ENHANCING THE UTILIZATION OF HUMAN FACTORS EXPERTISE WITHIN AIRLINE SAFETY INVESTIGATIONS

Heather Fitzpatrick, Manager Human Factors JetBlue

Heather's background is predominantly in aviation safety and applied human factors. For over 20 years she has specialized in a combination of safety investigation (incl. as a Human Factors-focused Senior Transport Safety Investigator with the ATSB), advisory work for aviation industry sectors including Defense, Regulators, aeromedical operations and manufacturers, and safety roles within airline operations in Australia, Hong Kong, Singapore and the United States. She is currently the Manager Human Factors for JetBlue, based in New York City.

Introduction

Human Factors (HF) relates to the application of what we know about human performance to the utilization of technology and equipment, the environments in which we function and jobs performed. ICAO (2021) recently published a series of revised principles that serve as a reminder that performance is influenced by both the capabilities and limitations of each individual, that we interpret situations differently, and that we adapt to meet the demands of our work environment. Therefore, understanding what influenced the performance of individuals involved in a safety event (whether accident, incident or other) is a necessary step in determining practical actions for risk reduction in the future.

As is now well-understood throughout the industry, applying human factors principles to accident and incident investigation facilitates a more detailed consideration of performance limitations (and strengths) in the context of an event to influence subsequent investigation outcomes. One of the reasons for incorporating human factors principles into the wording of investigation findings, is to drive greater specificity around the 'why' of a crewmember's actions or decisions. For example, consider the benefits of avoiding the trap of stating someone simply 'lost situational awareness'; there can be significant challenges in pinpointing practical actions from such a finding.

Investigation outcomes shaped by Human Factors principles

Within many States' investigations agencies and aviation operators, a formal HF capability is well-established, and subject matter experts have made many significant and meaningful contributions to investigations; indeed, there are few major investigations that do not include HF support, which has been demonstrated to facilitate complex analyses and findings that address likely reasons for behaviors and actions, which in turn contributed to an adverse outcome.

A sample of findings from recent safety investigations conducted by three agencies (ATSB, CENIPA and NTSB) that relate to key HF themes, are included in Table 1 below. They demonstrate that the 'why' behind actions and decisions can be explained in plain language terms, but as any Human Factors/Performance Investigator will tell you, actually belies the significant range and complexity of scientific literature often scoured to adequately evidence these seemingly-simple sentences.

Investigation identifier	Title	Examples of findings that relate to human performance
Australian Transport Safety Bureau (ATSB) investigation AO-2018-053	Airspeed indication failure on take-off involving Airbus A330, 9M-MTK Brisbane Airport, Queensland, July 18, 2018	'While independently trying to diagnose a rare and unfamiliar problem during take-off, the flight crew experienced high cognitive workload, time pressure, and stress. This reduced their capacity to effectively interpret the situation and make a decision early enough to safely reject the take-off' 'In the Airbus A330, there was no auditory alert associated with nil or unreliable airspeed from two or more sources during take-off (a high workload, critical phase of flight). Comparatively, other critical failures provide both visual and auditory indications.'
Aeronautical Accidents Investigation and Prevention Center (CENIPA; Brazil) A-157/CENIPA/2016	Loss of control in-flight of an R44, December 4, 2016	'Visibility restrictions and consequent loss of visual references promoted favorable conditions for pilot disorientation and loss of control of the aircraft, due to an inaccurate perception of the helicopter's behavior and its position in relation to the terrain'. 'The decision to proceed with the flight in degraded meteorological conditions denoted an imprecise assessment of the conditions in that operational context, setting up a failed decision-making process.'
National Transportation Safety Board (NTSB) DCA19MA143	B737 runway excursion, May 3, 2019	Contributing to the continuation of an unstabilized approach were 1) the captain's plan continuation bias and increased workload due to the weather and performing check airman duties and 2) the first officer's lack of experience.

