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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.

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focus ON COMMERCIAL AVIATION SAFETY

Making better use of data

by Dai Whittingham, Chief Executive UKFSC

Aviation in the UK at the moment seems like one of those cliff-hanging sporting events where the results could go either way. We have the uncertainties created by Brexit, demand appears to be increasing, employment models are shifting, and drone-dodging has become a near-daily game. There is a rising tide of evidence for the need to train new pilots, ATCOs and engineers at a rate faster than we can manage at the moment, we know the people currently in the system are up against the wire when it comes to fatigue no matter how carefully operators try to manage the risk, and there is also ample evidence of a gradual dilution of manual handling skills across the industry.

One has to have some sympathy with those caught between the conflicting demands of servicing the accounts bottom line and doing so while maintaining the highest standards of safety. As always, there is a trade-off. We all appreciate that the shareholder is king in any business, but we need to make sure that the shareholders understand the risks and the implications of some of the decisions taken in their names. There is a glue-layer in all organisations that sits between senior management and those actually producing, and it is quite common to find people in that layer making decisions that might satisfy an immediate personal performance goal but that would not hold water if exposed to the wider purview of the shareholder or board member. That is not intended as a criticism, merely an observation that we can only do our best with the information and context we have at any one time.

On the other side of the fence, there are some interesting conclusions emerging from new work on fatigue being done through FDM. What has that got to do with shareholders or senior management? Well, this work is starting to produce some empirical data on fatigue and its role in the operational costs and the risk of an incident or accident. It is very early days, but a comparison of FDM events between 'sleepy' and 'non-sleepy' pilots (using the Karolinska sleepiness scale) indicates that sleepy pilots have more fuel at shutdown, are more likely to fly slower on the approach (down to Vref-10), are later disconnecting the autopilot on approach, have an increased post-landing fuel burn and a slower taxy speed, and tend to land harder. In other words, there appears to be a causative relationship between inefficient operations, the risk of a damage event, and crew fatigue. What you have there is the genesis of a business case that could lead to some operators choosing to run an increased margin between the maximum usage rates for its flight crew and the published FTL. If you can show that in the long run it is cheaper to employ more (and therefore better-rested) pilots than to accept the engineering and operational penalties inherent with fatigued crews, then the argument becomes a simple matter of economics.

The above holds true provided you can supply pilots at the appropriate rate, which is far easier said than done. And those pilots need to be genuinely competent, not just those who have shown they can jump through a couple of key hoops. Much has been made of the race to the bottom when it comes to investment in training, and the industry will need to give some thought to the question of whether 'good enough' is indeed 'good enough' or whether it is actually 'barely sufficient', especially when the perceived degradation of manual handling skills is taken in to account.

Evidence-based training is not a new concept, but we need to make the best possible use of the data available through FDM programmes and, crucially, from simulators. Data science is improving on a daily basis, and there are some exciting advances being made through the use of artificial intelligence and machine learning which may offer human performance insights that conventional analysis alone could not. Somewhere in the flood of data (pace NOTAMs!) will be a grain of truth that can take us forwards into higher levels of safety, we just need to find it.

One area where we might make rapid progress is by better blending of the FDM/simulator boundary. Why does simulator data not make it into the FDM programme? It would not be appropriate to treat the data in exactly the same way, but it would arguably be reasonable as a de-identified means of improving trend data. It would also be the only risk-free method of accurately monitoring responses to abnormal situations such as rejected take-offs, engine failures and the like. There would need to be safeguards in place to ensure there was no additional jeopardy arising from the use of the data, so no equivalent of the video referee making judgements after the event…

There is also a good argument for using FDM data to programme the simulator, so crews would be able to see exactly what had occurred – great learning material. You might use the process to show other crews an event that had relevance to the whole fleet. Clearly, protocols would have to be carefully worked so that confidentiality was maintained throughout; that could start with selected events being replayed for all pilots, with scripted guidance on salient events and the learning points, and with none of the simulator staff being aware of the data source. You need not replay large segments of the flight, just those moments where, for example, an inappropriate FMC mode selection led the crew into an undesired state, or where an approach became unstable below 1000ft.

With 'Big Data' becoming ever closer to being a useful weapon in the safety armoury, we should perhaps look at a complete redesign of our training and licensing system. Where Pilot X is not performing adequately, there is normally plenty of evidence available from FDM, ASRs etc. to point out any problem areas, so why - other than because the rules say so - does so much time have to be given up to LPC/OPC in the simulator? By all means require demonstrations of someone's ability to handle technical failures or reject a take-off, but how about using the simulators for what they were designed to do, namely to train people? Decision making in complex scenarios could be checked by other means, using part-task trainers or even desk-top exercises. ICAO would need to take a lead on this; alignment of all the stake-holders would not be easy, but, as with airspace, the system has developed in response to pressures that are no longer the same as those being felt in the early days of the organisation. Planning for the future needs to take account of the pace of change and not be framed just by today's technology and mind-sets.

Continuing on the Big Data theme, artificial intelligence (AI) is a capability that when used properly could bring great benefits to both the operational and safety spaces. We talk of achieving predictive safety but we currently lack the ability to make sense of all the data we are presented with, and especially with understanding the relevance of small snippets of information emerging outside our own sphere of operations. AI can help with that, and the data visualisation techniques now being developed offer exciting possibilities for managing airspace and routes, with clear benefits also apparent for training – it will soon be possible to accelerate the acquisition of understanding (as distinct from knowledge) by providing a learning environment that is enriched by synthetic experience in the form of tailored data.

In the short term, though, we must rely on the human to get the job done. That means we need to have the right people with the right skills and in the right numbers. As we increasingly see safety analysts being recruited with no real aviation background on which to base some of their judgments, we need to invest in their training and supervision if we are not occasionally to arrive at the wrong answers and hence miss an opportunity to prevent an accident. Lack of experience is nobody's fault, but failure to provide adequate training is unforgiveable. Is your own safety office properly resourced so that you have the ability to train when necessary? And, if not, are the nominated post-holders fully aware of the situation? And if the post-holders are not fully aware, the next question for you is whether you have appropriately communicated the risks.

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Notices to Airmen (NOTAM)

by Jacky Mills, Chairman UKFSC

NATS provides the Aeronautical Information Service (AIS) as a specified service under the Air Traffic Services Licence granted to NATS by the Minister of State for Transport. NOTAMs (Notices to Airmen) are notices concerning the condition or change of any facility, service or procedure notified within the AIP. NOTAM are available in the form of Pre-Flight Information Bulletins (PIB) using a live database. The NOTAM office is a department with the AIS, which is a specified service undertaken by NATS on behalf of the UK CAA – it is a CAA requirement that all air users should be advised of unusual UK activities that might be hazardous.

A NOTAM is a text message transmitted over a global network via Aeronautical Fixed Telecommunication Network (AFTN). It is delivered to a wide range of aviation related organisations, such as air traffic control, flight planning offices, airlines and Private Pilot Licence holders, to bring attention to the fact that something affecting the safe operation of aircraft is taking place. This could be airspace restrictions due to volcanic ash, military exercises, closed runways or a whole host of other reasons.

There are even special names given for specific categories of a NOTAM, for example a SNOWTAM is used for notifications of runway/taxiway/apron status with respect to snow, ice, and standing water, and an ASHTAM gives notification of an operationally significant change in volcanic ash or other dust contamination.

NOTAMs have often been discussed during the Safety Information Exchanges at the UK Flight Safety Committee meetings over recent years. Reports have cited the high volume of NOTAMs delivered to flight crew pre-flight for even the shortest sector as well as time pressures restricting many pilots to reading only those NOTAMs relating to destinations and alternates.

A recent Confidential and Independent Reporting (CHIRP) report submitted regarding a Helicopter Task recounted the information contained in the 168 NOTAMs for their routing in the UK would have taken 4.5 hours to plot onto the requisite charts. A set of cranes which directly affected the routing was found 'buried in the middle of these'.

It has also been reported that Airports are increasingly replicating NOTAMs in Airport Operating Information (AOI) – for example, Malaga with 19 pages and Barcelona with 12 pages. Concerns are that important information buried within the NOTAM pack could be missed, and that the crew were physically unable to absorb the flood of information in the time available.

Discussions have also been conducted around the fact that this issue is not easy to resolve because of the international nature of the system and the clear problem with filtering information. NATS could only work with the AIS information presented to them.

A recent NTSB Investigation cited ineffective review of NOTAM information as the probable cause of a serious incident. The FAA are now reviewing how commercial operators present NOTAMs to their crew. Important NOTAM information was found to have been missed by the flight crew in this incident. The event was a Taxiway Overflight by an Airbus A320-211 in San Francisco California in July 2017.

