improving pilot recognition and response to flight safety events

by Richard Clewley and Jim Nixon – Safety and Accident Investigation Centre, Cranfield University

It is not always straightforward for pilots to recognise flight safety events in real-time. Aircraft systems are sophisticated, events arise in unusual ways with novel combinations of cues. Events also change and evolve over time – they are dynamic. Perhaps, crucially, an event in the real world may not look like the simulator event during training, that took place in the middle of the night, many months or even years ago, somewhere on a desolate industrial estate, while loaded on cheap coffee and hotel food.

Accidents involving the Boeing 737-MAX have brought scrutiny on the assumptions of airline pilot training. Some response protocols may not be easily retrieved during surprising, dynamic events. Some events, expected to be within the capabilities of airline pilots, appear to pose significant problems even for test pilots immersed in a test flying programme, presumably with more knowledge and resource available than the average, busy airline pilot[1].

Event variety, monkeys and sharks

Events come in different shapes and sizes. Some events, perhaps a straightforward generator failure, tend to resemble the training encounters. A training encounter, in a type rating or recurrent simulator session, acts as an *exemplar* event – an instance, derived from experience, that will later inform recognition. Humans use *exemplars* all the time. Having recently seen the squirrel monkeys at London Zoo, we can recognise one in a picture or in another context. At least for a couple of years, until our memory trace fades.

Typical events are also easier to recognise. These are known as *prototypes* – the clearest and best case, that works as a recognition reference point. Humans use *prototypes* all the time too – you can think of a typical ILS approach, a typical visual approach and perhaps even a typical high energy approach. Typicality is advantageous, in that typical instances (of anything!) are more readily learnt and easily recognised – they are stronger concepts. Think of a shark. You are likely imagining the prototypical great white shark.

Exemplars and prototypes help us order our knowledge, and pilots use them to think about and recognise events. But where is pilot event knowledge incubated? Exemplars tend to come from simulated encounters, where the pilot sees an event, such as a SLAT DRIVE malfunction or an ALTIMETER DISAGREE, that will later prove useful in recognising and responding to a similar event in the outside world[2]. Prototypes, or typical events, tend to be built through exposure and repetition in everyday flight operations. Weather encounters, regular system misbehaviours, common technical malfunctions and routine flight scenarios are subject to positive typicality effects.

As we move away from exemplars and prototypes, our recognition and response accuracy decline[3]. We take longer to make poorer decisions as we migrate from where our event knowledge is concentrated. Pilots sometimes sense when D for Diagnosis is not as strong as it could be. We really miss the dividend from a readily recalled exemplar or prototype.

Obscure, exotic and intricate?

Events in the real-world exhibit variety and diversity that may not be replicated in the simulator. Events arise with conflicting cues and sometimes systems do not stabilise in a failed state, presenting with transient or intermittent cues. Some system failures cascade, affecting numerous cockpit indications, showing salient cues that are misleading and not indicative of the failure.

When did you last experience an UNRELIABLE AIRSPEED or a FUEL LEAK in the simulator? Can you remember the pattern of cues that signalled the onset? Were the cockpit indications clear, unambiguous and stable? Perhaps you were even (half) expecting it, having heard on the sim grapevine. Will it look like that when it happens in the outside world? Some events, and their response protocols, are more obscure, exotic and intricate than others.

Pilot knowledge of event structures has limitations. A variety of events – from unstabilised approaches to flight control failures and air data malfunctions – suffer from recognition and response problems. When investigating the AF447 accident (loss of reliable airspeed data), the French investigation team reviewed thirteen similar events involving five different airlines. There was inconsistent recognition and no application of the correct memory items procedure[4].

Our research with airline pilots has revealed that some events are fundamentally challenging and airline pilot training may not produce robust, flexible event knowledge.

Developing knowledge about an event concept is different to developing a highly rehearsed response to a specific, and often typical scenario.

Dusty corners of a checklist

We have identified important variations in flight safety events, to better understand event diversity and pilot behaviour. We have described three different event types, as illustrated in Table 1[5]. An event close to a *prototype* (clear case) or an *exemplar* (a known instance) is ***friendly***. Of key importance is the associated pilot behaviour, and happily, it favours good, effective use of checklists and response protocols, to maintain or enhance safety.