Table 1: A sample of human factors-related findings (predominantly contributing factors) from recent accident investigation reports conducted by the ATSB, CENIPA and NTSB. The underlined words emphasize how HF principles are applied.

Taking a Human Factors approach to investigation findings can be met with reluctance from some investigators within agencies and aviation operators (incl. airlines), which can then limit the ability to explore the myriad of contributing factors adequately. In this author's experience, this reluctance seems to stem from a combination of; a) a perception that human performance-related evidence is not as tangible, or 'real,' as other types of more technical evidence and is therefore less credible, and/or b) not always being confident in applying HF principles due to limited exposure or familiarity, or the benefits that can be drawn from doing so. However, this author's perception on the matter sparked a motivation to increase both the tangibility of applied HF investigation contributions and familiarity with it as a source of useful outcomes.

Human Factors contributions to airline safety investigations

In late 2021, JetBlue re-introduced a formal Human Factors capability into the Corporate Safety Department, with the aim of supporting all operational work groups. A small team of two Analysts and a Manager were initially appointed, including those with experience in applied HF within safety investigations, and Cognitive Interviewing skills.

One of the first projects conducted was a detailed HF analysis of a JetBlue A320 tail strike event that occurred in January 2022, while departing from Hayden, CO. During the takeoff roll, an aircraft on final descent utilizing the reciprocal runway was detected by the crew who immediately initiated the aircraft rotation. The aircraft subsequently experienced a tail strike, continued the departure, and then diverted to Denver, CO. The HF analysis provided recommended findings and actions to the Safety Investigations team, in a manner similar to any SME contribution. In this case, some of the HF Team's findings included (underlined text included to emphasize key HF themes);

> *Both the Captain and First Officer likely did not perceive the intentions of the [aircraft on final approach] to land on the reciprocal runway heading of JetBlue's intended departure runway, due to a combination of the following factors*
>
> - *Increased crew workload during the pushback and taxi-out, resulting from concurrent tasking conducted under time pressure. This likely led to the crew dividing their attention with other operational tasks, resulting in subsequent 'task shedding' the need to actively monitor the CTAF frequency.*
> - *Both crew's likely expectation that any arriving traffic would likely utilize runway 10 as they did on arrival), and as other aircraft were intending at the time.*
> - *Crew's lack of familiarity with this airport specifically, and likely an overall reduced familiarity in monitoring CTAF frequencies, therefore reducing 'sensitization' to the need to direct particular attentional resources to that source of information.*
>
> *Neither crew identified they were experiencing task saturation due to time pressures, or the absence of a shared mental model identifying the threat, which reduced their ability to detect their misperception regarding the intruding aircraft's intentions.*
>
> *The Captain's…decision to rotate prior to reaching V1 was then a deliberate decision, under significant stress where both crew were likely experiencing the cognitive effects of a 'surprise' event (as opposed to a startle effect).*

The findings were finalized after testing as drafted hypotheses, and were then analyzed with reference to extensive scientific literature and event-based qualitative and quantitative evidence. The HF Team took part in debriefs for the involved crew, and offered lines of inquiry to follow.

Overall, the analysis then enabled specific, measurable and practical actions to be pinpointed, which in turn supported efforts to enhance pilot non-technical competency development as part of their overall training framework, operational guidance material for the airport and facilitated additional work to determine how to enhance familiarization of non-towered airports. However, this was a relatively straightforward event and the HF Team identified a need for a more systematic method for undertaking similar analyses; one that balanced the need for a timely response to the Investigator-In-Charge (IIC), while efficiently obtaining enough evidence to identify and test theories to reach the sometimes elusive 'why' and 'how to prevent'.