The flight took place in the hours of darkness in visual meteorological conditions, during an international scheduled passenger flight from Toronto International Airport to San Francisco International Airport (SFO). Flight 759 was cleared to land on runway 28R but instead lined up with parallel taxiway C. Four commercial aircraft, 2 Boeing 787s, an Airbus A340 and a Boeing 737 were on taxiway C awaiting clearance to take-off from runway 28R. The incident aircraft descended to an altitude of 100ft above ground level and overflew the first aircraft on the taxiway before initiating a go-around. The aircraft reached a minimum altitude of about 60ft whilst overflying the second aircraft on the taxiway before starting to climb away. None of the crew or passengers on the aircraft were injured and the incident aircraft was not damaged.

The flight crew had recent experience of operating into SFO at night and were probably expecting it to be in its usual configuration. On the night of the incident, parallel runway 28L was scheduled to be closed at 2300. Information of the runway 28L closure was included in the NOTAMs; however, the First Officer stated that he could not recall reviewing the specific NOTAM that addressed the runway closure. The Captain who was Pilot Flying (PF) stated that he saw the runway closure information but that he did not recall the information when needed as he lined up with taxiway C rather than runway 28R.

The Automatic Terminal Information System (ATIS) information Quebec received via the Aircraft Communication Addressing and

Reporting System (ACARS) also included information regarding the runway 28L closure. Both flight crew recalled reviewing the ATIS information but could not recall reviewing the information which described the runway closure.

A visual approach was being conducted with the ILS localiser providing back up lateral guidance during the approach. However, the Pilot Monitoring (PM) missed the step in the procedure to manually tune the ILS frequency. The PF, who would normally have reviewed all programming by the PM, did not notice that the ILS frequency had not been entered.

Whilst carrying out the approach the PF stated that he thought he saw runway lights for runway 28L and therefore believed that runway 28R was runway 28L and consequently that taxiway C was runway 28R. At this time the PM was focused inside the flight deck programming the missed approach altitude and heading in case a missed approach was required, and setting the runway heading, which reduced his opportunity to effectively monitor the approach. The PF asked the PM to contact ATC to confirm that the runway was clear. The PM looked up at this point and presumed that the aircraft was aligned with runway 28R due partly to his expectation that the PF would align the aircraft with the intended landing runway.

ATC confirmed that runway 28R was clear, but the flight crew members were unable to reconcile their confusion about the perceived lights on the runway – which were the lights from the aircraft on taxiway C – with the assurance that the runway was clear. The flight crew did not recognise that the aircraft was not lined up with the intended landing runway until the aircraft was over the airfield surface, when a low altitude go-around was initiated. The PF stated that he initiated the go-around at the same time that the PM called for a go-around. A collision between the incident aircraft and aircraft parked on the taxiway was thereby prevented but safety margins were severely reduced, given the incident aircraft's proximity to the ground prior to it climbing away, and the minimal distance between it and the aircraft on the taxiway.

Both flight crew members later stated that the taxiway C surface resembled a runway. There were multiple cues available to the flight crew to distinguish runway 28R from taxiway C. These included green centreline lights and flashing yellow guard lights on the taxiway. However, cues also confirmed the flight crews' expectation that the aircraft was aligned with the intended landing runway – the general outline of aircraft lights in a straight line – and the presence of runway and approach lights on runway 28R which also would have been present on runway 28L if open. Therefore, once the aircraft was aligned with what the flight crew thought was the correct landing surface, they were unlikely to be considering contradictory information as is usual in cases of Expectation or Confirmation Bias. Both are often cited as Causal Factors in Aircraft Accident or Incident Investigations and discussed during aviation Human Factors training.

Expectation Bias – 'Having a strong belief or mindset towards a particular outcome' or hearing what we expect to hear – in this case seeing what they believed they should see.

This could be the false expectation produced either as direct experience in the situational context or due to an assumption based on experience.

Confirmation Bias - Once an initial understanding (mental model) has been formed, the individual will search their memory and the immediate situation for additional data relevant to that mental model. Such data are apt to be recalled and regarded as pertinent only to the extent that they confirm the mental model at hand. Although potentially confirmatory information tends to be taken at face value, potentially disconfirming information is subjected to a more critical and sceptical scrutiny.

In other words, once the human has made up their mind they will look for evidence which confirms this hypothesis and tend to discount information which contradicts it. This could also be equated to what flying students should not do, the phenomenon of trying to make the ground features match what is printed on the half mil map when on a VFR Flying Exercise – 'that town has a railway roughly running north – south and that over there looks like a racecourse doesn't it....'

Confirmation bias can have such a strong impact that, once a mental model has been developed and the model has been confirmed, it becomes very difficult to let go of the model, even in the light of contradictory information. The need for a realignment of the mental model becomes apparent, only in the light of one or more extraordinary events that do not fit the model.

To return to the findings in this investigation. Fatigue also seems to have been a factor. The flight crew members also reported that they began to feel tired just after they had navigated through an area of thunderstorms approximately 2 hours before the incident. The incident itself occurred at 0256 EDT (Eastern daylight time) which, according to post incident interviews was when the flight crew would normally have been asleep, as well as being at the start of the human circadian low period as described in the Operator's fatigue information. The Captain had been awake for more than 19 hours, and the First Officer for more than 12 hours.

The investigation found that the flight crew members' lack of awareness about runway 28L closure and the crew members' previous experience seeing two parallel runways at SFO led to their expectation to identify two runway surfaces during the approach and resulted in their incorrect identification of taxiway C instead of runway 28R as the intended landing runway. It also found, amongst some other factors, that although the NOTAM about runway 28L closure was provided to the flight crew, the presentation of the information did not effectively convey the importance of the runway closure information and promote flight crew review and retention.

The Probable Cause was determined by the NTSB as the flight crews' misidentification of taxiway C as the intended landing runway, which resulted from the crew members' lack of awareness of the parallel runway closure due to their ineffective review of NOTAM information before the flight and during the approach briefing.

A Recommendation, amongst some others, was made to the FAA to establish a group of human factors experts to review existing methods for presenting flight operations information to pilots.

Full National Transportation Safety Board report for Flight 759 to SFO is available at: https://www.ntsb.gov/investigations/Pages/DCA17IA148.aspx

Another serious incident was investigated by the UK AAIB in their report published in 2006. The Boeing 737-86N undertook a flight departing from Runway 06L at Manchester International Airport with the flight crew unaware that this runway was being operated at reduced length. The take-off was conducted using a reduced thrust setting calculated for the assumed normal runway length. As the aircraft passed the crest of the runway, the flight crew became aware of vehicles at its far end but, as they were now close to their rotation speed, they continued and carried out a normal take-off. The incident aircraft passed within 56ft of a 14ft high vehicle.

The investigation cites, amongst some other factors, one of the Causal Factors was the crew did not realise that Runway 06L was operating at reduced length due to work-in-progress at its far end, until their aircraft had accelerated to a speed approaching the rotate speed, despite being in possession of a NOTAM concerning the work in progress.

NOTAM packs which are presented to flight crew pre-flight contain information critical to each flight; they also contain a lot of information which is largely irrelevant to the flight they are about to operate. The present system allows runway closures as described in this article, as well as instrument procedure changes, amongst others, to be hidden amongst huge amounts of other not so relevant data. As always, the diligence of the flight crew is the last line of defence and raising awareness of this hazard can only help. However, a technical solution of categorising data and highlighting the information critical to the flight, must be the optimum safety barrier to mitigate this risk.

It was suggested at the UK Flight Safety Committee earlier this year that it would be helpful to establish an industry-wide working group on the subject. It then became apparent that work was already underway by the Flight Service Bureau in the USA, sponsored by ICAO, using artificial intelligence to understand NOTAM criticality. The AI machine 'Norm' first needs to learn which NOTAMs were critical for operations and which were not. Further development of this initiative is certainly a positive step forward.

Our professional flight crew will continue to be diligent and check through these NOTAM packs every day, but we have just seen how easy it is to miss important information with the current rationale. We all look forward to a data driven solution being developed.

Task switching failure due to Cognitive lockup in Airline Pilots

by Capt. Amit Singh FRAeS, Royal Aeronautical Society, London

Abstract

Unstable approaches account for a high number of accidents during approach and landing. A large number could have been avoided with a decision to go-around. Studies have shown that operators of machines and even pilots are susceptible to what is called the Cognitive lockup. As per the definition, humans tend to deal with disturbances sequentially. Which means that they deal with one task at a time even if the subsequent task involves more significant risk. The pressure of task completion is proven to trigger cognitive lockup. On an approach to land, the pilot is under the pressure of task completion, time pressure and framing effect. In this situation, if an approach is destabilized, the pilot should ideally carry out a go-around and reattempt a landing. This involves switching to a second task, which holds higher importance. The pilot is unable to do so due to cognitive lockup since the current task is nearing completion.