Nontypical events deviate from prototypical event markers, and remember, this leads to a decline in pilot performance. Around a decade ago, researchers noted that experienced airline pilots suffered significant drops in performance even when well-rehearsed, well understood events were presented in unfamiliar positions[6]. Context is important. A procedural mis-step in a go-around can lead to significant divergence from the prototypical task execution, and pilots can rapidly enter a flight regime beyond their knowledge. The dusty corners of the checklist, oddities, obscurities and unusual failures also fall into this ***alarming*** bracket.

Some events are plain ***hostile***. To understand and respond to an event, pilots must describe it. This means we aggregate the cues, match them to some known system behaviour or configuration. Malfunctions involving many disparate cues that do not stabilise in a coherent, known system state are perhaps the most challenging of all event structures. These events do not look like training. Some events are simply wider, longer and deeper than pilot knowledge. We have at best *weak*, at worst *no* conceptual knowledge of these events. Events come in different shapes and sizes.

What of acquiring and maintaining better, stronger, more flexible event concepts?

Knowledge has tentacles

We have developed an app that builds and consolidates pilot knowledge around a concept, encompassing the friendly, alarm and hostile levels found in Table 1. The app design has been led by cognitive theory and provides new ways for pilots to interact with event information. Figure 1 shows the Approach Stability Toolkit app, designed to improve pilot recognition and response to unsafe aircraft energy, flight path and configuration events on the approach to land.

The app addresses typical presentations of events as well as more unusual and demanding iterations, involving nontypical, high risk event factors and hostile variations. It explicitly covers pilot recognition and Crew Resource Management aspects of these event types and describes the risks and adverse outcomes. Response protocols and type-specific procedures are covered, with embedded links to controlled documents, safety data trends and further resources.

The app has a variety of novel features. The 'Relatives' tab (Figure 2) provides details of other events that are closely related, prompting useful thinking about neighbouring concepts. For example, when considering approach stability, it may be useful to also consider flight path intervention techniques, discontinued approach procedures and go-arounds. This is about forming connections. Most safety events have relatives, but structural weaknesses in pilot training often do not facilitate making strong connections between related events. Knowledge has tentacles. We can grow them.

User knowledge can be tested. The app includes informal self-testing and can be configured for serious games and knowledge

Figure 1. The Approach Stability Toolkit app. An innovative way for pilots to acquire, develop and maintain event knowledge outside of conventional training and testing encounters.

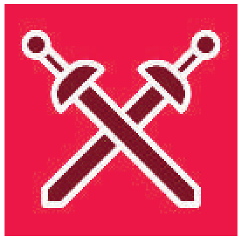
Type of event		Predicted pilot response	Characteristics	Example events
 Prototype/ Exemplar Status: Friendly	Clearest and best cases. Proximal to previous encounters. Typical and stable features. .	Adequate recognition. Appropriate response. Checklists, protocols and procedures used to enhance safety.	Encountered regularly in operations or well replicated in simulations. Clear correspondence with checklist/protocol. Descriptive, unambiguous cockpit annunciations. Tending towards unitary cues.	Unitary system failures with descriptive caption, such as AC1 GEN FAIL; engine failure, with clear cockpit indications, in a scenario similar to regular test conditions; go-arounds from minima with normal levels of automation;
 Non-typical Status: Alarm.	Event features may be unusual, conflicting, or intermittent. Limited correspondence with previous encounters.	Recognition may be delayed or inaccurate. Checklists, protocols and procedures delayed or not used effectively. Startle and surprise possible. Procedures vulnerable.	Encountered periodically but arise in significantly different contexts or formats. Familiar events but mismanaged. Borderline events, that are conceptually similar to others, causing confusion. Tending towards multiplicity of cues.	Mis-managed go-arounds; go-arounds from unusual positions and configurations. Intermittent and/or similar cockpit cues combined with rarely used procedures, such as alternate FLAP/SLAT configurations.
 Weak or no concept Status: Hostile.	Event features likely to be unusual, unfamiliar, conflicting, intermittent and dynamic. Distal from pervious encounters.	Recognition likely to be delayed, inaccurate or absent. Checklists and protocols not used or used ineffectively. Startle and surprise likely. Procedures fragile.	No previous encounters with an equivalent case. Malfunctions that do not stabilise in a coherent state. Complex events where cue processing in training/ testing is inadequate to form robust, flexible knowledge; Unfamiliar events mismanaged. Multiplicity of cues.	Complex system failures that cascade to affect numerous cockpit indications, such as intermittent, dynamic AIR DATA malfunctions; sophisticated system failures and rarely used memory/ recall procedures that are trained through contrived, brief or weak exemplars.

