

Fatigue and alertness management for ATC: does it really have to pay off?

By Jean-Jacques Speyer

Reflecting way back to the early nineties, as we at Airbus were developing and validating fatigue and alertness management strategies with the Université René Descartes and under contract to the French DGAC, we performed numerous commercial long-range flights that eventually led to a getting-to-grips guide (in this case with fatigue and alertness management¹) available to Airbus airline customers.

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During one of these flights, on a late night let down at the end of a trans-atlantic journey, we were vectored away for traffic spacing and after many long minutes on an outbound leg, the commander took the initiative to get back to the approach frequency to request further instructions. The answer came back just as soon: "Air BC, turn immediately to heading xyz for an approach to runway nm, sorry sir!" This non-standard end of a phrase left the crew some-

what startled and surprised. Whilst hurriedly reprogramming their FMS, the captain said jokingly: "Guys, we haven't got a minute to lose!" And he added for us: "ATC should perhaps think of doing some of your fatigue and alertness management stuff as well!" Rightly or wrongly, they firmly believed that approach control had forgotten us because the frequency controller had somehow hit the sack himself... Or perhaps he had just come back from relief...

Unknowingly, this crew had triggered the saga of what was about to start on a much wider scale: the systematic transfer of sleep research to air traffic control to explore and solve pressing fatigue issues for air transportation actors. Granted that endeavours like this had already been made, but not to the point that they would eventually become fertile ground for sleep scientists to cooperate on a global scale. **Now that ICAO provisions require fa-**

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tigue risk management systems for flight operations to take over a potentially wider role from fatigue and alertness management strategies, we are entitled to wonder whether all this could also become applicable to ATC. Close examination of dedicated ATC studies reveals both differences and similarities with pilots. Having been actively involved in the domain as far as airline pilots are concerned, sheer curiosity made me reread bits and pieces of the literature, and make contact with former HF researchers now fully versed in the theme with ATC. Work and studies have been carried out by various institutions, from Massey University in New Zealand to the FAA's Civil Aero Medical Institute in Oklahoma, USA, and including the Université René Descartes in France, Murdoch University in Australia and the Volpe Center in Cambridge, USA. I also read articles on ATM shift-work management, readily available from SKYbrary. And in the process, I tapped into quite an exhaustive literature review of managing shift-work in European ATM performed by EUROCONTROL.

Even though ATC controllers do not go through time zones and suffer jet-lag, they work against their own body clock with shift systems, especially since night work is involved. These shift-work arrangements are hence associated with general syndromes such as fatigue and stress, sleep disturbance and debt, circadian rhythm disruption, gastro-intestinal disorders, impaired performance and family/social disruption. In addition, ATC workload varies considerably during the day, during the week and during the year. It is well known that many variations do exist in actual practices in ATC shift scheduling.

There are many different shift systems that have become widespread in the last few years. Alternate shift systems (moving every week) are more common in Europe than permanent systems. Forward rotating systems (CW) i.e. morning, then evening and ultimately night duty) appear to be commonly preferred to backward rotating ones (CCW), largely because of the belief that since humans by and large tend towards a 25-hour circadian clock, they will favour progressively



Jean-Jacques Speyer

JJ Speyer, MS El & Mech Eng, VUB, Brussels, Belgium, MS Aero & Astro, MIT, USA, DU HF's & Ergonomics, Univ René Descartes, Paris, France.

After an airline start as B707 Flight Engineer, JJ Speyer moved on to Flight Operations Engineering & Certification at Airbus where he retired as Senior Director Airline Consulting, Fuel & Flight Efficiency end 2009. He is currently Professor at the Vrije Universiteit Brussel in Aircraft Specification & Certification.

advancing cycles. Forward rotating shifts appear to be more tolerable by the body than backward rotations (causing fatigue and sleep problems), often enabling more coherent free time. Worldwide research at some point had to document, review, evaluate and challenge all of this.