Training and framing of the task are two ways of eliminating the cognitive lockup.

Keywords: Cognitive lockup, task switching, framing effect, unstable approach, long landing, go-around.

Introduction

Approach and landing are considered critical phases of flight. The statistical summary of commercial jet airplane accidents around the world, between 1959-2016 (Boeing, 2017), reveals that 48% of fatal accidents and onboard fatalities by the phase of flight occur during the final approach and landing. As per international air transport association (IATA) publication on unstable approaches (Unstable approaches 2nd edition, 2016), data from 2011-2015 shows that approximately 65% of all recorded accidents occurred in approach and landing phase of the flight, and Unstabilised approaches were identified as a factor in 14% of these approach and landing accident. Further, 31% of runway/taxiway excursion was a result of unstabilised approach.

The International Civil Aviation Organisation (ICAO) Safety report 2017 (ICAO safety report 2017, page 16) provides statistics on the accidents and the related risk factors for the year 2016. The top risk factors as per categories and numbers are depicted in Table 1.

Table 1 – Categories and numbers

Sr. n.o.	Category	Number
1.	Controlled flight into terrain	**2**
2.	Ground safety	**20**
3.	Loss of control in-flight	**8**
4.	Injuries to and/or incapacitation of persons	**18**
5.	Operational damage	**16**
6.	Other	**5**
7.	Runway safety	**41**
8.	Unknown	**3**

The highest number of accidents as per categories is runway safety, which includes runway excursions and incursions, undershoot/overshoot, tail strike and hard landing events.

Approximately 65% of all accidents take place in the approach and landing phase. 83% of the accidents could have been avoided in the approach and landing phase, which amounts to 54% of all accidents, if a go-around was carried out. This is stated in the Flight Safety Foundation Go-Around Decision-Making and Execution Project p3 released in 2017.

Pilots are trained to carry out a go-around but the practice is insufficient. As compared to the number of approach and landings, the number of go-arounds is approximately one sixth. At present, there is no training program which addresses cognitive lockout in any phase of the flight.

Boeing gives an analysis of the causes of landing overruns (Boeing magazine Aero Q3 issue 12 page 16), in Figure 1.

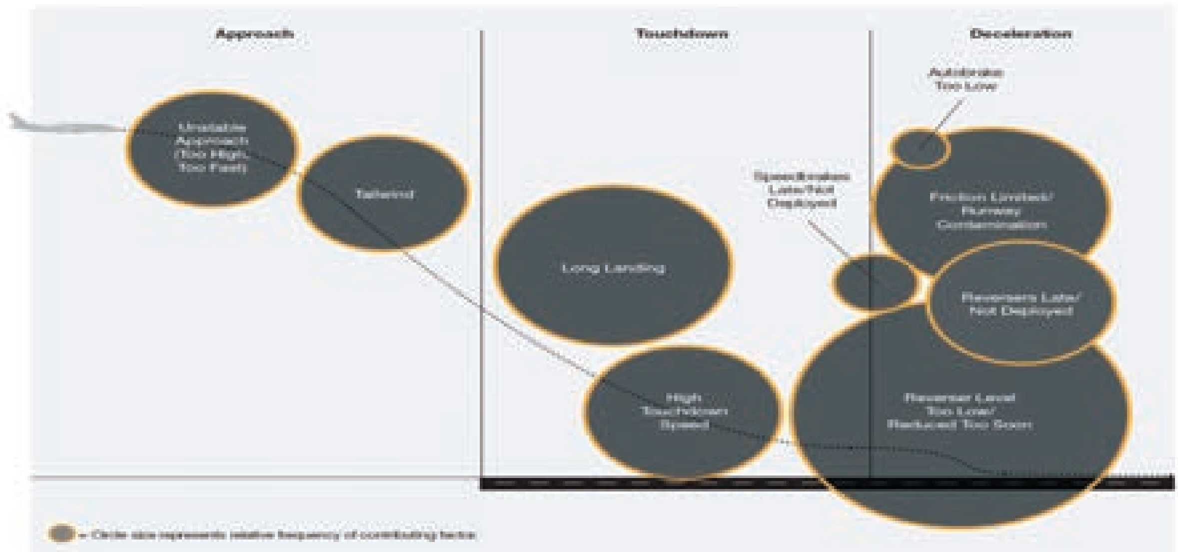


Figure 1 Factors affecting approach and landing overrun

Approach and landing scenario

In this paper we will consider two events, they are, unstable approach and long landing. Both these event are prior to landing at the destination, which is considered to be very close to task completion. The task is to fly from departure to destination. During the approach to land, approximately 95% of the flight has been completed and the two events amount to 70-80% of the remaining time, from beginning of approach to completion of flight.

Event 1

An aircraft on final approach is expected to be configured in terms of vertical and lateral position, speed, the rate of descent, bank angle etc. at or before crossing 1000' above aerodrome level in order to be considered stable for a safe landing. When either or a combination of these parameters are not within specified limits, the approach is considered unsafe and the pilot must discontinue the approach and carry out a maneuver called goaround to attempt another approach.

Event 2

In order to land safely, the pilot, when close to the runway, arrests the rate of descent by raising the aircraft's nose. This maneuver is called a flare. The pilot pulls the control column based on the depth perception and other parameters like speed and environment factors like winds and elevation of the aerodrome. The aircraft on a typical medium to long runway must touch down the wheels at or before 3000' from the beginning of the runway. If the aircraft touches down later than this value, it is called a long landing and there is a high risk of the aircraft not being able to stop within the runway length available. To mitigate the risk, the pilots must go-around and reattempt a landing.

Why do pilots continue an unsafe approach and landing?

The question arises, despite intense and detailed training, why do pilots continue with an unstable approach and/or a long landing? Standard operating procedures (S.O.P.) have clearly defined flight parameters for compliance and the pilots are trained in the class room's for theory relating to technical knowledge, Crew Resource Management (CRM) for nontechnical skills, flight simulators for procedures and skills. Threat and error management is the focus of all training, and awareness of risks and measures to mitigate the risks is the key learning. The pilots who fly commercial airliners need to qualify for their initial and yearly recurrent training, and demonstrate their competence in terms of knowledge, skill and behavior indicators. Despite these barriers, pilots continue to get trapped into continuing with an unstable approach and/or a long landing.

The pilots are performing the task of approach and landing. The mitigating task is that of carrying out a go-around procedure which can be performed at any stage of the approach or landing, even after touch down of the aircraft wheels, till the time reverse thrust is not applied on the engines.

Pilot training

Commercial airline pilots undergo intense training as a part of their qualification process to fly an aircraft. CRM is a training intervention to develop threat and error management skills. The training is both in-depth initial training and an annual recurrent training for the flight crew. The training topics include the following (Commission Regulation (EU) No 965/2012 on air operations, May 2017):

1. Human factors in aviation
2. Human performance and limitations
3. Threat error and management
4. Personality awareness, human error and reliability, attitudes and behaviours, self-assessment and self-critique
5. Stress and stress management
6. Fatigue and vigilance
7. Assertiveness, situation awareness, information acquisition, and processing
8. Automation and philosophy on the use of automation
9. Monitoring and intervention
10. Shared situation awareness, shared information acquisition and processing
11. Workload management
12. Effective communication and coordination inside and outside the flight crew compartment
13. Leadership, cooperation, synergy, delegation, decision-making, actions
14. Resilience development
15. Surprise and startle effect
16. Cultural differences

Cognitive lockup

Moray and Rotenberg (1989) have defined the term 'cognitive lockup' as the tendency of operators to deal with disturbances sequentially. Cognitive lockup however does not occur when people can perform all their tasks consecutively.

Cognitive lockup can also be defined as holding on to a task or sticking to a problem. In terms of the task-switching paradigm, cognitive lockup can be considered as reluctance to switch to an alternative task or problem. (Meij, 2004).

Accident of Eastern Airlines flight 401

The accident of Eastern Airlines flight 401 in 1972 is a good example of cognitive lockup. As per the NTSB report (NTSB,1973), the probable cause of the accident was "Failure of the flight crew to monitor the flight instruments during the final 4 minutes of the flight, and to detect an unexpected descent soon enough to prevent impact with the ground. Preoccupation with a malfunction of the nose landing gear position indicating system distracted the crew's attention from the instruments and allowed the descent to go unnoticed". The pilots got a landing gear warning signal during the approach to land. The crew canceled the landing and began investigating the warning. In the process, the missed critical warnings about lowering altitude and the plane eventually crashed.

Experiments on cognitive lockup

Research on fault management in process control (Moray, N., & Rotenberg, I. 1989), reveals the onset of "Cognitive lockup" when faults in the system are simulated. When multiple faults are triggered, the sequence of preferred fault management by operators of thermal hydraulic systems is sequential. The result of the research was that operators liked to focus and complete one fault or if it can be replaced by stating one task at a time. There is a strong cognitive lockup, which restricts the operator's information capability. The subsequent fault is noticed but no action is taken, till the handling of the first one is completed.