Table 1. Three types of flight safety event, based on Clewley and Nixon[5].

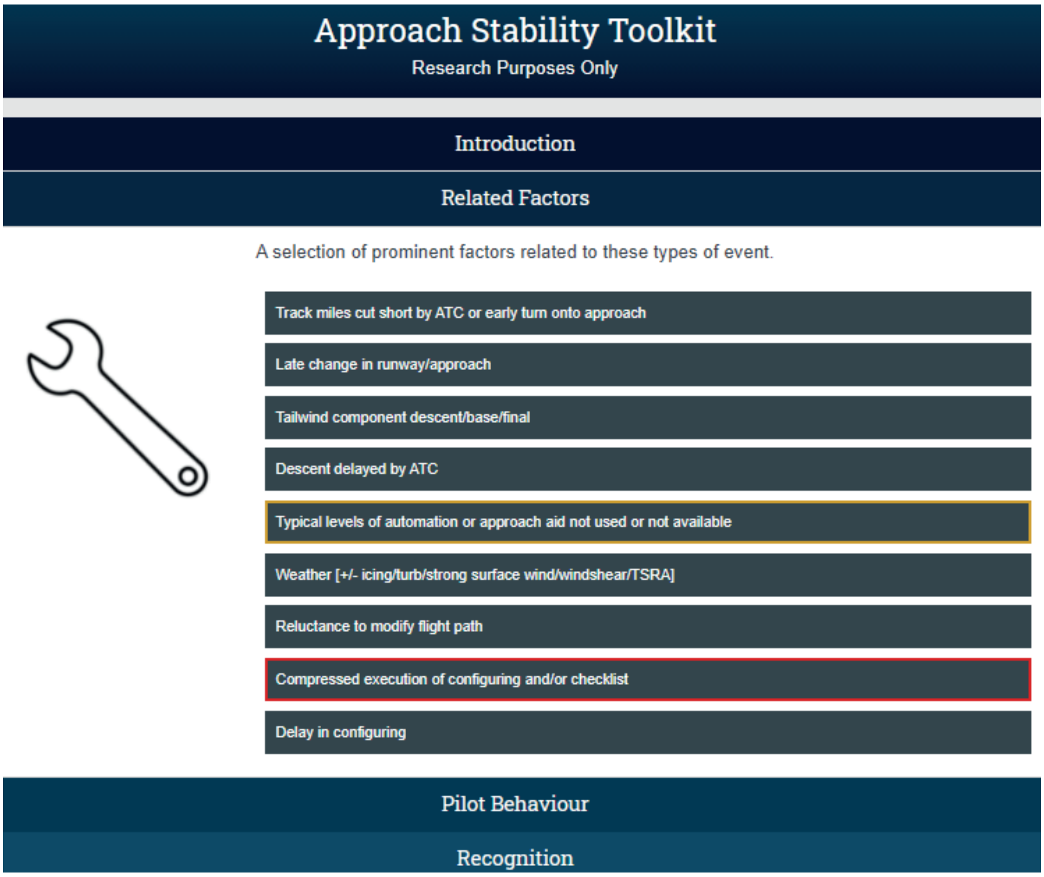


Figure 2. Pilots can view factors related to these event types. The app owner can highlight or graphically enhance information within the tabs, to increase salience and promote content in line in safety campaigns.

snacks, fostering game or task-based learning that can boost pilot event knowledge in the long gaps between resource-intensive simulator visits. For example, crews can view a real event case study and then use the app to identify key features, contributory factors and optimal pilot behaviour. Equipping pilots with better, more accessible knowledge about early recognition, signatures of high-risk events and desirable flight path interventions may broaden and deepen knowledge beyond that available in conventional pilot training.

Pilot training or pilot education?

