

Managing fatigue

in a large mixed fleet operation

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Flying



**Real
Flying**



Outline

1. Background, previous work
2. Method
3. Results
4. Possible applications
5. Where to now?



Background – ICAO Guidance

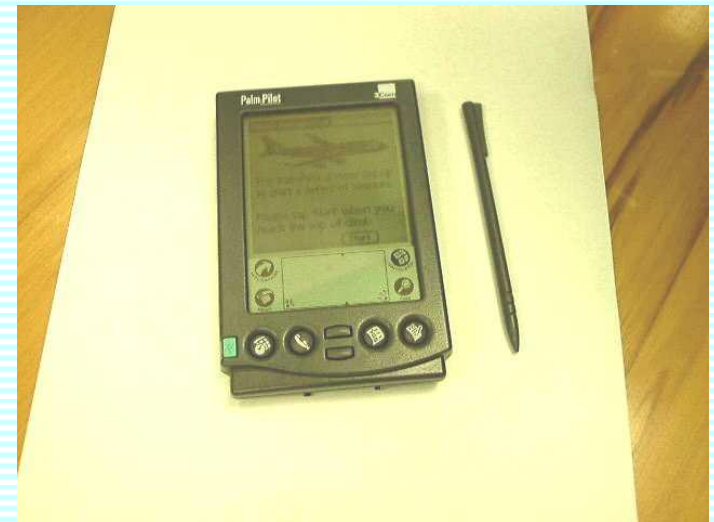
1. FRMS policy and documentation
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 - Identify fatigue hazards
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 - including measures of effectiveness
4. FRMS promotion processes – training, education

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Background - studies

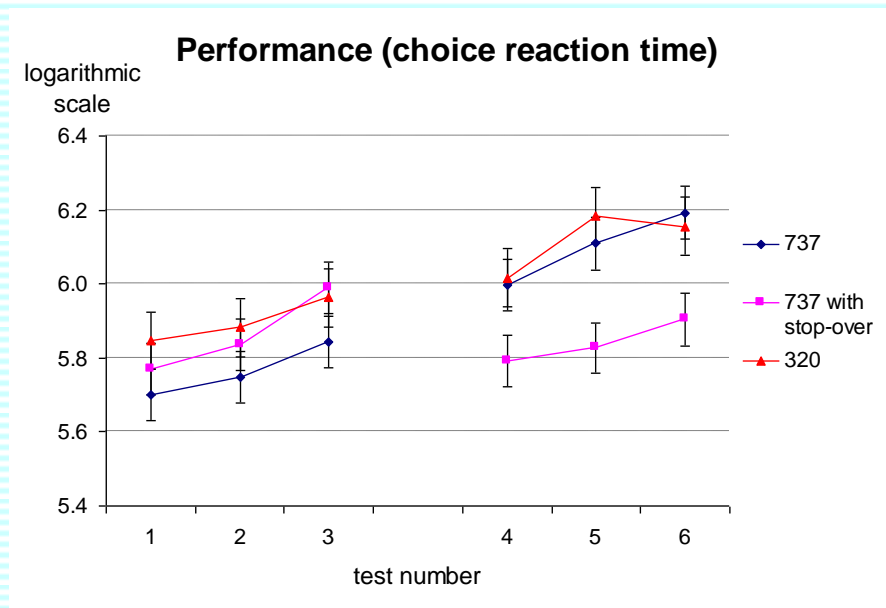
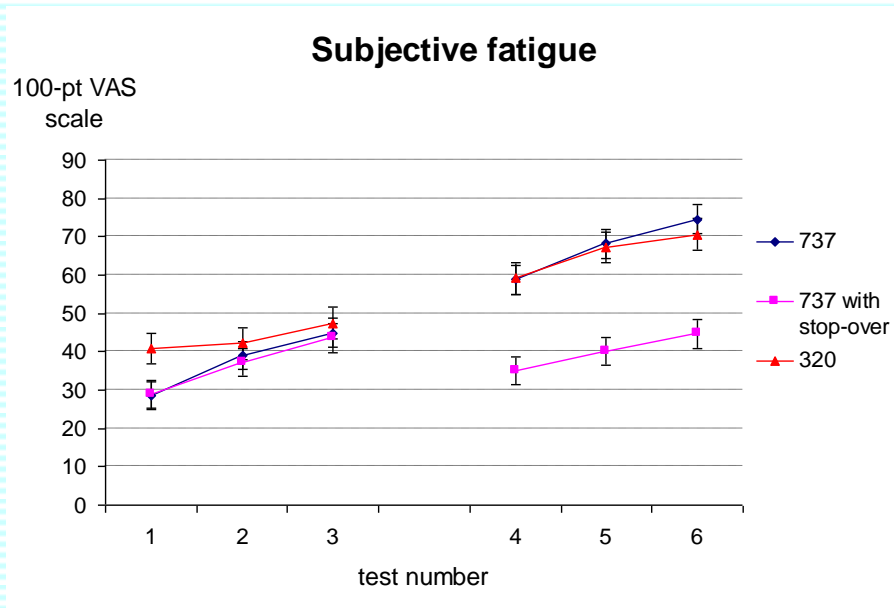
- Typically 20-30 pilots over six weeks
- Studies conducted without an experimenter on board
 - crews are briefed prior to the first departure
- Participants wear a wrist actigraph throughout the study
 - provides an indication of the timing of their sleep periods
- In-flight information obtained using a Palm Pilot computer
 - subjective assessments of fatigue, sleepiness and mood
 - a choice reaction time test