Study 1

The project, HUMAN Model-based Analysis of Human Errors During Aircraft Cockpit System Design was initiated in 2008, to develop a methodology based on a cognitive model of the crew behavior, to support the prediction of human errors in ways that are usable and practical for human-centered design of systems operating in complex cockpit environments (Cacciabue, Hj lmdahl, Luedtke & Riccioli, 2011).

The study identified cognitive lockup as a serious error causing mechanism for airline pilots. Scenarios from human factor perspective with operational relevance were developed, wherein the combination of contextual factors would induce cognitive lockup.

The simulated cognitive model was based on Rasmussen's three behavior levels (Rasmussen J,1983) in which cognitive processing takes place that of skill based, knowledgebased and behavior based. The decision-making module, also called the goal management, determines which goal is executed. In the decision-making process, cognitive lockup was found as a relevant error producing mechanism (EPM). EPM has been modeled in the decision-making process, as task switch cost (TSC) representing the difference the goal priorities must have prior to switching goals.

Scenario. In the scenario, the aircraft is in cruise phase and a thunderstorm is presented very close to the destination. This attracts the attention of the pilot, as it is not clear if there is a need to divert to the alternate or not. The pilot keeps monitoring the movement and intensity of the thunderstorm. During this monitoring phase, a failure is introduced in one of the aircraft engines. The pilot recognizes the failure but does not react and continues to monitor the thunderstorm. After a while, the urgency to handle the engine malfunction is realized and the pilot begins to solve the engine malfunction task.

The cognitive lockup prevents the pilot from immediately switching task, from that of monitoring the thunderstorm to handling the engine malfunction. Figure 2 (Cacciabue, Hj lmdahl, Luedtke &

Riccioli, 2011), shows the goal priorities of each goal over time during thunderstorm avoidance.

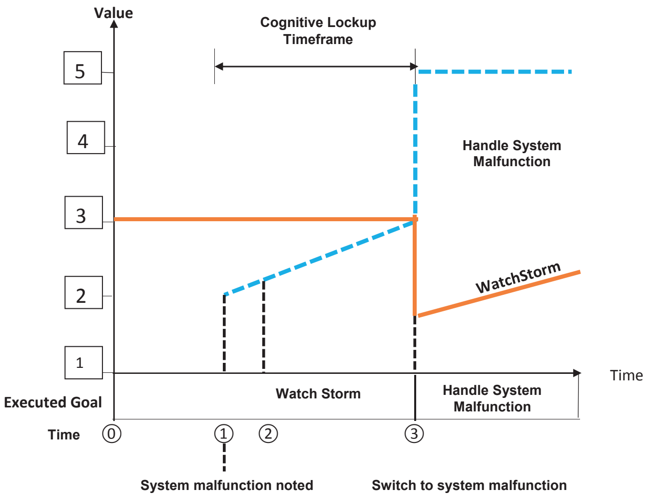


Figure 2 Goal priorities during thunderstorm avoidance

Study 2

Another study was presented at the proceedings of the 4th workshop human centered processes (2011) with the topic as "the effect of time pressure and task completion on the occurrence of cognitive lockup. Mental set and shift" by Aurther T.Jersild (1927), analyses the relationship between mental set and shift. The more homogenous and uniform the mental task, the less will be the demand for adjustment. Human beings cannot perform two tasks simultaneously and must prioritize and shift between tasks. This results in an added expenditure of time and energy. The mental set comes into being through practice and a more comprehensive mental set can be formed through more or less practice. If two tasks are well practiced, the losses are less.

Factors influencing cognitive lockup

Sunk cost fallacy

Individuals commit the sunken cost fallacy when they continue a behavior or endeavor as a result of previously invested resources (time, money or effort) (Arkes & Blumer, 1985). This fallacy, which is related to status quo bias, can also be viewed as bias resulting from an ongoing commitment.

Task completion

The project completion hypothesis–have shown that individuals become more willing to allocate resources to the invested option as goal attainment nears and goal completion becomes more important than economic concerns (Boehne & Paese, 2000).

Garland and Conlon (Garland and Conlon,1998) stated: "as progress moves forward on a project, completion of the project itself takes increasing precedence over other goals that may have been salient at the time the decision was made to begin the project". When task completion is high, the probability of cognitive lockup increases.

That means, in case people deal with a task, and another more urgent task is triggered, people tend to stick to the current task when they have almost completed this task. People have the tendency to stick to their current task when 90% or more of the total stages of a task have been completed (Boehne and Pease, 2000; Garland and Colon, 1998).

Time and task pressure

There are typically two types of pressure on pilots. Time pressure and task pressure. Since the aircraft is constantly moving, there is a finite amount of fuel, which relates to time. Nearing the destination the fuel remaining is sufficient to approach and land and an additional fuel to divert, if required, and hold for 30 minutes prior to landing at the alternate. The fuel remaining at approach is approximately 25% of the total fuel uplifted and the fuel required for approach approximately 85% of the total fuel required for approach and landing. From the perspective of time, approximately 95% of the flight is completed and the two event amount to 70-80% of the remaining time.

Time pressure is dependent on the number of tasks to perform at a given time. Time pressure is high when there is a perception that the time is scarce. According to a study on man-machine system design (Beevis, 1992), people experience time pressure when the time required to execute the task is more than 70% of the total time available to complete the task.

Study on the influence of time pressure. A study was conducted in order to investigate the influence of time pressure and task completion on cognitive lockup. Furthermore, the aim was to identify critical situations in cockpit environments that would allow for designing cockpit systems that would help pilots avoid critical situations and decrease the probability of cognitive lockup.

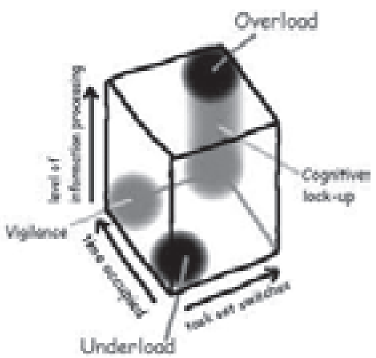
The research was carried out at TNO human factors research institute, Utrecht (Schreuder & Mioch, 2011). The task required two types of fire to be extinguished in a computer simulation. One was the normal fire and the second was an urgent fire. Fires were of different types and they needed to be treated differently. The time to react and the time to extinguish the different types of fire were also variable. The results of the experiment indicated that although time pressure can influence decision-making, people are able to assess the priority of different task while dealing with the task and switch to the more important task if necessary when facing time pressure.

The experiment, however, supported the hypothesis that task completion would have an effect on cognitive lockup. The results showed that people who have almost completed the task tend to finish the task even when a more urgent task is triggered. In other words, if task completion is high, the probability of cognitive lockup is also high. It was also observed that the effect of cognitive lockup was reduced in the second attempt as compared to the first one.

Risk Perception

Framing effect. Framing effect (Tversky & Kahneman, 1981) is a decision problem based on the decision maker's perception of the problem, formulation of the problem and partly by norms, habits and personal characteristics. A problem can be framed and presented with a positive and a negative connotation, despite having the same end result. There is a tendency for the decision maker to shift from risk aversion to risk taker.

The pilots are trained and the policies are defined to indicate that the primary task is to fly from departure to destination and divert to alternate aerodrome if landing at the destination is not possible. The pilots flying the approach are under self-imposed task pressure to land at the destination and the diversion to alternate is taken in a negative connotation. However, if the policy is redefined to word that the primary task of the pilot is to fly from departure to alternate aerodrome if landing at the destination is not possible, the then pilot's task completion pressure is substantially reduced.



Conclusion

Pilots approaching the destination have invested a lot of time in their task and it is nearing completion. Task pressure of completing the flight and the framing of the policy with the primary task of landing at the destination increases the possibility and effect of cognitive lockup. As a result, the pilot will continue with the first task, that of landing at the destination, despite being unstable on approach or when performing a long landing. Carrying out a go-around can be inferred as task switching. This task will be carried out provided there is enough time to realize the consequences of persisting with the primary task. Since there is not enough time and the task completion is within sight, the pilots will continue and land.

Training has an effect of reducing cognitive lockup by increasing practicing task switching that of approach/flare followed by switching to the task of a go-around and reattempting a second time.

The policy, if framed to depict a go-around and a diversion in a positive light will reduce the pressure of task completion from the pilots and they would be more prone to switching the task to go-around with ease.

Cognitive lockout is the primary reason for the reluctance to go-around. If task switching practice is increased, as compared to other tasks, in the trainings, there will be a significant drop in the number of unstable approaches and long landings.