Developing and *maintaining* event knowledge needs solutions beyond conventional pilot training. The crew workforce, both cabin crew and pilots, is growing again, including many new to the industry. These crew members need access to high quality, on-going educational resources.

Apps that can enhance event knowledge can be deployed across a range of events and event management skills, as shown in Figure 3. Checklists are large and nuanced documents, and memory/recall actions have been shown to be vulnerable across a range of unusual, high-risk events. Some events are difficult to train in simulated encounters or simply fall through the gaps of type ratings and recurrent checks.

It is important that pilots recognise and respond to flight safety events. We have discussed some important variations in event structures that drive pilot behaviour. Airline pilot training does not always convey the sophisticated event knowledge needed to manage some events. The apps described here can provide useful, flexible event knowledge that can improve, supplement and develop knowledge gleaned in both everyday flight operations and in simulated encounters.

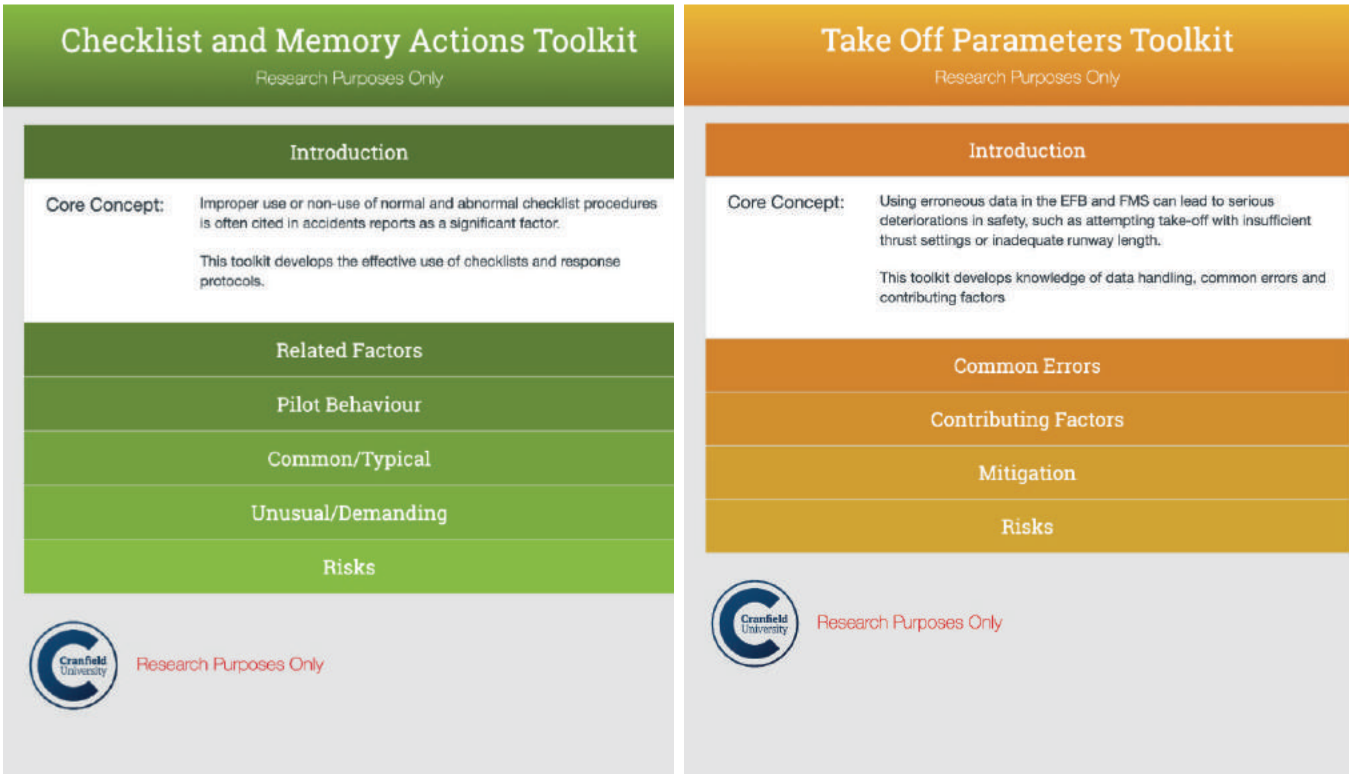


Figure 3. Cockpit resilience through a family of apps. Managing events and optimal checklist usage are often not explicitly covered in airline pilot training and memory/recall actions are vulnerable to failure. Some events may fall through the gaps of pilot training.