Traditional studies

Christchurch-Brisbane-Christchurch

2-pilot overnight



Powell DMC, Spencer MB, Petrie KJ. *Fatigue in airline pilots after an additional day's layover period.* Aviat Space Environ Med 2010; 81:1-5

Routes studied with PDA/actiwatch

Pilots	Cabin Crew
AKL-LAX-LHR-LAX-SYD	AKL-NAN-RAR-PPT-RAR-NAN-AKL*
SYD-KIX-BNE-SYD (Ansett)	AKL-KIX-CHC-AKL
SYD-LAX-AKL* 3 vs 4 pilot	AKL-PER-AKL
AKL-LAX-AKL* 1 vs 2 nights	AKL-TBU-HNL-AKL*
AKL-LAX-LHR-LAX-AKL 1 vs 2 night	AKL-LAX-APW-AKL
CHC-BNE-CHC* B737/A320	AKL-LAX-AKL
AKL-HKG-LHR-HKG-AKL x2	CHC-BNE-CHC
AKL-ADL-AKL	AKL-PPT-AKL*

* - Changes made

Another way

- More flights
 - Brief measure
 - Critical phase:
 - Probability of brain impairment
 - Demands of task and environment
 - Impact of failure
- = Top of Descent

Top of Descent Survey

Last descent of duty day

Self rated fatigue (SP, VAS)

Three months

>9000 responses

Three parts of operation



AIR NEW ZEALAND

PILOT ALERTNESS REPORT FORM

Forms to be completed immediately prior to Top of Descent on last leg of duty period.

Report Time (UTC)

Time (UTC) at Top of Descent

Name the Sectors operated this duty period.

Please circle "How you feel" at Top of Descent

1. Fully alert, wide awake
2. Very lively, responsive, but not at peak
3. OK, somewhat fresh
4. A little tired, less than fresh
5. Moderately tired, let down
6. Extremely tired, very difficult to concentrate
7. Completed exhausted

