PILOT FATIG

AND THE LIMITS OF ENDU

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URANCE

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AN ENDURING AVIATION image is Charles Lindbergh struggling to stay awake as he flies the Spirit of St Louis heroically across the Atlantic towards France.

Today's automated systems would let Lindbergh give in to the demons of sleep, at least for a short time. Despite advances in technology, we have yet to adequately address the problems created by fatigue in aviation operations.

An airline pilot colleague (let's call him "Wally") related that he had logged hours on an aircraft type for which he was not endorsed. Wally had been travelling to the USA on an industry discount ticket but was off-loaded at Auckland. After some negotiation he had gained the captain's approval to ride on the flight deck for the next sector.

Half an hour into the cruise, the check flight engineer took a walk around the cabin because his back was playing up. Then the flight engineer asked for the captain's permission to take a snooze. Apparently the crew had experienced difficulty in adjusting to the time zone changes of transmeridian flight and had been up much of the previous night.

Shortly afterwards the first officer left the cockpit to see a flight attendant he knew.

A few minutes later the captain asked Wally if he would mind sliding into the right hand seat, otherwise the pesky FARs (Federal Aviation Regulations) would require him to don the oxygen mask – a real nuisance. Wally agreed. They spent the next half hour discussing the merits of the aircraft's systems, including the recently upgraded weather radar system, about which Wally was surprised to learn that he knew more than the captain.

As Wally sat watching a nasty-looking storm cell approach on the radar, the captain slipped into his own deep snooze.

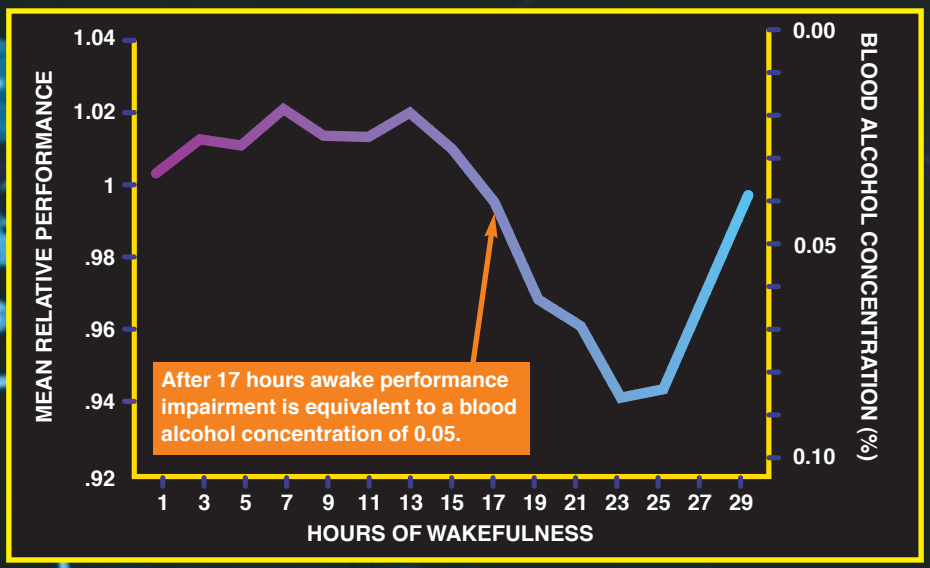
When Wally asked (in appropriate CRM style) what the captain thought of the look of this approaching cell, his question was met with stony silence. Alone on the flight deck, in the dead of night, Wally was flying a foreign registered aircraft for which he was not endorsed. It brought a whole new meaning to the term PIC. Wally flew around the storm cell, put the aircraft back on track, and was later thanked by the captain.