References

1 United States House Committee on Transportation and Infrastructure, "Final Committee Report: The Design, Development and Certification of the Boeing 737 MAX," Washington, DC, 2020.

2 R. Clewley and J. Nixon, "Penguins, birds and pilot knowledge: can an overlooked attribute of human cognition explain our most puzzling aircraft accidents?," *Human Factors: The Journal of the Human Factors and Ergonomics Society*, no. Online first, 2020.

3 R. Clewley and J. Nixon, "Now you see it, now you don't: dynamism amplifies the typicality effect," *Cognition, Technology & Work*, vol. In press, 2021, doi: https://doi.org/10.1007/s10111-021-00686-9.

4 BEA (Bureau d'Enquêtes et d'Analyses), *Final Report on the accident 1st June 2009 to the Airbus A330-203 registered F-GZCP operated by Air France flight AF447 Rio de Janeiro – Paris*. Paris: BEA, 2012.

5 R. Clewley and J. Nixon, "Understanding Pilot Response to Flight Safety Events Using Categorisation Theory," *Theoretical Issues in Ergonomics Science*, vol. 20, no. 5, pp. 572–589, 2019, doi: 10.1080/1463922X.2019.1574929.

6 S. M. Casner, R. W. Geven, and K. T. Williams, "The Effectiveness of Airline Pilot Training for Abnormal Events," *Human Factors: The Journal of the Human Factors and Ergonomics Society*, vol. 55, no. 3, pp. 477–485, 2013, doi: 10.1177/0018720812466893.