An approach to HF investigation analysis suitable for the airline context

Airline safety investigators are often working with relatively short timeframes to complete their follow-up of an event, and possibly have access to only a limited range of evidence. However, exploring the presence and contribution of any human performance themes remains possible in nearly all circumstances. An operators' HF specialists should be proficient in safety investigation methods and frameworks, in order to contribute in a useful manner. Proceeding with this as an assumed skill, the author offers the following considerations for airline HF teams:

1) ***Initiate a discussion with the safety investigations teams to identify when your expertise may be useful; and do so quickly***

   It can be extremely useful if a HF team is notified quickly of an operational event, so as to engage at the earliest opportunity and commence discussions with the safety investigations team. The decision to commence an investigation (especially when not a mandatory reportable event) is of course not always immediate, but not only should HF SME's offer their help if one has commenced, but also suggest reasons for why an investigation may be valuable to launch.

   When, and to what extent might your expertise be of value, depends on the extent and type of human performance 'issues' (not just errors per se) that appear to be present. It can be limiting to have very specific criteria to follow only, but one rule of thumb can be asking the question, 'were any apparent actions taken, decisions made and/or behaviors exhibited, something the operation can learn from?'.

2) ***Develop HF-related hypotheses early into the investigation to influence evidence gathering***

   As soon as preliminary details of an event are known, HF teams are in a good position to a) determine whether their involvement may be beneficial, and b) immediately 'brainstorm' possible lines of inquiry, based on known factors from other similar events, and/or possibly-evident decision/action errors. This is the stage where inherent HF expertise is needed to apply what is known about relevant human performance issues, which then need to be woven into some initial hypotheses, which in turn can drive specific questions within any subsequent interview (or 'debriefs', as many operators refer to them as) with those involved; it is critical this occurs before the interviews.

   Interviews are one of the most important sources of event information for an HF team, as they are a critical means of obtaining qualitative evidence regarding a person's recollections and perceptions of an event. While interviews will naturally be led by the airline's safety investigator, an HF expert is in an excellent position to advise its direction, and help apply cognitive interviewing methods to ensure the HF-related evidence obtained in credible and accurate; additionally, the HF team should consider being the 'guardians' of cognitive interviewing processes for the operation.

   It is more challenging (although not impossible) to only be provided with the outcomes of an interview after it has occurred, in the hopes that an HF team can intuit all human

performance issues without the opportunity to shape the means of obtaining evidence. Additionally, requests to review drafted safety investigation reports and 'add in some HF' increases the risk that findings will not be accurate or credible.

One sign that HF teams should be sensitive to; the ready use of the word, 'complacency' to describe crew's actions. Often in industry, sentiments such as, 'the pilot/dispatcher/maintenance engineer/ground operations crew were probably complacent' will be spoken soon after an event. This assertion can be an indicator that HF expertise can be beneficial, because 'complacency' can be an easy go-to for explaining an otherwise seemingly inexplicable error, and in place of a more accurate assessment of the 'why' behind the 'what'.

3) Actively seek evidence to test for a presence of fatigue known to affect performance

There can be the tendency for investigators following up an event, to either wait for the word 'fatigue' to be raised, or only ask, 'did you feel fatigued at the time?' (or similar), i.e. relying on a subjective perception of alertness. However, given that humans tend to chronically underestimate our own levels of fatigue, there is considerable value in building in a routine series of questions that also focuses on a person's 72 hour sleep/wake history, normal sleep habits allows for a proactive testing of an hypothesis, perhaps similar to this;

'It is likely that [person] was experiencing a level of fatigue known to adversely affect performance, due to [evidenced factors such as the time of day, sleep obtained, etc].'

It may not be possible to demonstrate whether fatigue *contributed* to any adverse outcomes in an event, but supporting evidence of *existence* allows for what can be an unrecognized yet insidious safety issue to be drawn out. Without routinely 'screening' for fatigue, it can easily be missed.