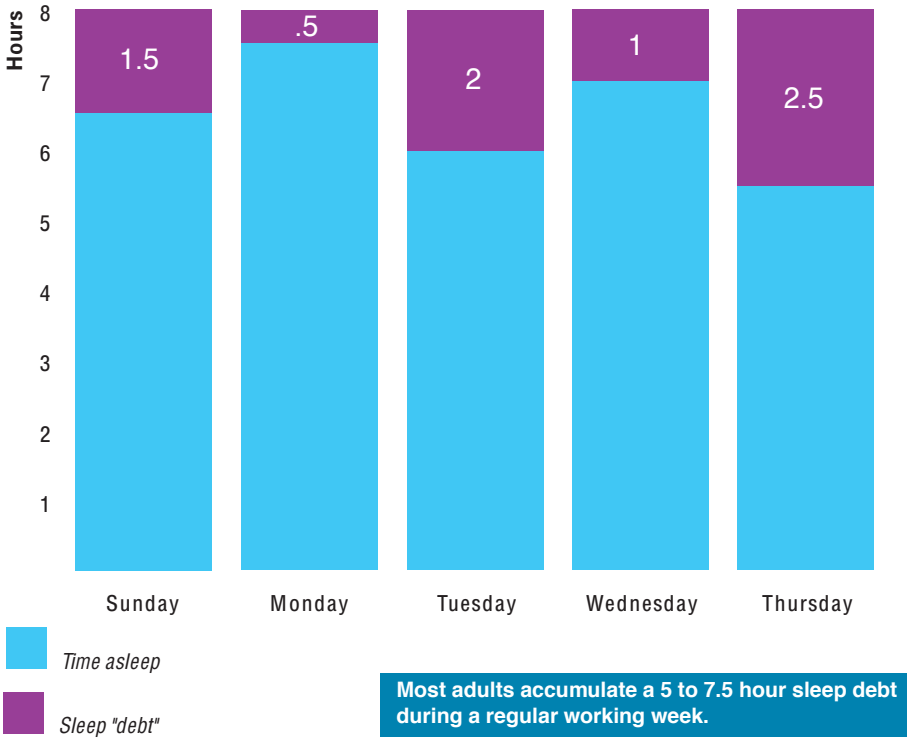
Leaving aside the lack of professionalism of the crew, this incident warns us of the insidious effects of fatigue.

As long ago as 1940, it was calculated that about 70 per cent of aircraft accidents could be attributed to the performance of man (Meier Muller, 1940) – these days, some would argue that up to 100 per cent of accidents are caused by human error. Frank Hawkins, in *Human Factors in Flight*, identified fatigue as one of four major factors that contribute to human error. Fatigue is especially dangerous as it is "invisible", affecting people before they are aware of it. A fatigued pilot can be indifferent to the outcome of the flight and his or her operational performance. Managing our fatigue level is, therefore, an important step in reducing our human proneness to error.

Although fatigue has long been presented as a contributing factor in aircraft accident investigation reports, serious attention began to be given to its effects after the Challenger space shuttle disaster in 1986. Among a wide range of human factors deficiencies considered in this incident were the possible effects of sleep loss, excessive duty shifts, circadian or daily rhythm effects, and the resulting fatigue on the decision to launch the shuttle in spite of concern about its safety (Presidential Commission, 1986).

The significance of fatigue on pilots was highlighted in the National Transporta-





Most adults accumulate a 5 to 7.5 hour sleep debt during a regular working week.

tion Safety Board's Aircraft Accident Report (NTSB/AAR-94/04) in an air accident on 18 August 1993. The highly experienced crew of a DC-8-61 freighter accident lost control of the aircraft on final approach to the US Naval Air Station Guantanamo Bay, Cuba, and struck level terrain about 400 metres west of the approach runway threshold. The aircraft was destroyed by impact forces and a post-accident fire. All crew sustained serious injuries.

They had signed-on the previous night in Dallas at 2300, departing for Detroit via St Louis at 2400 and arriving at 0325. Departing Detroit at 0620, they arrived at Atlanta and finished duty around 0800. However, as the company needed them for an additional trip, they returned to duty. They departed Atlanta at 1010, arrived NAS Norfolk at 1140, departed NAS Norfolk (IFR) at 1413 and arrived at Guantanamo Bay at 1656. By that stage they had been on duty for almost 18hrs.

The NTSB determined that amongst the probable causes of this accident were "the impaired judgment, decision-making, and flying abilities of the captain and flight crew due to the effects of fatigue", the inadequacy of the applicable flight and duty time limitations, and the corporate circumstances that led to the extended flight/duty hours and resultant fatigue of the crew members.

Dr David Neri, of NASA's Fatigue Countermeasures Program, said he believes that this incident was the first time that the NTSB had identified fatigue as a cause rather than a contributory factor in a major aircraft accident investigation.