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In 2006 EUROCONTROL performed a study aimed at identifying best practices to help define solutions for managing shift work in European air traffic management (ATM). This work^{2,3} presented ways and means for facilitating the planning and management of flexible working practices to improve safety and productivity. The study underlined a higher risk of physical and mental impairment for those controllers working in atypical shift systems compared with employees with regular working hours. In particular this risk needs to be managed in the knowledge that:

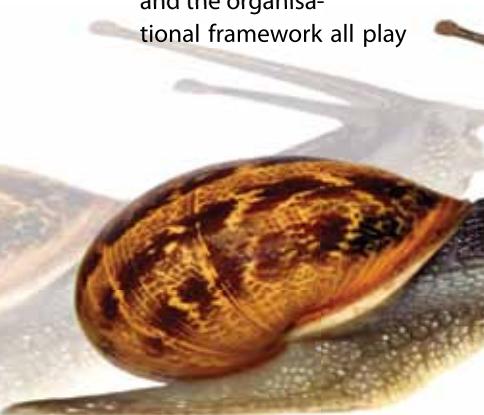
- the risk increases from early to late shift and is highest during the night shift, short-term memory tasks being at their peak in the morning, and decreasing through the day,
- during dayshifts a break is due at the latest after 4 hours,
- tasks demanding high vigilance levels should be followed by a break after just 2 hours,
- the minimum duration of a break should be 10 minutes plus 5 minutes per hour of work,
- breaks should allow napping (typically 20 to 40 minutes) with ample time (15 minutes) to overcome subsequent inertia (period of grogginess experienced upon waking),
- the "hand-over after a break" was considered critical, as the potential for operational errors is highest and increases exponentially as we progress from dayshift to nightshift because the ongoing traffic picture has to be assimilated quickly,
- demands for designing night shift rosters should support European Directive 93/104, restricting shifts to 8 hours.

This research^{2,3} concluded that an optimum shift system in ATM cannot be defined in absolute terms. The specific conditions of the work situation, the workload, its spatial and temporal distribution, individual conditions such as age, attitude, and social support and the organisational framework all play

a vital role in the design of shift systems. The study provided 10 guidelines for shift-work design but acknowledges that some of these recommendations may be contradictory and cannot all be implemented at the same time. Particular choices have to be made: do we look for optimum regeneration after a shift or for the possibility of spending a maximum amount of time with friends and family? Even though it is very difficult to put the recommendations in a particular order, specific aspects take priority concerning the reduction of health risks. European guidelines concerning working hours

hence take precedence, and require internal coordination.

In the US, Congress had mandated a study⁴ in 1999 to conduct an extensive survey of sleep/wake cycles and performance of ATC operators. This included comparing rapidly rotating clockwise and counter-clockwise shift schedules. A third of the respondents said that variable shift work was more fatiguing, with progressively poorer sleep quality as they were getting through the working week. Younger subjects also experienced more car driving issues following shifts. But the study did not support the common belief that a clockwise rotation would result in significantly better performance for complex tasks. The FAA's Civil Aero Medical Institute⁴ said that test performance was notably poorer during the mid-shift (night) and on the





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final (fifth) day of 2-2-1 (2 afternoons, 2 early mornings, 1 midnight) shifts. An ATC shift-work and fatigue evaluation followed with computer-based performance tests, actimetry (i.e. the use of wrist movement measurement devices to accurately ascertain sleep/wake occurrences) and logbooks. Sleep duration and quality, mood and sleepiness appeared to be a function of shift start time, with the preference going to the less abrupt rotations offering

more recovery time. Quick-turn rotations, which allowed more sleep with at least 12 hours off (or more), also resulted in better performance and more favourable subjective reports. A subsequent lab study⁴ confirmed few differences between rotating conditions. Performance was maintained during afternoon shifts, notably reduced during early morning shifts and dramatically reduced during midnight shifts irrespective of the rotating condition. The effects of a counter-clockwise 2-2-1 rotation schedule were no different to those of the clockwise variant. Early mornings and midnights remained a concern for maintaining performance in either rapidly rotating shift schedule. Napping was highly recommended, especially before the midnight shift, resulting in better performance and significantly fewer micro-sleeps. Besides offering a productivity boost,

napping is also known to especially increase creativity and problem-solving skills.

In an early study⁵ comparing clockwise and counter-clockwise rotations, Barton and Folkard concluded that "the critical feature may not be related entirely to the direction of rotation but to a combination of direction and the length of break when changing from one shift to another". And more recent work by the Université René Descartes⁶ on behalf of the French CENA (Centre d'Etudes de la Navigation Aérienne) used both subjective (sleep log, shift difficulty, fatigue and sleepiness scales) and objective data (actimetry and electro-encephalogram (EEG) recordings) to demonstrate that ATC controllers' on-the-job fatigue and sleepiness may not result just from work schedules, but rather from complex interactions between schedules, workload, and stress during the activity. Measurements were correlated with daily assessments of sleep latency (the time it takes to fall asleep) and of sleep quantity (and awakenings) as well as sleep quality during rapidly rotating (i.e. short breaks) backward shifts (CCW) over 10 days for 23 volunteers, 8 of whom had EEGs. This again revealed how fatigue and sleepiness can be at odds.