4) Establish specific, plain-language findings (focusing on the 'why') using well-evidenced HF principles

Human Factors research, like many other disciplines, is often academic in nature (as it should be) and requires expertise to find and utilize relevant and credible content that relates to appropriately-categorized error types and the contextual circumstances of the event. However, utilizing what could be considered either academic terms, or ones more designed to be a construct rather than an explanation ('situational awareness' comes to mind as an example; one needs to ask, 'what does that actually tell us?') can be alienating. More useful can be findings that focus on plain language, i.e.;

> *'The pilot's attentional resources were wholly applied to monitoring traffic in the region, due to a previously-established perception that this task required prioritization, likely due to an anchoring bias, which led to a loss of situational awareness that precluded a detection of the gear position.'*

Or as an alternative:

> *'The pilot was likely focused on monitoring airspace traffic (a priority discussed prior to departure), which in turn reduced their ability to detect the position of the gear lever.'*

The research and testing to reach either of the above findings may be represented in a same way within an analysis (i.e. extracts of scientific literature relating to anchoring bias, focus of attention, etc), but the wording of the second is aimed to be more easily absorbed. Seemingly, the simpler the wording, the more likely it will be acted upon.

5) Take the time to help operational groups feel comfortable with the findings

Findings that point to operational risk (and therefore a problem that needs fixing) can be challenging to impart, and even more challenging to influence positive safety action given the high workloads of decision makers, etc. Findings and recommendations relating to a human performance matter can be open to dismissal as potentially 'excuse-making' a crew's decision or action, for example. Therefore, taking the time to explain the path taken to reach an HF-driven finding can be the difference between inaction (or limited-effectiveness action, such as defaulting to re-training) and full engagement where agreed actions can be made and tracked. The transition from, 'How could a professional make such a mistake?', to 'I can see how that could happen to anyone' can be an indicator of how influential well-applied human factors principles can be.

Overall, if a Human Factors team has the opportunity to be involved early, are able to help shape the collection of evidence to test human performance-related hypotheses, provide a thorough yet fathomable analysis and is then able to engage directly with operational teams to determine effective actions based on the 'why' rather than 'what', this is time and effort well-spent.

Facilitating others to apply Human Factors principles (even when not subject matter experts)

Human Factors teams within aviation operations do not tend to have large teams of staff working within them, and it is unlikely their expertise can be made available at all times when it may help. Facilitating others involved in the investigation of events to apply HF principles is highly advantageous, including outside of the safety investigation team. The question of how to best equip others with sufficient HF proficiency to do so therefore needs our attention.

JetBlue's HF Team has, and continues to develop comprehensive 'Human Factors Guidelines' to be used specifically by the SMS teams that are part of each operational group. Figure 1 firstly shows a detailed 7-step process for when and how to apply HF principles. It also includes a (hopefully) simple error classification guide along with a short overview of the human information processing model, which can be helpful in guiding a way of thinking about how an event has taken place. Figure 2 shows a screen capture of the index for a comprehensive list of common Human Factors topics that often relate to airline operations.

In order to achieve accurate and credible results, the HF Team has encourages those using the Guidelines to seek a short 'consult' to establish likely topics of interest, and then once selected, each topic has a corresponding one-page topic overview, including:

- A definition of the term or topic
- Other ways to think about the topic, including day-to-day relatable examples
- A list of targeted questions that can be used in interviews/debriefs to explore the topic
- Examples of how investigation findings may utilize that term for its wording; and
- Names and links to specific references that may help them.

The SMS Teams have access to an extensive 'library' of HF references. The HF Guidelines will remain a 'work in progress' for some time to come but thus far have been useful in guiding brainstorming sessions for hypotheses, and curtailing the time required to seek out relevant references. Most of the staff within the SMS Teams have also completed Cognitive Interviewing training.

Conclusion

Applying Human Factors principles and expertise within safety investigations has significantly increased in recent years, particularly within State Investigation agencies. In the context of airline operations, there appears to be a variance in whether dedicated HF expertise is available. In the case where it is, amplifying HF involvement in event-based safety investigations can offer the opportunity to pinpoint, with precision, likely reasons why decisions and actions were taken so to more effectively reduce risk in the future.