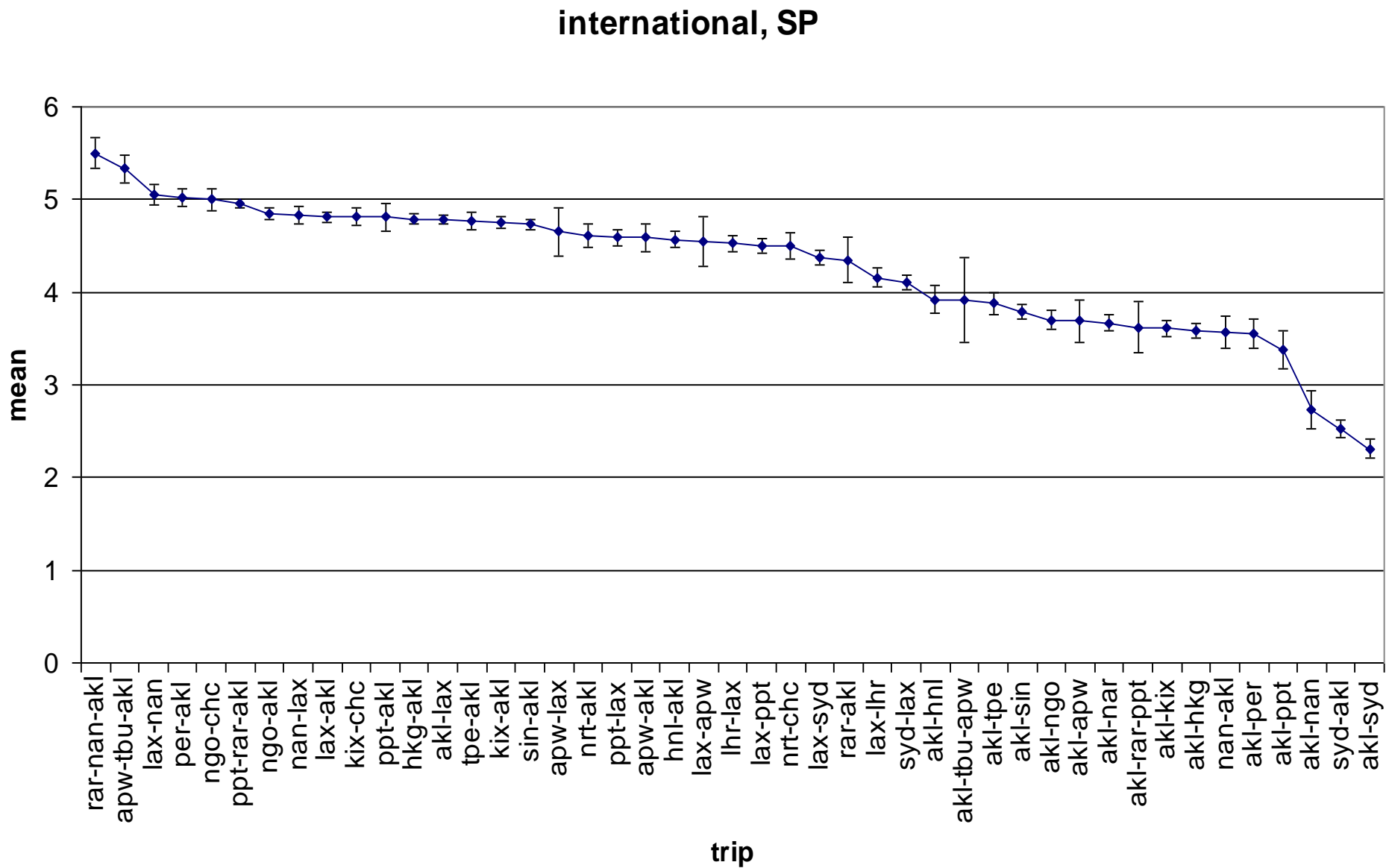
Please mark on the line below

Alert

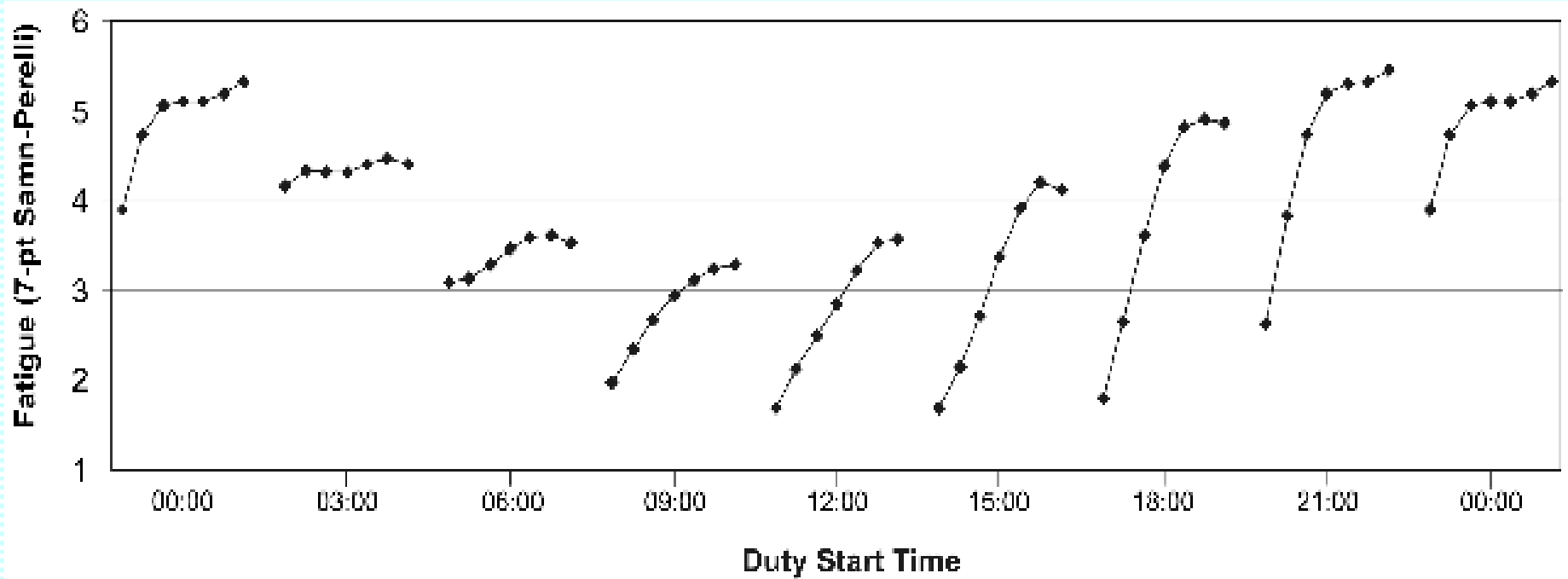
Drowsy

Please place in brown envelope

Top of descent survey results (Longhaul)