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CHIRP Reports for FOCUS

Information Overload

Report Text: Every day when I come to work I am presented with a thick pad of NOTAMs relating to the flight I am about to undertake. With a 1 hour report and a need to be on the aircraft about 30 minutes before departure, there is absolutely no way any pilot can sensibly read and assimilate the volume of data presented. Very often the information is 'coded' or in poor English making the task even harder. Almost without exception crews only read the NOTAMs related to Destination and alternates.

Within the on-board information (in the case of my company, LIDO documentation) - increasingly, airports are using the Airport Operational Information (AOI) pages of the airport plates to replicate NOTAMs or give the air traffic manual for the destination. For example, Malaga currently 19 pages and Barcelona 12 pages. There is absolutely no way a pilot can reasonably read and retain that volume of information and there is a great danger of something important being lost in 'noise'.

Obviously, a portion of the cruise is spent preparing for the arrival but with multi-sector days (or a diversion) it simply cannot be reasonable to expect anyone to absorb that volume of data.

There must be a better way to present the data and minimise the risk of confusion and data being missed? In discussion with colleagues, there is a strong feeling that the intent is to absolve authority of responsibility in the event of an issue arising because 'the information was there and you should have seen it'.

***CHIRP* Comment:** The reporter highlights 2 related problems: the presentation of relevant NOTAMs and the amount of information placed in AOI pages of on-board documentation. There are a number of work strands seeking to address the issues including a survey conducted by the Flight Service Bureau – an airline cooperative – and Eurocontrol has been working for a number of years on a project called Digital NOTAM. The CAA has also identified problems with NOTAM proliferation, relevance and presentation as risks to be investigated and mitigated by its International Group.

The presentation of NOTAM information is a global challenge and there are several reasons, for example Q-codes and their use, as to why managing and presenting them is problematic. There are several commercial applications which display NOTAMS graphically and, as long as they source the information from the approved provider, they can be used for flight planning purposes. There is also work going on at ICAO to address this issue, but this will be a longer term project. The CAA will be reviewing their requirements to provide a more user-friendly display of NOTAM information online and discussing these with NATS.

The AOI pages are consolidated AIP information which is generally provided from the AIP by the charting company; this can be tailored by the Operator but usually at cost. The counter challenge is how to make crews aware of AIP information in a simple manner – again this is a fine balance and if the airport creates a great deal of information then the crew are obliged to see it or have it available. This issue needs to be managed at operator level.

While the efforts to improve the NOTAM system are welcome – urgency is required. It is to be hoped that the nearly disastrous incident at San Francisco, when an aircraft narrowly avoided landing on a taxiway, may provide the impetus to make genuine and rapid progress. Inadequacies in the presentation of information to the flight crew were identified in the NTSB investigation report which included the following recommendation to the FAA:

> *Establish a group of human factors experts to review existing methods for presenting flight operations information to pilots, including flight releases and general aviation flight planning services (pre-flight) and aircraft communication addressing and reporting system messages and other in-flight information; create and publish guidance on best practices to organize, prioritize, and present this information in a manner that optimizes pilot review and retention of relevant information; and work with air carriers and service providers to implement solutions that are aligned with the guidance.*

Unfortunately, with no early solution in sight, pilots must continue to work through the difficulties with the current NOTAM system and be meticulous in checking for relevant NOTAMS for every flight.

Use of Commander's Discretion

Report Text: As I understand it, Commander's Discretion is to be used to enable the completion of a flight duty due to unforeseen circumstances. There seems to be a grey area around departing from a home base, where it is known the discretion would need to be used on the final sector back to base to complete the duty. For example flying a four sector day, and a delay arriving back in home base on sector 2 would mean that sector 4 would require discretion to be used. It could be argued that crew, faced with the choice of either an overnight at an outstation, or positioning as pax after a relief crew had been dispatched to the outstation could be swayed into accepting operating in discretion regardless of fatigue level, to 'get home quicker'.

My company define 'unforeseen circumstances' as those occurring after check-in, however I would argue that if it became evident during the duty that discretion will be required later, and opportunity arises for a new crew to be called in with no impact to the operation that this should be the default position?

***CHIRP* Comment:** The operator's definition of unforeseen circumstances is compliant with EASA regulations: ORO.FTL.205 f (1) refers to the conditions under which Commander's Discretion may be used,

> *"unforeseen circumstances, which start at or after the reporting time, ..."*

However, AMC1 ORO.FTL.205 (f) (a) includes,

> *"The exercise of Commander's Discretion should be considered exceptional and should be avoided at home base and/or company hubs where standby or reserve crew members should be available."*

Although the EASA FTL AMC refers to the use of discretion being "exceptional", regrettably there is no specific guidance on what exceptional means. EASA has published a Q&A document that includes the following text:

> *Commander's Discretion may be used to modify the limits on the maximum daily FDP (basic or with extension due to in-flight rest), duty and rest periods in the case of unforeseen circumstances in flight operations beyond the operator's control, which start at or after the reporting time.*
>
> *Considering the ICAO definition of 'unexpected conditions', unforeseen circumstances in flight operations for the purpose of ORO.FTL.205 (f) are events that could not reasonably have been predicted and accommodated, such as adverse weather, equipment malfunction or air traffic delay, which may result in necessary on-the-day operational adjustments.*
>
> *Commanders cannot be expected to exercise discretion without an understanding of the events that constitute unforeseen circumstances. It is therefore necessary that they receive appropriate training on the use of Commander's Discretion along with how to recognize the symptoms of fatigue and to evaluate the risks associated with their own mental and physical state and that of the whole crew.*
>
> *Operators should ensure that sufficient margins are included in schedule design so that Commanders are not expected to exercise discretion as a matter of routine.*

In practice, the controls on the use of discretion are the operator's appetite for disruption when discretion is declined and the NAA's tolerance of how frequently discretion is used. Operators that launch crews from home base when the use of discretion will be required to complete the rostered return leg rely on the safety net provided by the Commander's authority to decline the use of discretion. Commanders must retain this authority but there is undoubtedly pressure associated with the decision with its potential for disruption to passengers, the crew and the operator. Modern airline operations with reliable communications to ops controllers may require Commanders to make fewer independent decisions of this nature than hitherto and decisions over discretion may take on extra significance. Although there may be exceptions, the majority of Commanders are conscientious 'can-do' professionals who will default to using discretion unless there are safety concerns associated with doing so.

The CAA supports EASA's view and also the use of Commander's Discretion from home base. While the AMC highlights that use of Commanders Discretion from home base should be exceptional, it is permitted at any stage of the FDP. The CAA monitors the use of discretion as a core regulatory activity.

The bottom line is that only the aircraft Commander is empowered to make the decision about the use of discretion, in accordance with the requirements, AMC and guidance material.

Use of Controller Pilot Data Link Communications (CPDLC)

Report Text: I am a keen user of CPDLC. Many of my colleagues are not. This is because the system has too many failures to be trusted by many controllers and that coupled with reluctance of pilots to actually log in early enough, or at all, in their flight means that lots of controllers don't want to alter their technique to make full use of it. It needs to be realised that to make full use of this technology controllers do need to alter the way they work, so they are either all in or use it infrequently.

Controllers have periods of incredibly high RT load and CPDLC is excellent at relieving this. It isn't always as simple as splitting a sector to control RT load due shortage of staff and complications in traffic handling caused by splitting.

I urge pilots to log in as much as possible and as early as possible in their flight. We need to make this a high usage piece of equipment. This will require pilots to have better understand of the system, especially those in B767/757/747 which due to their age do not show route clearances as clearly as they might. These pilots need a little extra training.

I have already spoken to my senior management about spending money on making this system better. System experts already know what is needed but do not get the go ahead due lack of money to spend on system updates.

It is also necessary to make the carriage of this equipment compulsory as soon as possible. Controllers need the Aeronautical Telecommunications Network (ATN) version of this as it is better than Future Air Navigation System (FANS) which is generally much slower and more restrictive than ATN. Airlines ordering new aircraft need to make sure that the equipment is fitted and pilots trained fully.

This system will help everyone, pilots included, it will increase sector capacity, reduce errors on read backs (as there are none) making it safer and make the RT quieter. This in turn allows the controller more thinking time to work out how to give continuous climbs and descent therefore saving fuel.

***CHIRP* Comment:** CPDLC is excellent over the N Atlantic but its use in Europe is patchy. Information about its use in Europe can be found on the Eurocontrol website. Its potential to reduce reliance on voice communications is recognised but it will only be realised if aircraft are suitably equipped, pilots log on and controllers use it. Currently not all aircraft are compatible with both FANS and ATN. From a controller perspective it is the Human-Machine-Interface (HMI) that is critical to exploiting CPDLC. Area controllers with support controllers to input instructions are better able to use CPDLC than TMA controllers without support and where the number and timing of instructions become prohibitive. Developing the HMI, possibly to include the facility for controllers to input their instructions using speech recognition à la Siri and Alexa, is the key to fully exploiting the system. Notwithstanding this, pilots are encouraged to log-on whenever possible and to reply promptly to all data link messages. It is important always to 'Accept' the up-link instructions.