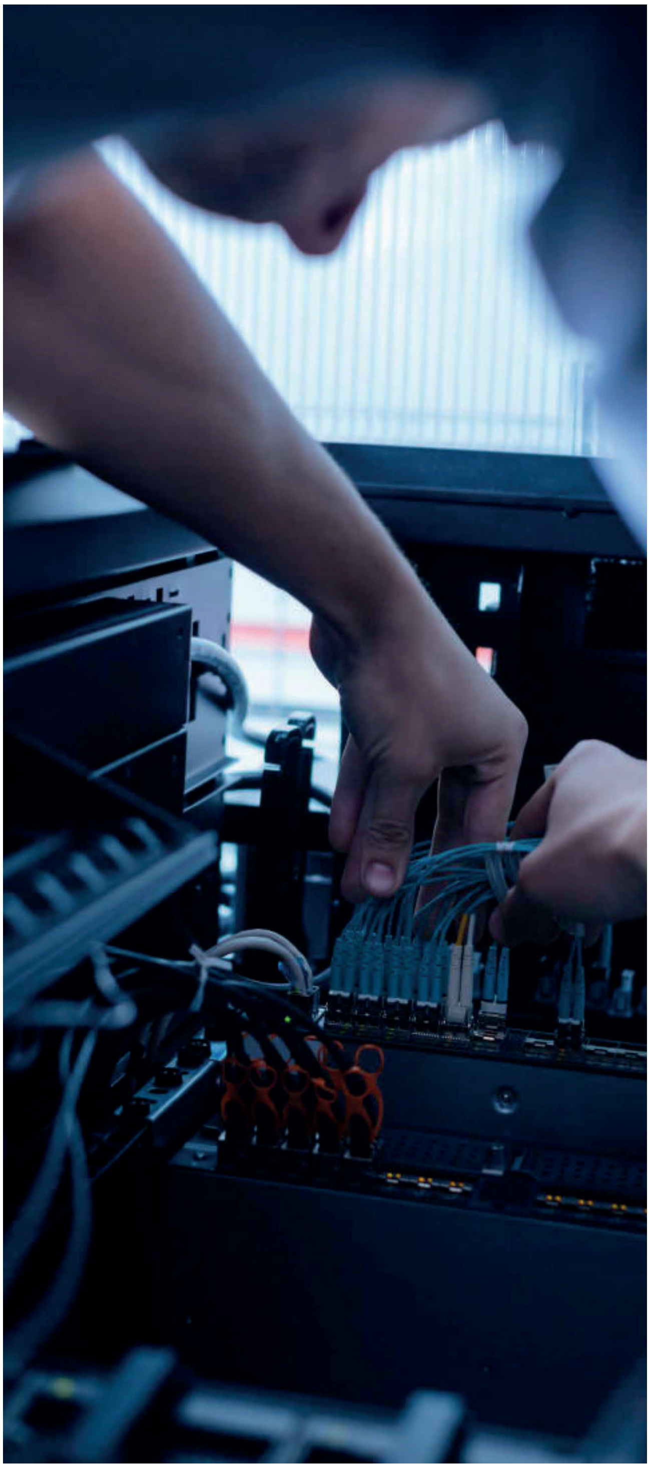
Acknowledgement

For the images, thanks to Greg Boulton, Senior TEL designer, Cranfield University.

We Need To Talk About Engineering

by Dr Steven Shorrock

When it comes to human performance, most efforts to understand work are dedicated to operational roles such as air traffic controllers and professional pilots. In this article, Steven Shorrock outlines five challenges for engineers in the drive for digitalisation.



After many years working in and with air navigation service providers (ANSPs) and air traffic management organisations around Europe, talking about work with almost every kind of role from front line staff to CEOs, I notice a curious thing. Little attention is paid to the nature of the work of those that we rely on to keep all the critical technical systems running effectively: the engineers. There are many studies of the work of air traffic controllers, and, of course, professional pilots. But there are very few studies, either published or unpublished, on the work of engineers in ATM.

Few people – other than engineers and engineering managers – seem to talk to engineers about the nature of their work. What is working well in their day-to-day work? What problem situations do they face? What challenges and dilemmas do these present? How do they respond to these? What do they need to make work more effective? Discussions with engineers are rather more along the lines of whether and when things can or will be done. Like their operational counterparts, engineers tend to be associated with 'getting stuff done'. But how they do it is given little attention.

These sorts of questions are becoming more urgent and critical, especially with the digitalisation drive. Reflecting on the period when I first dipped my toe into the world of engineering in the late 1990s, until now, I get a sense of how much things have shifted. Engineers' work is changing in a way and at a pace that they have never experienced before. Few outside of their world really understand it.

In this article, I outline five universal challenges that summarise what many engineers from around Europe have relayed to me. These challenges have implications not just for engineers, but for the managers and other staff who interact with engineers, whether in operational, recruitment, training, safety, quality, or other roles.

Challenge 1. Dealing with change and production pressure

When we talk about 'workload' in aviation, we usually think about 'sharp end' operational roles such as controllers and pilots. But increasingly in ATM engineers are balancing on sharp edge of workload peaks, partly associated with continuous changes in technologies and ways of working with them. Engineers can struggle with the number, scale, and speed of changes, sometimes occurring simultaneously in major software releases. Many people overestimate what can reasonably be achieved by human engineers in the acceleration of digitalisation. Few people, except engineers and their immediate managers, understand the pressure. Unfortunately, the increase in work – both planned and unplanned – is often not matched by increases in people with appropriate expertise.

And engineers have worries, but they rarely seem to talk about them without coaxing. These worries concern many things. Some relate to the nature of the equipment itself, such as lack of redundancy, system readiness for implementation, and use of technical systems beyond design intent. Some relate to the work, such as backlogs, thoroughness of maintenance, and the capacity to deal with unpleasant surprises requiring intervention. Who worries about the worries of engineers?

There can be a delicate and difficult trade-off between innovation (to provide additional functionality) and maintenance requirements, both planned and unplanned. Shortcuts and workarounds – traditionally often loathed by engineers – can become normalised, as efficiency rules over thoroughness (e.g., time for testing during the night). It should be no surprise, then, that surprises happen, sometimes requiring rollbacks to previous software releases, while engineers hunt for latent bugs that may have been introduced several releases earlier. Engineers juggle demands and deadlines, pressures and priorities, and can end up feeling overloaded, sometimes overwhelmed, and often without the kind of peer support that is available to operational staff.