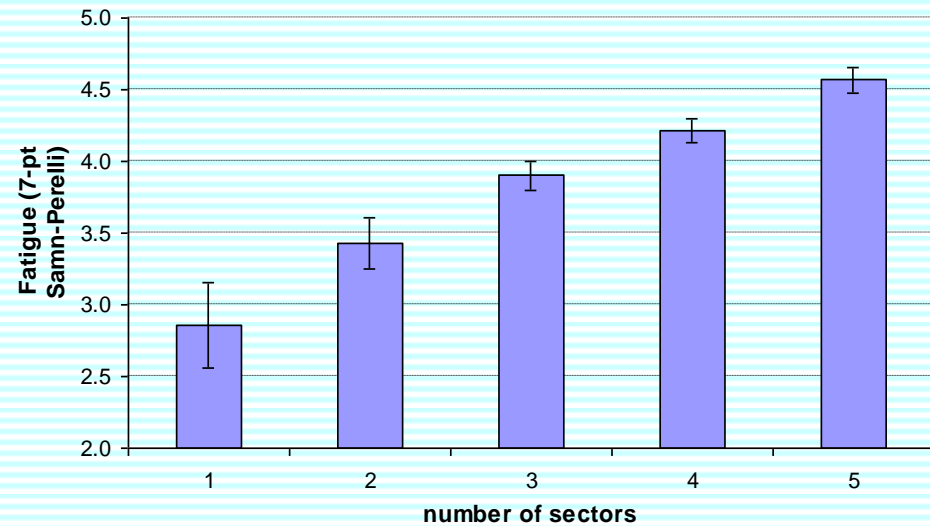
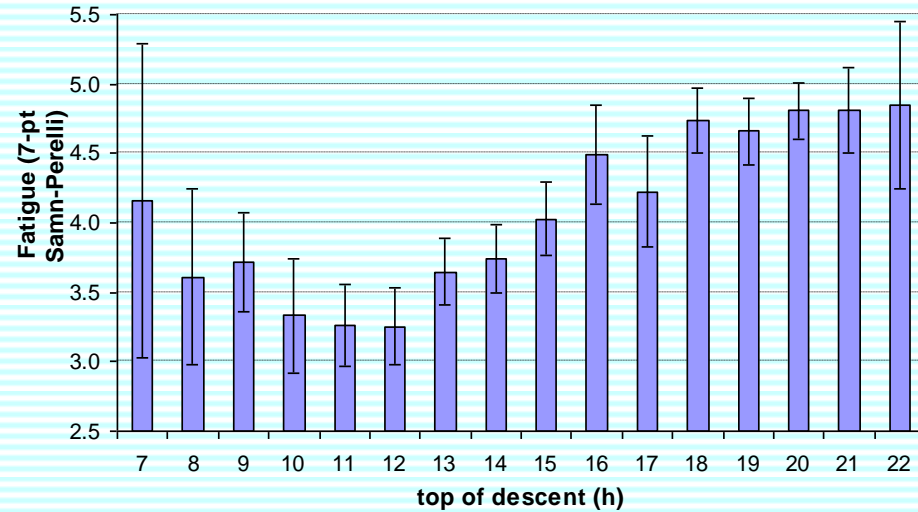
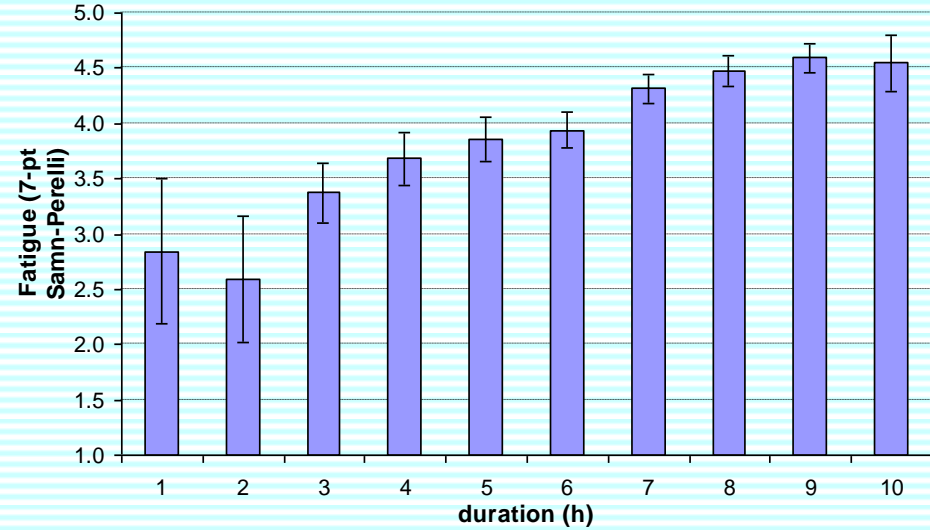
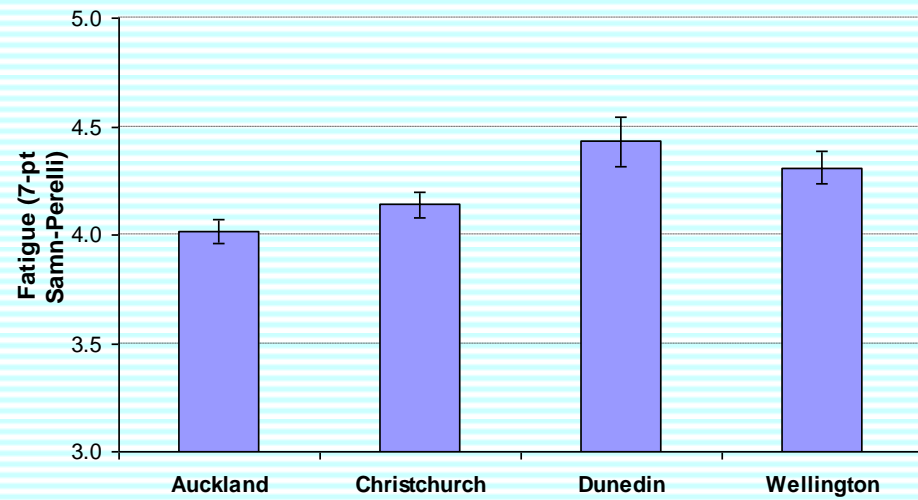
Top of Descent (Regional)



Powell D, Spencer M, Holland D, Petrie K. Fatigue in two-pilot operations: implications for flight and duty time limitations. *Aviat Space Environ Med* 2008; 79:1047-1050.