Called to Prepare an Aircraft but not operate

Report Text: I was on an Airport Duty in the crew room. ([This operator] allocates a duty for crew to be on immediate readiness at the airport).

The crew dispatch officers came into the standby room and requested that a pilot (me) and 4 cabin crew proceed to a spare aircraft on the airfield, conduct safety checks and pre-flight preparations, and board passengers in advance of a flight to [XXX] that we would not operate. The scenario was that a XXX-based aircraft was inbound with a technical problem, and that in order to avoid delay and preserve on time performance, we would prep their new aircraft and board their passengers in anticipation of their arrival from their now AOG aircraft.

I immediately had a number of concerns with this, which included:

1. Should the crew not be allocated an hour's full briefing/prep time as required by the authority?
2. If the 'aircraft prep' was not being allocated to the roster (it never appeared as a separate item), would it be considered FDP or just duty period?
3. The company did not appear to be keeping a record of which crew members it was using for this unusual duty
4. Who was the legal commander of the flight to be conducted? In my mind this was me until such time that the XXX Commander relieved me, however I was being expected to oversee a security search and take a number of safety critical decisions on behalf of a Captain I had no contact with.
5. What provision did the operator's Ops Manual have regarding this? The Ops Manual states that one non-operating member of cabin crew may 'stand in' for an operating member during boarding until such time as the operating member arrives, but makes no mention of a whole crew doing so. There used to be a provision that a flight may be boarded only if the operating senior cabin crew member is present, but this appears to have been rescinded.

After a discussion with the member of pilot management present, his view was that this procedure was not explicitly outwith the Ops Manual, and that we should proceed to the aircraft and prep it as instructed. I reluctantly complied.

We proceeded out to the aircraft and I reviewed the tech log and completed a walk around whilst the crew began their security search. The aircraft had a number of issues which I wanted dealing with before the passengers were boarded - the passengers were being held on a bus outside the aircraft. There was an outstanding tech defect which required engineering input. De-icing was indicated so I called for it (although it was not conducted whilst I was the Commander). I had been given the first page only of the outbound flight plan to take a fuel decision on, so loaded some extra as a precaution.

After confirmation that the cabin crew were as briefed as they could be and had completed a standard security search, we boarded the passengers. As the last passengers arrived so did the operating XXX crew - I gave the operating pilots as full a handover as I could, and the 4 cabin crew and I proceeded back to the crew room to continue our airport duty.

On return to the crew room, I reiterated my safety concerns, in particular regarding the issue of who was legally responsible for the different aspects of the flight. The base manager was happy with the procedure as conducted because the overriding principle of delegated responsibility applied.

I have since been on a further airport duty and have had the same thing happen - crew dispatch coming round the crew room asking for airport duty crew to 'prep' an aircraft. It seems that this practice is now firmly established as standard procedure at this base.

I believe that there are too many grey areas with a procedure like this for me to be happy to conduct it again.

I would be very interested to know CHIRP and the CAA's views on this practice.

***CHIRP* Comment:** Using a crew on airport duty to prepare an aircraft for another crew to fly is an entirely reasonable use of the Operator's available resources and the reporter had clearly been thoroughly professional in complying with the task. However, there are some grey areas. For example, a crew preparing an aircraft may not require the full standard 'report to departure time allowance' but there should be some prior consideration about how much time is necessary. Also, fuel decisions are personal choices and a potential area for concern. That said, it seems likely that most Commanders would err on the side of caution if preparing an aircraft for another crew, who could in any case load more fuel before departure if required.

It would be helpful and good practice if guidance about preparing an aircraft for another crew were published in company ops manuals. This should include the requirement for an audit trail of who had been tasked with the duty, if and when signatures were required to effect the handover and the point at which legal responsibility was transferred. It is also essential to ensure that crews that take over prepped aircraft do not feel under pressure to expedite their departure to the extent that they are rushed.

The reported Operator has agreed to review this subject with the intention of adding an appropriate level of detail in a future amendment to its Ops Manual.

Supporting Pilot Competence

Competency issues sometimes emerge from accident investigations. Where this is the case, it is usually associated with training and monitoring, and the design and implementation of SOPs. Understanding the reasons for SOPs is critical for judgement and decision-making, as Captain Ed Pooley explains.

Key Points

- Pilots must be individually competent for their role before release from supervision.
- Competence is achieved by delivering task-appropriate training to carefully selected individuals.
- Pilots are necessarily specialists from the start, but expertise comes – in varying degrees – from experience. the acquisition of 'expert' status is neither a given nor a necessity.
- Competence includes procedural compliance driven by understanding rather than solely by directive.
- Effective monitoring of actions taken is the primary defence against omissions and unintended or inappropriate actions. Monitoring by humans is not 100% reliable and so the process must fully embrace the opportunities provided by system automation.

I'm going to start with a very brief discussion about how I believe competence and expertise apply to pilots in two-pilot fixed wing aircraft. I'm then going to look at some real events where competence has failed to deliver safe outcomes, and suggest why. I'll conclude by proposing ways we could improve the extent to which competence is delivered more reliably. Some of this should read across to controllers, too. Like pilots, controllers are first trained to obtain a licence and then task-trained for a specific use of that licence.

Self-evidently, task competence is essential. Contrary to the usual mantra of 'knowledge, skills and attitudes', I prefer the variation 'aptitude, knowledge and skills' – in that order. Aptitude and the ability to absorb knowledge ought to be part of any selection process. And any training regime must be explicitly focussed on the skill-based competence it seeks to establish. Recurrent training, whether in the classroom, in a simulator or during supervised flying, must involve sufficient training to revalidate competence rather than just be a hoop to be jumped through. This is particularly important to revalidate competencies that may, in today's age of automated reliability, rarely if ever be needed.

Once a licence holder has gained some initial relevant experience, the build up of expertise will have begun. Useful expertise will not automatically accumulate at the same rate for everyone, and this will affect the career path that follows. Clearly an aircraft commander will need to have demonstrated sufficient relevant expertise as a First Officer before being considered for such a position. And for appointment as a Training Captain, the evidence of skill based on expertise and on consistent demonstration of competency will need to be very carefully considered alongside the particular aptitude and the extensive knowledge required for this role.

That's the theory. But human performance is inevitably imperfect. This is relevant in selection for training, in the design of training regimes, and in the assessment of competence for our actual performance on the front line. Whilst I am absolutely not discounting what we can learn from what goes well, especially when the unexpected presents itself, I'm now going to offer a few cases where things have gone wrong on the front line. These have been independently (and competently – still unfortunately far from a global achievement) investigated in order to remind ourselves of ways that this can happen. I have deliberately chosen cases where the aircraft operator involved can be characterised as an established and reasonably large business that actively seeks to achieve safety. Such operators will invariably recognise, to varying degrees, that the safety they seek depends on a great deal more than regulatory compliance, which for them serves merely as a baseline rather than the goal. But we should bear in mind that such an approach is still a very long way from being universal.

The order in which the following events are presented is of no significance.

Although in a few cases, the aircraft involved may have been destroyed, no occupant fatalities resulted nor, in many cases, any risk of it. I have mostly avoided using more than one example from any particular airline. Note also that the selection made is not predicated on the potential seriousness of the outcome but on the effect of competency problems, and how these might have come about.

It is not suggested that these competency problems were the fault of the individuals, nor that competency was the only issue. In most cases, problems of competency are associated with training or monitoring, or both, and coexist with problems in the design and implementation of SOPs. Rather, the cases are presented as examples where aspects of competency, and the implications for training and procedures, must be considered in order to learn.

An A319 departing **Ibiza** in 2016 did not follow the previously trouble-free procedure to taxi off the gate using a clearly marked sharp left turn, and the right wingtip struck the air bridge, where it became lodged. One engine taxi departures (OETD) are a discretionary fuel saving technique described in the Operations Manual. The procedures explicitly require consideration of the direction and degree of turn away after pushback and during taxi, but presume that engine 1 will be started first. By omission, the Operations Manual effectively assumes that pilots will understand that it would be ineffective to attempt to follow a taxi line that requires a significant and sustained turn in a confined space using the engine on the inside of the turn. **Ref. 1**.

An A340-300 arriving at **Paris CDG** in 2012 continued descent on an ILS Cat 3 approach when so far above the glideslope that eventually, when 2 miles from the runway and still 2500 feet above it, it pitched up abruptly as the false glideslope upper lobe was captured and in the resultant confusion, control was almost lost before recovery was achieved. The formal conclusion of the investigation noted (1) inadequate monitoring of the aeroplane's flight path by the controller and by the crew during the CAT III precision approach and (2) the crew's decision to continue the approach after the FAP when the aeroplane was above the glide path. The report also observed that the Cat 3 SOP did not include any operational limits for its use. **Ref. 2**.