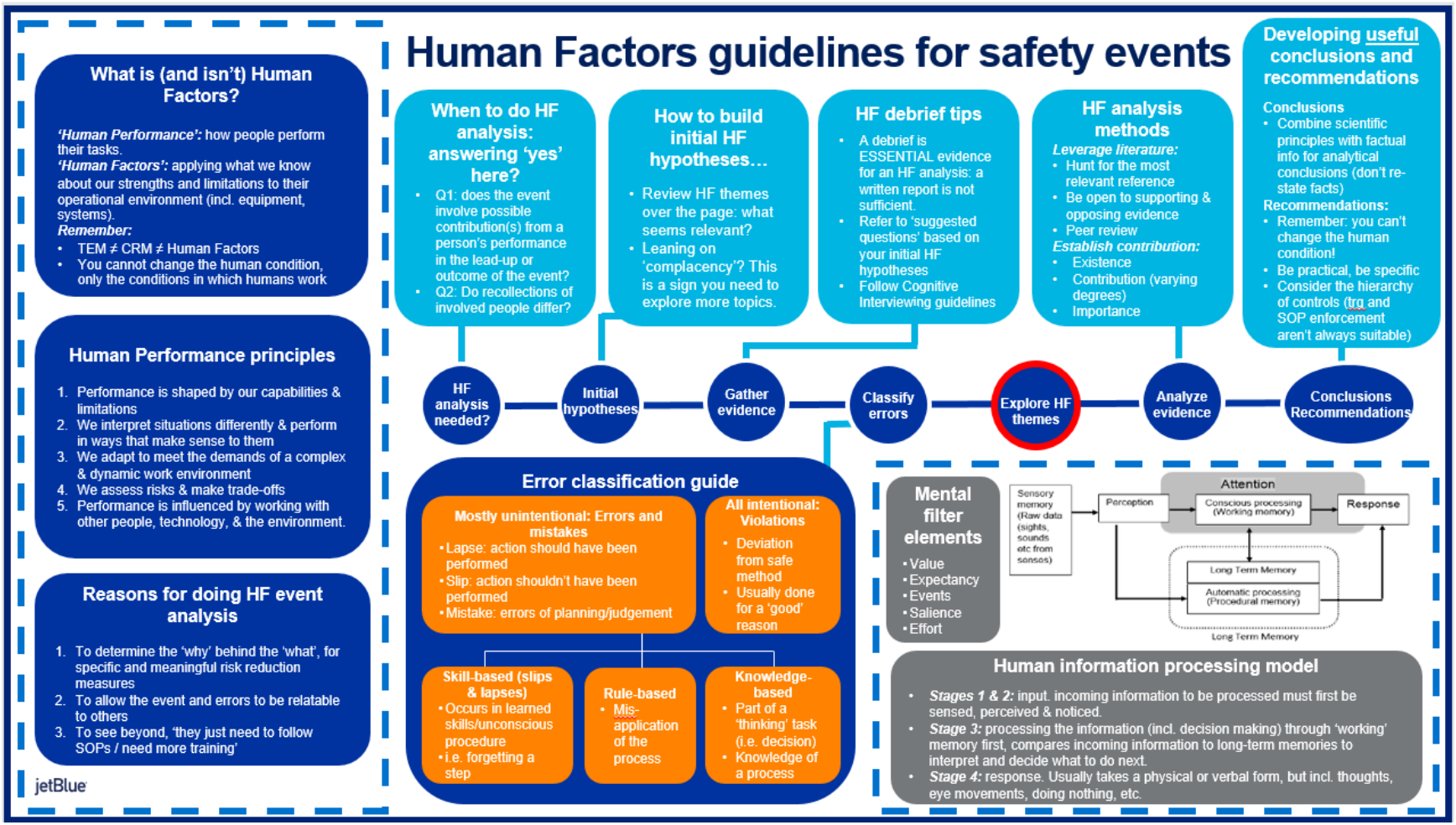

Figure 1: a screen capture of the 'Human Factors Guidelines' 7-step process developed by the HF Team, to assist operational SMS teams incorporate HF principles within their own investigations.