Top of descent (Dom)

Powell et al Aviat Space Environ Med 2007; 78:698-701



Why not try to do it routinely?



Top of Descent Alertness Evaluation (ToDAE)

A new tool for monitoring fatigue in
commercial airline operations

Input Screen

ATC	FLIGHT INFORMATION	COMPANY
REVIEW	MANAGER	NEW MESSAGES
hhmmZ	TOP OF DESCENT ALERTNESS EVALUATION	XXXXXXXXXX
1. Fully Alert, wide awake		
2. Very lively, responsive, but not at peak		
3. OK, somewhat fresh		
4. A little tired, less than fresh		
5. Moderately tired, let down		
6. Extremely tired, very difficult to concentrate		
7. Completely exhausted, unable to function effectively		
0. Not Applicable		
Pilot A <input type="checkbox"/>	B <input type="checkbox"/>	C <input type="checkbox"/>
	D <input type="checkbox"/>	
RESET		RETURN
EXIT		

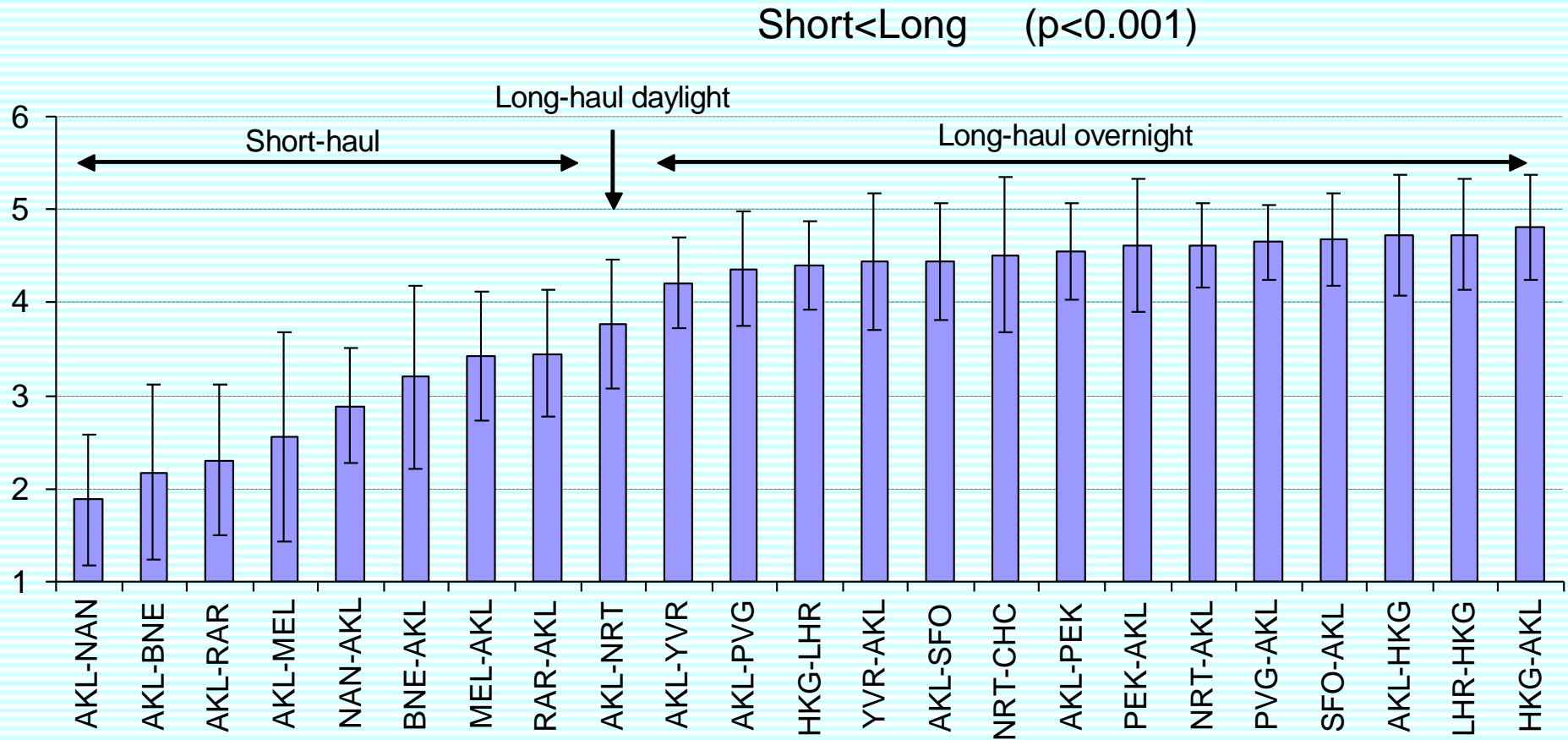
Participants

- All pilots on the 777-200 fleet were invited to participate
 - anonymous
- Mixture of operations
 - long-haul international (almost all overnight)
 - out-and-back duties (daytime)
- Between Jun 09 and May 10
4629 ratings were obtained
 - from over 50% of flights
 - approx. 38% of pilots