Challenge 2. Coping with complexity

Engineering in ATM has always been 'complicated', reflecting the nature of the technical systems. But engineering has changed significantly in the last decade or so; it is now much more complex. There are now more goals, relating to safety, quality, security, reliability, availability, etc., which can shift in emphasis over time. Technical system structure now comprises a more diverse mix of new and legacy system elements. Crucially, interconnectivity between these (e.g., routings, data streams) is more complex, along with interdependency between hardware and software elements (e.g., tools and applications). The boundary of the system is less well defined, with multiple system environments (e.g., primary, backup, test), and collaborating systems such as data centres, sometimes outside of the ANSP itself. With older, complicated systems, things tended to work much more 'as documented'. But with more complexity, it is impossible to document everything as one would imagine.

For all these reasons, technical systems are harder to manage. What will be the unintended consequence of a software update on collaborating technical systems? How can we detect problems with code in a software release when there are no obvious consequences until specific operational conditions occur? How can one know in which release a bug was introduced? Should we roll back to a previous software release (which may itself contain bug fixes), or try to find and fix the bug we are presented with now? Just as air traffic controllers can find it difficult to keep a mental picture of traffic in some situations, engineers increasingly struggle to maintain a mental model even of their own technical systems, let alone how they may interact with other systems. All of this requires staff, expertise, and time; all of which are in short supply.

Challenge 3. Planning and coordination

In operational roles, planning and coordination tends to be over the timeframe of minutes or hours. In technical roles, coordination can be over minutes and hours (for maintenance and testing) through to months and years (for projects). With growing complexity, planning and coordination has become much more difficult, with many stakeholders, both internal and external, who have different demands, knowledge, understanding, tools, terminology, and languages. Because of the interdependencies between systems, where systems depend on other systems to be able to function, systems are more affected by failures of other systems. Without effective planning, engineers can end up overloaded, diverting from one activity to another, and losing track of what they were originally working on. Without effective communication, there can be assumptions and misunderstandings about who is doing what, when, why, where, how, with whom and for whom. This can result in unpleasant surprises.

Challenge 4. Maintaining expertise

Engineers involved in projects and maintenance face a heavy burden in terms of the knowledge and skills required. The knowledge requirements are not fully known, however. And in ATM, much of the needed expertise is developed 'in-house' via experience. Engineers obviously need to understand the hardware and software directly relevant to their work now, and the tools, procedures and processes that (should) assist their work. But they also need to have some understanding of emerging technologies that may be relevant to their future work, interdependent aspects of collaborating internal and external systems, and new tools (e.g., for ticketing, communication, reporting). And with increased complexity and interdependency, engineers need to understand at a 'good enough' level the system architecture as a whole. Each engineer has a mental model of the structure and behaviour of interconnected subsystems, which may be more or less complete and accurate.

Increasingly, there is also a need know and use new and fundamentally different development approaches and processes that were rare even a few years ago in ATM (e.g., agile software development, compared to the more established waterfall model of system development). This creates a need for different philosophies and practices for different systems. But engineers often lack dedicated time to attend training courses, or even group discussion and reflection.

There is another pattern at work in engineering that does not affect operational staff in the same way: with a need for deep expertise, there is a tendency for some engineers to become 'single points of expertise', who are not easily replaceable. This, in turn, affects the resilience of organisations to function in case engineers change jobs, need to attend a course, are off sick, or retire.

Finally, there is an additional tradeoff when it comes to expertise. With the need to hire engineers quickly, without the commitment of a long-term contract, contractor engineers help to fill important gaps. But, of course, once contractors leave, they take their existing and acquired expertise with them.

Challenge 5. Learning from experience

Learning from experience is as critical to engineers as it is to operational staff. But, in some ways, it can be more difficult. Technical systems for ATM tend to be very reliable, thanks to expertise in design, implementation, testing, and maintenance. When things do go wrong, engineers need to be deeply involved in learning from incidents. This is unplanned work that takes time away from planned work, which may already take engineers to full capacity. Additionally, while a low failure rate is, of course, very welcome, an implication is that learning from failures alone gives a narrow base of experience for learning. This presents a corresponding need to learn from everyday work.