NASA's Aviation Safety Reporting System⁴ was screened for major operational errors, such as a reduction in applicable separation minima. This



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confirmed that a high percentage of errors do occur during midnight shifts. Also, nearly half of all the errors recorded in daytime occurred within 30 minutes in position, usually upon returning from a break. Schedule variability pointed to the need for greater care in the actual planning of controllers' working hours and to the actual timing of their sleep windows, which by the way is also a matter of personal discipline. Some incidents indeed point directly to systemic dysfunctions related to fatigue and which could be remedied. Some highlight the impact fatigue has on controller performance.

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At 09h07 Central Standard Time, a controller issued conflicting clearances to two aircraft, resulting in a runway incursion at XYZ airport. The controller cleared an aircraft A to cross runway xy and, less than 15 seconds later, cleared an aircraft B to take off on the same runway. The pilots in the departing aircraft B observed aircraft A moving toward the runway, rejected the takeoff, and stopped before reaching the taxiway intersection where aircraft A was to cross. The controller later stated that when he issued the takeoff clearance for aircraft B he had forgotten having instructed aircraft A to cross runway xy. He stated that he was sequencing incoming flight progress strips when he forgot about the crossing clearance and that he had neglected to use a memory aid to remind himself about the crossing traffic, as required by facility operating procedures. The investigation determined that the controller had worked an 8-hour shift the previous day until 2130 and was then off duty for 9 hours. Because of commuting and personal activities, he slept only about 4 hours before returning to work for the incident shift,

which began at 0630. He reported that he felt "semi-rested" during his shift but was "not as sharp as he could have been." He stated that the second shift had been a quick turnaround with no coffee.

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Having contributed to the world's very first fatigue risk management system^{1,8} with the advent of the ultra-long range A340-500 at Singapore Airlines, I realised that pilots are certainly not unique, and that there is definitely room for dedicated FRMS⁸ in ATC (and maintenance) as well.

This is where FRMS⁸ must finally come into its own, providing the educational package on fatigue, sleep and alertness, proposing ways and means of evaluating performance risks and preventing undue handling. Practical FRMS⁸ that have to include organisational fatigue policy, alertness models, risk management frameworks, communication strategies including training and education. But that also offer necessary tools to create alternative

schedules and shifts. And that can make necessary checks & balances to help administer resources accountable for fatigue and alertness management. Wouldn't we be asking too much if on top of all this, FRMS⁹ had to offer compelling business cases with adequate cost-benefit leverages so that the end justifies the means? Does it really have to pay off in that way? Do we have to literally transpose innovative FRMS⁹ (such as the one devised at easyJet to enable work outside current flight and duty time limitations) to the somehow different world of ATC?

It is somehow symptomatic of the increasing complexity of our society to witness so many basics of our trade

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having to be formally documented, so many of our working practices having to become structured processes because so many of our natural risk mitigating practices have in fact become slightly atrophied.

Perhaps the best remedy of all remains the "classical call for duty" and proper "airmanship", transposed to controllers.

Disregarding the contrasting results from these study reviews, the best news about all this in the end is seeing so many researchers all over the world now able to talk to each other with more scientific evidence based on actual ATC fatigue research, each in their own setting. And hence create conditions, inventive schemes and solutions to induce documented change for the sake of safety.

And perhaps good narratives, real-life stories written as self-study notes, are just as desirable as well. These would be real-life examples, such as those developed for pilots in the Operator's Guide to Human Factors in Avia-

tion (www.skybrary.aero/index.php/Portal:OGHFA), to convey the stories as seen through the eyes of the participants. **My message is that in addition to dry theory (which is also very dependent on the socio-economic (EU vs US) context), well-written stories, and in general story telling, can guide us in our behaviour.**

"My mind clicks on and off... I try letting one eyelid close at a time while I prop

the other open with my will. My whole body argues dully that nothing, nothing life can attain, is quite so desirable as sleep. My mind is losing resolution and control." C.A. Lindbergh, The Spirit of St. Louis.

Well-chosen examples that are safety-effective can make a good point. These would be a necessary complement to FRMS ... once they have been broadly proven and implemented⁹. **S**

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