Flights covered

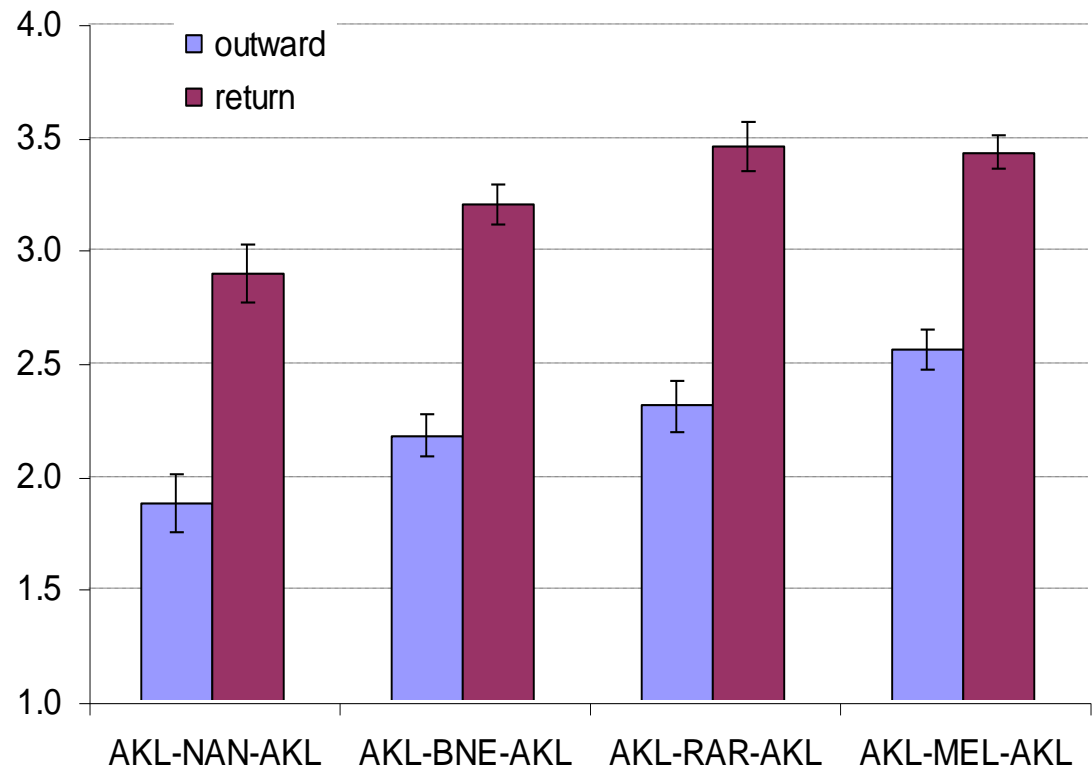
From	To	Take-off (approxLT)	Flight durn (h)	No. of pilots	Type of flight	Prior nights layover	No of flts
Auckland	Fiji	12:00	3.0	2	S/H out	0	36
Auckland	Brisbane	10:00	3.5	2	S/H out	0	69
Auckland	Cook Islands	11:00	3.8	3	S/H out	0	34
Auckland	Melbourne	8:00	3.8	2	S/H out	0	75
Fiji	Auckland	16:00	3.0	2	S/H back	0	37
Brisbane	Auckland	13:00	3.0	2	S/H back	0	75
Cook Islands	Auckland	17:00	3.5	3	S/H back	0	37
Melbourne	Auckland	12:00	3.4	2	S/H back	0	94
Auckland	Tokyo	10:00	11.2	3	L/H out	0	104
Auckland	Shanghai	0:00	12.5	3/4	L/H out	0	63
Auckland	Beijing	23:00	13.5	4	L/H out	0	34
Auckland	Hong Kong	0:00	11.5	3	L/H out	0	129
Auckland	San Francisco	20:00	12.2	3/4	L/H out	0	92
Auckland	Vancouver	20:00	13.2	4	L/H out	0	26
Tokyo	Auckland	18:00	11.0	3	L/H back	1,2+	83
Tokyo	Christchurch	18:00	12.0	3	L/H back	1,2+	33
Shanghai	Auckland	14:00	11.5	3/4	L/H back	2+	57
Beijing	Auckland	12:00	13.2	4	L/H back	2+	40
Hong Kong	Auckland	18:00	10.8	3	L/H back	1,2+	148
San Francisco	Auckland	20:00	13.2	3/4	L/H back	2+	106
Vancouver	Auckland	20:00	14.0	4	L/H back	2+	21
Hong Kong	London	8:00	13.2	3	L/H back	1,2+	99
London	Hong Kong	21:00	12.2	3	L/H back	2+	91

Samn-Perelli scores by sector



Out and back daylight duties

- Scores on return were considerably higher than on the outward flight $p < 0.001$
- The Fiji flights were less fatiguing than the others $p < 0.05$
- The Brisbane flights were less fatiguing than the Melbourne flights $p < 0.01$