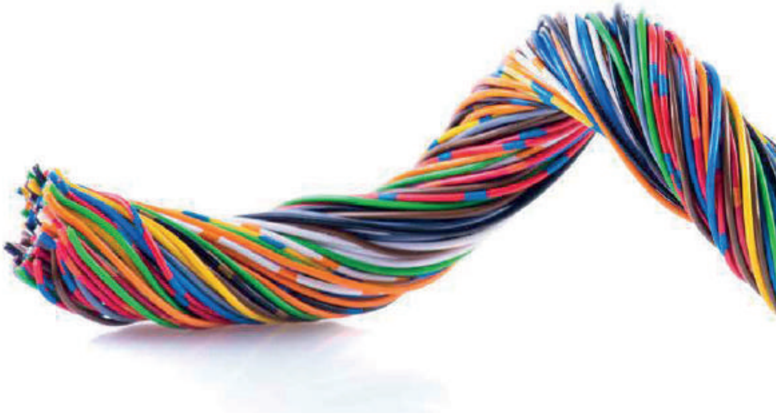
Without such learning, many questions go unanswered. What has worked well, that we should continue or extend? How is work-as-done drifting from work-as-prescribed and work-as-imagined? What has surprised us recently? Again, complexity and production pressure create difficulties for learning from experience, because of difficulties in understanding the technical system, and lack of time and opportunity to invest in learning.

We need to talk about engineering

As managers, air traffic controllers, recruitment specialists, training specialists, legal specialists, or safety, quality and security specialists, how much attention do we really pay to the work of engineers? How much time is spent understanding their work, and our impact on their work? How much effort is spent making it easy for them to do a good job? Whatever your role, it is worth spending some time reflecting on how your decisions impact them, and how you can help them, while they try to help us.

Dr Steven Shorrock is Editor-in-Chief of HindSight. He works in the EUROCONTROL Network Manager Safety Unit. He is a Chartered Psychologist and Chartered Ergonomist & Human Factors Specialist with experience in various safetycritical industries working with people in a wide variety of roles. He co-edited the book Human Factors & Ergonomics in Practice and blogs at www.humanisticsystems.com.

Reprinted with kind permission of EUROCONTROL HindSight 33, Winter 2021/22



Members List

Members of The United Kingdom Flight Safety Committee

Acropolis Aviation	CargoLogicAir	Irish Aviation Authority	SAS Ireland
A|D|S	CargoLux Airlines	Jet2.com	Shell Aircraft International
Aegean Airlines	CHC Helicopter	Joint Helicopter Command	SMS Aero Limited
Aer Lingus	Charles Taylor Adjusting	L3 Harris - Flight Data Services	Specsavers Aviation
AIG UK Ltd	CityJet	Loganair	STS Aviation Services UK
Airbus SAS	Cranfield Safety & Accident Investigation Centre	London's Air Ambulance	TAG Aviation (UK)
Air Tanker Services	Devon Air Ambulance Trading Company	McLarens Aviation	Teledyne Controls
Airtask Group	DHL Air Ltd	Manchester Airport	The Honourable Company of Air Pilots
Air Mauritius	Draken Europe	Marshall Aerospace & Defence Group	Titan Airways
Ascent Flight Training	Dubai Air Wing	Military Aviation Authority	TUI Airways
ASL Airlines Ireland	Eastern Airways UK	National Police Air Service	UK Meteorological Office
BA CityFlyer	easyJet	NHV Group	UTC Aerospace Systems
BAE SYSTEMS (Corporate Air Travel)	Emirates Airline	Offshore Helicopter Services UK	Virgin Atlantic Airways
BAE SYSTEMS Marine	Flight Calibration Services	Oliver Wyman CAVOK	Virtus Aviation
Baines Simmons	FlightDataPeople	Pen Avia	Vistair
BALPA	Flight Service	Prospect	West Atlantic UK
Belfast International Airport	GATCO	QinetiQ	Wiltshire Air Ambulance Charitable Trust
Bristow Helicopters	Gatwick Airport Ltd	RAeS	Wizz Air UK
British Airways	Gulf Air Company	Rolls Royce Plc	
British Antarctic Survey	Hans Airways	Royal Air Force	
British International Helicopter Services Ltd	Heathrow Airport	Royal Navy	
CAE Oxford Aviation Academies	Independent Pilots Association	RVL Group	
Capital Air Services	INEOS Aviation	Ryanair	

CO-OPTED ADVISERS

AAIB	CHIRP	Holman Fenwick Willan LLP (Legal Adviser)	Royal Met Society
CAA	GASCo	NATS	UK Airprox Board