Effects of fatigue: The NASA fatigue countermeasures program has established that fatigue degrades your:

- Muscular strength and co-ordination.
- Vision and perception.
- Memory.
- Performance monitoring.
- Error management.
- Decision making.
- Motivation and attitudes.
- Communication.
- Ability to cooperate.

Regardless of how a pilot may feel, NASA research shows clearly that fatigue caused by no rests and long hours of work steadily and measurably reduces a pilot's performance.

Fatigue makes a pilot less vigilant, more willing to accept below par performance and begin showing signs of poor judgment. The pilot may find it increasingly difficult to make decisions and may have to re-check information several times because of impaired memory or inability to process information. Alertness and reaction times are also decreased. Irritability and mood swings easily block communication and hamper CRM principles.

Additionally, fatigue leads to slower physical and mental reaction times, increased errors despite an increased effort, variability and unpredictability in performance, preoccupations with a single task or fixation on a single source of information, and perseverance with ineffective solutions, all with the potential to create sloppy flying.

Fatigue=drunkenness? Research has shown just how dangerous fatigue can be. NASA-Ames studies show a person who goes without sleep for 18-20 hours will act and perform as if they have had two or three beers. They are punchy, with longer response times and reduced motor control skills, and have impaired thinking.

Australian research by Associate Professor Drew Dawson and colleagues at the centre for

THE RULES ON FATIGUE

Section 48 of Civil Aviation Orders (CAOs) deals with flight time limitations in aerial work, charter and regular public transport service operations. Although these CAOs are not mandatory for private operations they serve as appropriate guidelines to safe conduct.

Section 48.0 (1.4) clearly identifies the inadvisability of pre-flight fatigue: "Notwithstanding anything contained in these Orders, a flight crew member shall not fly, and an operator shall not require that person to fly, if either the flight crew member is suffering from, or, considering the circumstances of the particular flight to be undertaken, is likely to suffer from, fatigue or illness which may affect judgment or performance to the extent that safety may be impaired".

This is a general rule that all pilots should apply to themselves to ensure that they do not commence a flight with an unacceptable existing fatigue level and its resulting performance deterioration.

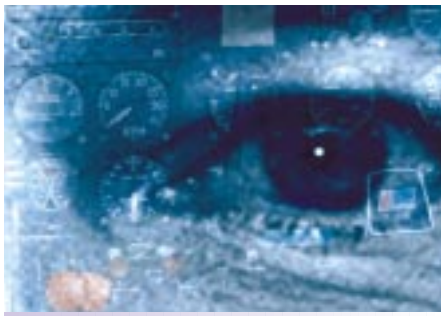
Pilots should consider the effect of their waking time and activities before undertaking a flight, taking into account the amount of sleep they have had, and what time they woke up to start their day.

If, for example, you have had a restful 8 hours sleep, rise at 0530 hours, are active throughout the day, and step into the cockpit for a one-hour flight at 2230 hours, your performance level may have deteriorated as much as if you had a blood alcohol concentration of .05 per cent.

Section 48.1 (1.2) states that a tour of duty or period of reserve time at home shall be preceded by a rest period on the ground of at least: (a) nine consecutive hours embracing the hours between 10pm and 6am local time; or (b) 10 consecutive hours.

Section 48.1 (1.3) states that an operator shall not roster a pilot for a tour of duty in excess of 11 hours.

Section 48.1 (1.14 and 1.15) stipulate that a pilot shall not fly, nor shall an operator roster a pilot to fly as a flight crew member, in excess of 900 hours in 365 consecutive days, and that pilots should not fly, nor be rostered to fly, more than 100 hours in 30 consecutive days.



STAY TUNED

Ten steps to make sure you don't fall victim to fatigue

1. During a layover, sleep as you would normally in a 24-hour period; if you feel sleepy and the circumstances permit, then sleep.

2. If you awake spontaneously and cannot go back to sleep within 15-20 minutes, or you are finding it difficult to fall asleep, get up and try again later.

3. Planning for known sleep disruptions is essential to manage alertness and avoid building up a sleep debt.

4. Develop a regular pre-sleep routine and sleep in a comfortable environment.

5. Do not exercise or eat a large meal directly before sleep.

6. Have a proper diet, keep physically fit, and avoid alcohol and smoking – this will help the body to cope better with the effects of fatigue.