Dep 1200
2 pilot

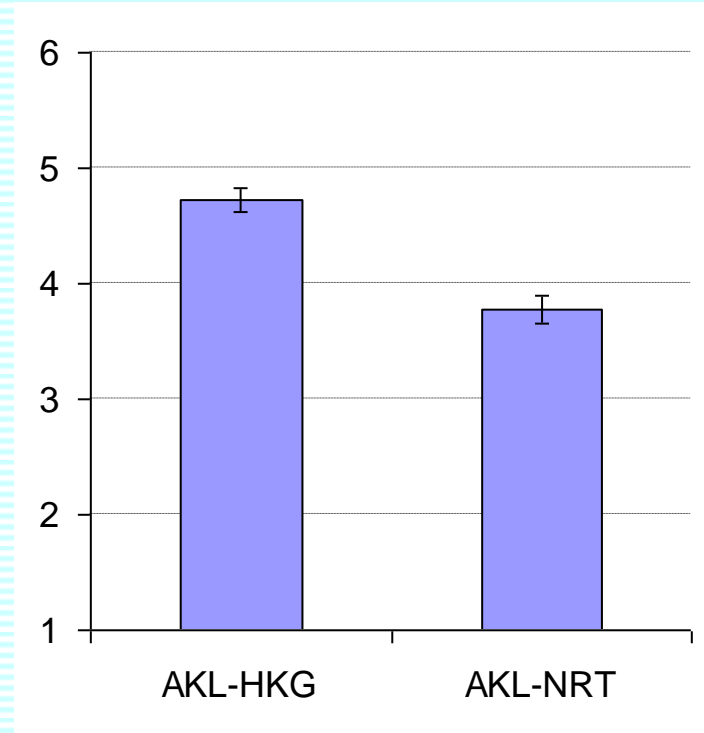
Dep 1000
2 pilot

Dep 1100
3 pilot

Dep 0800
2/3 pilot

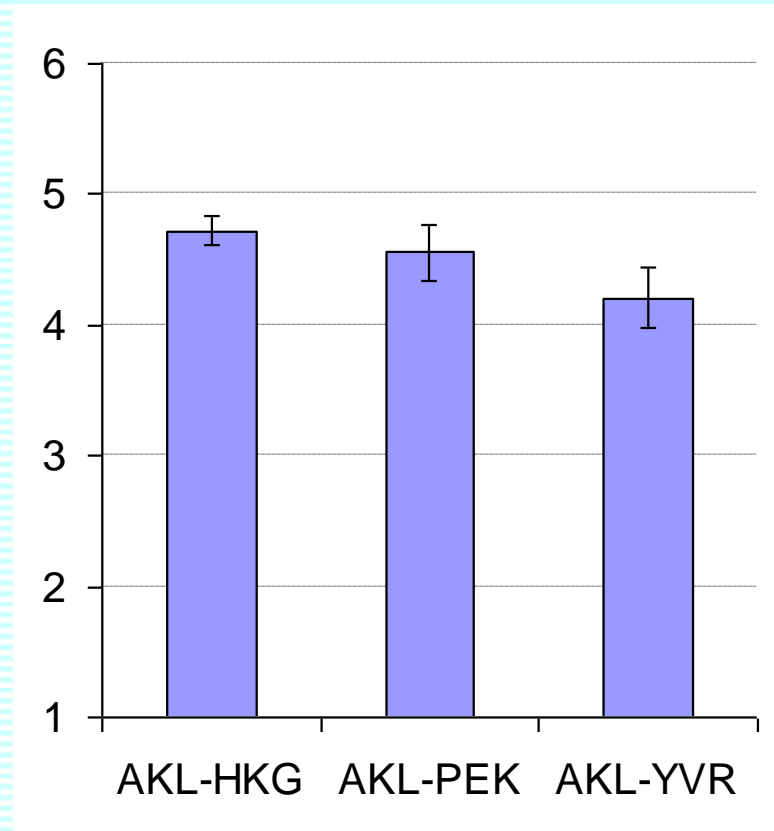
Effect of time of day

- Comparison between an overnight flight (AKL-HKG) and a daytime flight (AKL-NRT)
- Flights of similar duration
- $p < 0.001$