A Boeing 777-300 began a go around from the runway at **Dubai** in 2016 after touching down late, but its initiation was attempted by selecting TO/GA thrust on the switches (the airborne go around procedure) instead of advancing the thrust levers to the TO/GA position as the SOP requires for a rejected landing. The aircraft reached 85 feet above the runway with thrust at idle before descending onto it – all occupants escaped before the destruction of the aircraft was completed by fire. **Ref. 3**.

A Boeing 767-300 began its night takeoff at **Singapore** in 2015 from a parallel taxiway instead of from the runway for which take off clearance had been given. The crew did not 'follow the greens' as instructed and crossed an illuminated red stop bar. **Ref. 4**.

A Boeing 767-300 made a belly landing at **Warsaw** in 2011 when the crew were not able to lock the landing gear down using either the alternate or free fall procedures after earlier loss of a single hydraulic system. The reason for this was that a tripped circuit breaker controlling all emergency electrical circuits was not noticed and reset. This meant that the electrical release of the landing gear up locks, which is common to both alternate and free fall gear deployment procedures, was prevented. **Ref. 5**.

A Boeing 767-300 was in the cruise eastbound over **Atlantic** in 2011 when the First Officer awoke from an abnormally long period of 'controlled rest'. After a startle response (reportedly based on mistaking the planet Venus for the lights of an opposite direction aircraft at the same level), the First Officer put the aircraft into a steep dive towards an opposite direction aircraft 1000 feet below, causing multiple passenger injuries. The Captain took control and recovered the aircraft. Sleep inertia after excessive 'controlled rest' was considered likely to have been contributory. The procedure for 'controlled rest' was examined and it was found that the rest taken prior to the excursion did not comply with it in a number of respects. **Ref. 6**.

An Airbus A330-200 left the landing runway at **Jakarta** in 2013 after the final stages of the daylight approach were continued after the Captain, as Pilot Flying, had lost his previously acquired visual reference in heavy rain. The First Officer reported that he had not intervened because he could still see the runway. The aircraft touched down with the right main landing gear on the grass and continued like this for 500 metres before regaining the runway, sustaining damage that precluded taxiing in. Prevailing SOPs clearly required that a go around should have been flown. It was considered that the Captain's failure to do so "might have been the result of his insufficient intuitive decision making to cope with the situation". **Ref. 7**.

"SOPs must be properly documented and trained, and finally that this training must include *an appreciation of why they exist*."

What can we learn from these few selected events? Compliance with SOPs is clearly important but SOPs need to be supported by an appropriate context. That context includes recognition that the SOPs must exist where appropriate, must be properly documented and trained, and finally that this training must include an appreciation of why they exist. The importance of the last of these, which can be described as 'background knowledge', is frequently ignored in favour of a 'just do it' approach. More classroom training of pilots in this area would be beneficial.

Interestingly, explaining what underlies SOPs is also likely to improve the quality of judgement and decision making, which is needed when what happens is not entirely addressed by them. This could be because the response to a situation is either seen as a matter of licence level awareness of the operation of a generic aircraft. It could also be because the circumstances that are encountered are unanticipated or are so rare that they are not the subject of an entirely SOP-based response.

Of course, this leaves unintended noncompliance with appropriately constructed SOPs still reliant on monitoring one's own actions or monitoring by the other pilot. This monitoring is heavily relied upon to support compliance, but is not fully effective given that pilots, however competent, will still make mistakes. It also ignores the risks that can follow the actions of a pilot who is 'startled' and then suddenly acts contrary to training. This is an area where we have so far been rather slow to embrace all the opportunities that modern aircraft systems have given us to introduce automated gross error monitoring. We could start with pilot FMS inputs but that could be just the beginning. A comprehensive in-depth assessment of this area could be made but I am not sure that one has yet been published. If this is so, it is overdue and we do not need to wait for more fatal accidents. The opportunity to enhance operational safety performance by leveraging automated systems in this way is clear, and it would constitute a realistic support for competence.

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Analyzing Fatigue

by Linda Werfelman

Survey finds pilot briefings regularly discuss fatigue, but some say their airline isn't responsive to complaints.

Two-thirds of airline pilots responding to an online survey say they routinely discuss fatigue as a safety threat during their preflight and approach briefings, but just over half that number consider their employer "receptive and responsive" to fatigue reports, according to a report in the October issue of *Aerospace Medicine and Human Performance*.[1]

Only 32 percent of the 1,108 pilots responding said they considered their employer receptive and responsive when they called in to report themselves too fatigued to fly, the report said.

Responses differed among pilots in the airline's nine different fleets, and especially between those on short-haul and long haul/ultra-long-range routes, the report said.

"Fatigue reports from crewmembers are a vital source of information for effective fatigue risk management, and pilots are also required not to accept or continue a duty assignment if they consider they are too fatigued to operate safely," said the report, based on responses from pilots for Delta Air Lines to survey questions developed by researchers from the Sleep/Wake Research Centre at Massey University in Wellington, New Zealand.

All of Delta's 13,217 pilots were invited to participate in the survey, which was posted on the company intranet from Aug. 23 through Sept 29, 2017. Of the 1,108 pilots (8.4 percent) who completed the survey, 622 were captains, and 483 were first officers; three did not specify their crew position.

The report characterized the survey as a unique examination of fatigue in that it identified and addressed concerns raised by the pilots. The survey was developed to follow up on issues raised in 2010 line operations safety audits and in a 2016 line audit by the airline's Flight Operations Quality Assurance Department. Its goals were not only to gather information on fatigue issues but also to determine whether those concerns involved only specific fleets or specific operations and to improve Delta's overall fatigue risk management processes.

Response rates ranged from a low of about 7 percent for pilots of Airbus A330s to a high of 13 percent for pilots of Boeing 777s, and the higher 777 response rate "may reflect the fact that their operations are covered by the Delta FRMS [fatigue risk management system], so they might be expected to have a greater awareness of fatigue and possibly more contact with the Delta Fatigue Risk Management Team," the report said.

For pilots in other fleets, fatigue was managed in accordance with prescriptive flight and duty time requirements outlined in U.S. Federal Aviation Regulations Part 117. Pilots in all fleets were trained according to standards set forth in Part 117, and the Fatigue Risk Management Team, made up of representatives from labor and management, works with pilots in all fleets, the report said. In addition, all fatigue reports, safety reports, and operational data for flight and duty times and lengths of layovers are monitored. Fatigue risk management procedures are periodically reviewed.

Survey questions focused on five areas:

- Pilot demographics, including how much time they spent traveling to work;
- Rotations, including the preferred number of days in a rotation, the optimum amount of time off between rotations, the maximum number of consecutive days worked and fatigue ratings for rotations with varying start times;
- Two-pilot night flights, including their preferred placement at the beginning, middle or end of a rotation, and the preferred length of recovery time;
- Layovers, including the quality of hotel sleep and whether a hotel near the airport is preferred; and,
- Fatigue culture, including whether the threat of fatigue is discussed during preflight and approach briefings.

The answers revealed a wide range of opinions about the preferred length of a rotation "in relation to fatigue," from five days for pilots of Boeing 717s and 737s and McDonnell Douglas MD-88s to 14 days for flight crews on 747s (Table 1).

Table 1 — Duration of Rotations

Fleet	Maximum Days Safe Median[1]	Maximum Days Worked Median[1]	Maximum Days Worked Range	Percent of Pilots Exceeding Own Limit	Percent of Pilots Who Build Back–to–Back Rotations
Airbus					
A320	6	8	4–15	67.6	10.1
A330	8.5	8	4–19[2]	27.5	34.3
Boeing					
717	5	7	4–26	68.8	8.2
737	5	7	3–18	71.2	14.0
747	14	12	7–14	6.3	43.8
7ER	7	6	3–15	55.6	18.9
777	7	8	4–16	48.1	18.8
757/767	7	9	4–22	49.6	18.4
McDonnell Douglas					
MD-88/90	5	7	4–23[3]	75.9	11.5

1. The data distributions are right–skewed. 2. Extreme value of 140 (reported by one individual) excluded.
3. Extreme values of 0 and 210 (reported by one individual in each instance) excluded. Extreme high values are unlikely, given that cumulative flight duty period time may not exceed 60 hours in seven days and 190 hours in 28 days.
Source: Philippa Gander, Jim Mangie, Adrienne Phillips, Edgar Santos-Fernandez and Lora J. Wu

The length of rotations actually flown also varied, from as few as three days for pilots of 737s and 737ERs to as many as 26 days for pilots of 717s. A majority of pilots of airplanes in almost every fleet said that they had at times exceeded their own limits. The percentage was greatest – 71 percent – for pilots of 737s and smallest – 6 percent – for pilots of 747s.