7. Use caffeine sparingly during flight – it may keep you awake later when you are trying to sleep and will cause dehydration (water is best for dehydration - one glass per hour in the air is recommended).

8. Exercise while flying, stretch and flex limbs, relax the neck and back muscles periodically to improve blood circulation and reduce fatigue.

9. Your awake time before flying is part of your hours without rest.

10. Remember that degraded pilot performance because of fatigue occurs whether you feel it or not, and that no amount of willpower will overcome the effects of fatigue.

sleep research at the University of South Australia, published in the 17 July 1997 issue of *Nature*, has shown "The performance [loss] on the job for every hour of wakefulness between 10 and 26 hours is equivalent to the performance [loss] observed with a .004 per cent rise in blood alcohol concentration.

The research says that after 17 hours of sustained wakefulness your cognitive pyschomotor performance loss is the same as if you had a blood alcohol concentration of 0.05 per cent (the proscribed limit in many states for drivers). And it gets worse – after 24 hours of sustained wakefulness, performance at a hand-eye coordination task is on par with someone with a blood alcohol concentration of 0.1 per cent.

Dawson and his colleagues have developed a fatigue model which can be applied to most rostered work situations. To tailor information for specific workplaces, you only need to provide start and end times of shifts. By expressing fatigue as a score, the model allows users to estimate a "blood-alcohol equivalent" for performance deterioration. Available as an Excel worksheet, you can download the model from the internet at: www.unisa.edu.au/sleep/main/tcsr_home.html. The model is also relevant for round-the-clock operations, such as those involving maintenance crews, air traffic controllers, fixed-base pilots and others in the aviation industry.

Assisting your sleep patterns: NASA's fatigue countermeasures program and other studies offer specific ways to minimise the effects of fatigue.

Don't begin a duty period with a "sleep debt" or built-up successive sleep debts – make this a priority above outside activities.

Sleep debts ("owing" yourself hours of sleep i.e.: any amount less than your normal requirement) can be potentially dangerous in terms of human performance. For example, if an individual sleeps 2 hours less than normal per night for four nights, they accumulate an 8 hour sleep debt. Estimates in the US suggest that most adults obtain 1 to 1.5 hours less sleep per night than they need, translating to an accumulated sleep debt of 5 to 7.5 hours in a regular working week. Most people in this routine will compensate by sleeping late on weekends, which will usually make up for the performance loss caused by accumulated daily sleep debts. Although it may sometimes be difficult to obtain, with 2 consecutive nights of recovery sleep most people will recuperate from sleep debt.

Naps can work to your advantage: A 30 minute NASA nap (used by NASA in its tests of the effect of naps or sleep periods on crew during long-haul flights) will aid rejuvenation.

When large blocks of time for sleep are unavailable, naps can be used to augment sleep periods at home or on layover. Studies show that naps can acutely improve alertness and should be taken when a person feels sleepy. It is important to keep to the 30 minute limit in order to avoid the sleep inertia associated with awakening out of deep sleep. NASA researchers contend that no nap is too short and that some sleep is better than no sleep.

NASA/FAA tests of long haul flight crews have demonstrated that pilots and flight engineers who have a 20-30 minute nap followed by a 20-minute recovery period, maintain a higher performance level than pilots who do not have a planned nap. On average, pilots or flight engineers fell asleep in less than six minutes, which is generally a sign of "moderately sleep-deprived individuals".

The control group (allowed no rest) in this study clearly demonstrated the body's lack of ability to fight fatigue. Despite these staff being motivated to maintain their usual flight activities, four members of the group of nine fell asleep during the flight for periods ranging from several to 14 minutes—one even slept twice. These results, detailed in the NASA paper on *Alertness Management on Long-Haul Flight Operations*, supports previous information that regardless of training, professionalism, or having the "right stuff", extreme sleepiness can precipitate uncontrolled and spontaneous sleep.

Avoid alcohol: Many think of (and use) alcohol as a sleeping aid, but NASA studies have shown that alcohol actually disturbs normal sleep architecture and disrupts sleep. One NASA study found that short-haul pilots consumed three times more alcohol on trips than at home. They used alcohol (within regulations) to unwind and promote sleep after long duty days that preceded early wake times. However, alcohol suppresses REM sleep, and can lead to withdrawal effects, sleep disruption and overall sleep loss.

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