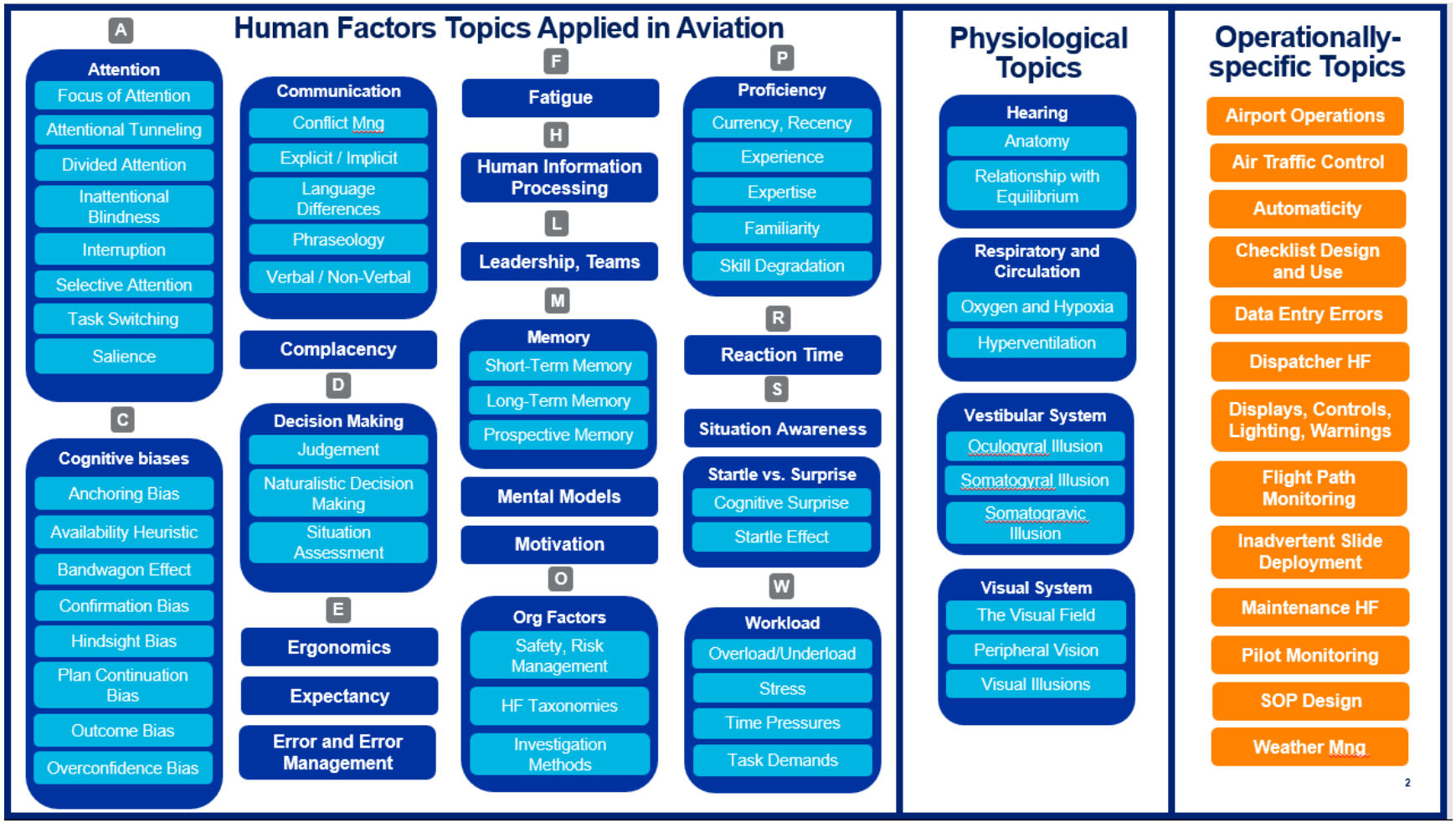

Figure 2: A list of HF topics that are commonly applied within the context of aviation operations, with corresponding links to dedicated topic-based pages, as part of the HF Guidelines.