Pilots of 747s also were the most likely (44 percent) to build their monthly schedules with back-to-back rotations. The next-highest percentage was recorded by another group of long-range pilots — 34 percent of those in the Airbus A330 fleet sought back-to-back rotations.

Otherwise, the report said, in seven of the nine fleets, fewer than 20 percent of pilots sought similar schedules.

Quality of Sleep

About two-thirds of the pilots in each fleet described as "highly fatiguing" rotations in which each day's flight duty period begins earlier than it did the day before. An average of responses from pilots across all fleets showed a similar percentage considered the quality of sleep they obtained in hotels to be worse than their sleep quality at home, with 23 percent characterizing it as "much worse."

Asked to identify airports where they prefer — when they have layovers of more than 12 hours — to stay at hotels near the airport rather than in the city, the pilots placed New York's Kennedy International and LaGuardia airports at the top of the list, followed closely by Los Angeles International. The same three destinations topped the list of those needing "special consideration because of unique situations or high workload," the report said, noting that responses to both questions were related to the large number of flights to and from those airports.

When assigned to overnight flights, most said they preferred that those flights be scheduled at the end of their rotations.

"There was a clear preference for longer breaks after red-eye flights occurring at the start or in the middle of a rotation," the report said, adding that, after a red-eye flight scheduled at the beginning of a rotation, 43 percent of pilots said they preferred breaks of at least 30 hours and 50 percent preferred 24-hour breaks. Only 7 percent said they preferred 12-hour breaks.

When red-eye flights were scheduled in the middle of their rotations, pilots expressed similar preferences for longer breaks, the report said.

Operational Pressure

Pilots in almost all fleets said that operational pressure contributed to their fatigue at least sometimes (Table 2). Pilots of 747s reported more often (19 percent) than those in any other group that operational pressure was "always" a factor in their fatigue. At the same time, 12.5 percent said fatigue was "often" a factor, 25 percent said it was "sometimes" a factor, and 37.5 percent said it was "seldom" a factor.

Pilots in all other fleets were most likely (between 41 percent and 46 percent) to say their fatigue was sometimes influenced by operational pressure.

Table 2 — Operational Pressure and Fatigue

Fleet	Optimum Break Length (Days) Median (Range)[1]	Bid for 30-Hour Breaks (Percent of Pilots)	How Often Operational Pressure Contributes to Fatigue (Percent of Pilots)				
			Never	Seldom	Sometimes	Often	Always
Airbus							
A320	3 (0.4–24)	20.6	2.2	11.1	45.9	25.9	14.8
A330	3 (0–14)	24.3	13.2	17.7	42.7	22.1	4.4
Boeing							
717	3 (0.7–7)	24.7	0.0	15.8	47.4	27.4	9.5
737	3 (0–7)	16.8	3.7	14.3	42.4	29.1	10.6
747	4 (0.5–30)	18.8	6.3	37.5	25.0	12.5	18.8
7ER	3 (0–5)	5.6	2.8	16.7	41.7	22.2	16.7
777	3.2 (0–14)	6.3	7.7	25.6	41.0	20.5	5.1
767/757	3 (0–24)	15.2	3.8	17.3	43.0	23.6	12.2
McDonnell Douglas							
MD-88/90	3 (0–7)	37.0	1.1	13.7	45.6	31.3	8.2

1. Ranges exclude four extreme values (of more than 98 days). Excluding these did not change the median.

Source: Philippa Gander, Jim Mangie, Adrienne Phillips, Edgar Santos-Fernandez and Lora J. Wu

Fatigue Culture

Although two thirds of all pilots surveyed said that they routinely discuss fatigue during their preflight and approach briefings, on a fleet-by-fleet basis, those percentages ranged from a low of about 60 percent for pilots of 747s to a high of about 75 percent for 737N pilots (Figure 1).

The survey found considerable differences among pilots of the various fleets in their assessments of how receptive and responsible Delta has been to pilots who file fatigue reports and to those who call in too fatigued to fly, the report said.

"Among the short-haul fleets, MD-88/-90 pilots were much more likely to agree that Delta is receptive and responsive to fatigue reports (47.8 percent) and to calling in too fatigued (42.5 percent) than were [Airbus] A320 pilots (30.8 percent and 24.2 percent) respectively," the report said. "Similarly, among the long-range/ULR fleets, 777 pilots were much more likely to agree that Delta is receptive and responsive to fatigue reports (51.3 percent) and to calling in too fatigued (40 percent) than were 757/767 pilots (27.3 percent and 25.8 percent, respectively)."

The report concluded that more information is required to determine why pilots of A320s and 757/767s are less satisfied than pilots from other fleets with the company's input on fatigue. Improved satisfaction would lead to more effective safety reporting and reduced fatigue, the report said.

Australian Review

In another fatigue-related matter, the Australian Civil Aviation Safety Authority (CASA) has begun updating fatigue rules[2] in response to an independent review[3] issued earlier this year that called for, among other things, revised flight and duty time limitations that more closely align with international averages.

The first phase of the transition to the new rules will involve high capacity regular public transport operators, which face a Sept. 30, 2019, deadline.[4] Other air operators will follow, by March 26, 2020.

CASA accepted 21 of the 24 specific recommendations contained in the independent review, noting that there had been a "broad consensus on the need to modernize Australia's fatigue rules, with some differing views on some specific details."

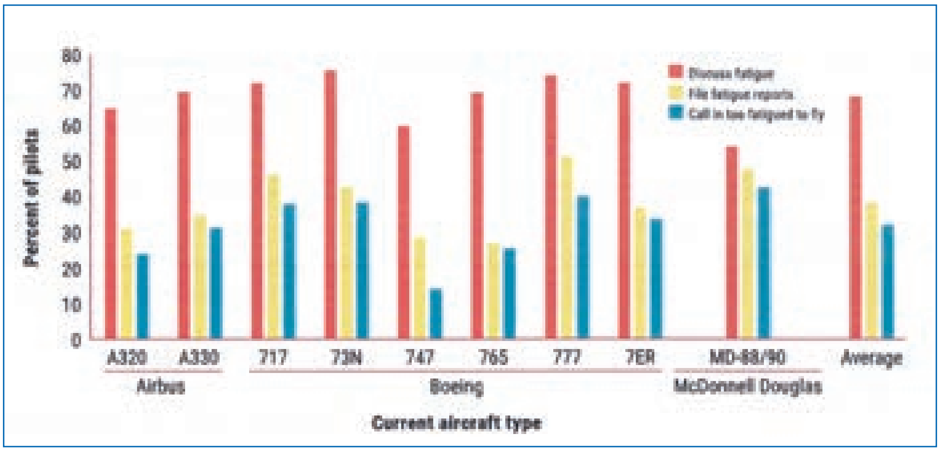
In its formal response to the review, CASA said that its board was "satisfied that CASA's response strikes an appropriate balance between safety and impact on industry, and expects that industry will work with CASA to transition to the modified rules."

CASA noted that the independent review had concluded that "scientific knowledge about fatigue and its effects on human reliability suggest a significant potential risk that needs to be properly managed" and added that CASA's goal is to protect the industry and the traveling public "from all intolerable risks associated with pilot fatigue."

The review found that some of the prescriptive limits in the existing rules are "conservative when compared with similar international jurisdictions and … the requirements in relation to fatigue risk management systems are expressed in an overly prescriptive tone."

CASA's response also noted that an industry technical working group had agreed on the need to modernize the current rules through changes in prescriptive limits, as well as making FRMS available to small operators.

Figure 1 – Safety Culture and Fatigue



Source: Philippa Gander, Jim Mangie, Adrienne Phillips, Edgar Santos-Fernandez and Lora J. Wu

Notes

1. Gander, Philippa; Mangie, Jim; Phillips, Adrienne; Santos-Fernandez, Edgar; Wu, Lora J. "Monitoring the Effectiveness of Fatigue Risk Management: A Survey of Pilots' Concerns." Aerospace Medicine and Human Performance, Volume 89 (October 2018): 889–995.
2. CASA. File ref D18/198602, Modernising Australia's Fatigue Rules. September 2018. <https://www.casa.gov.au/sites/g/files/net351/f/modernising-australia-fatigue-rules-casa-response-to-independent-review-recommendations.pdf>
3. Dédale Asia Pacific. Independent Review of Aviation Fatigue Rules for Operators and Pilots. Final report prepared for the Civil Aviation Safety Authority of Australia. March 20, 2018.
4. A high capacity aircraft is one certified to have a maximum seating capacity of more than 38 seats or a maximum payload of more than 4,200 kg (9,259 lb).

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