Effect of an additional pilot

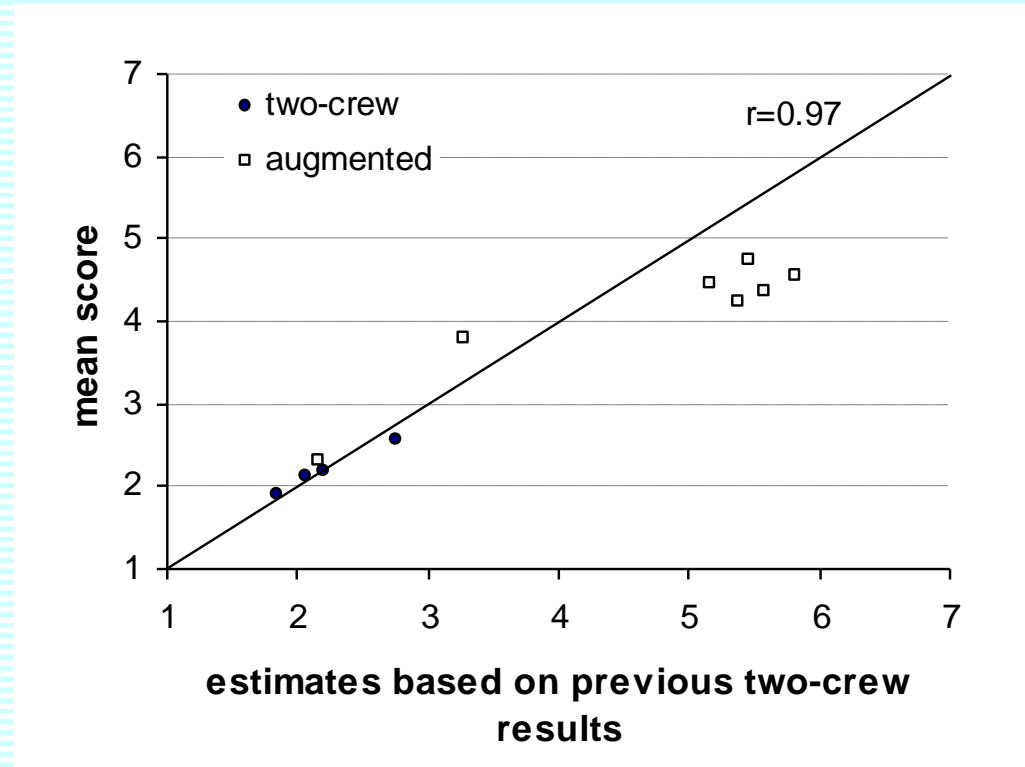
- Comparison between:
 - **AKL-HKG (3 pilot)**
 - start 00:00; duration 11.5h
 - **AKL-PEK (4 pilot)**
 - start 23:00; duration 13.5h
 - **AKL-YVR (4 pilot)**
 - start 20:00; duration 13.2h
- Scores were higher at the end of AKL-HKG than AKL-YVR
- No difference between AKL-HKG and AKL-PEK



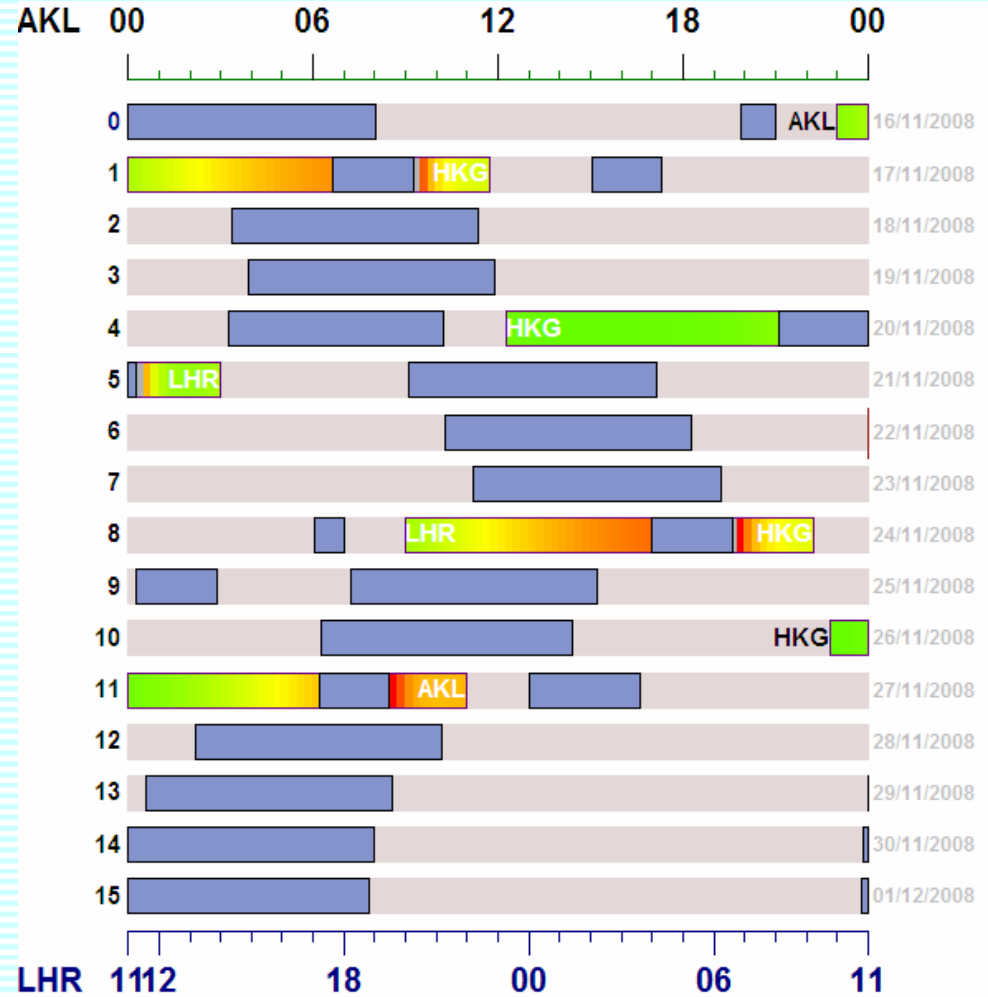
* $p < 0.05$

Comparison with previous two-crew results

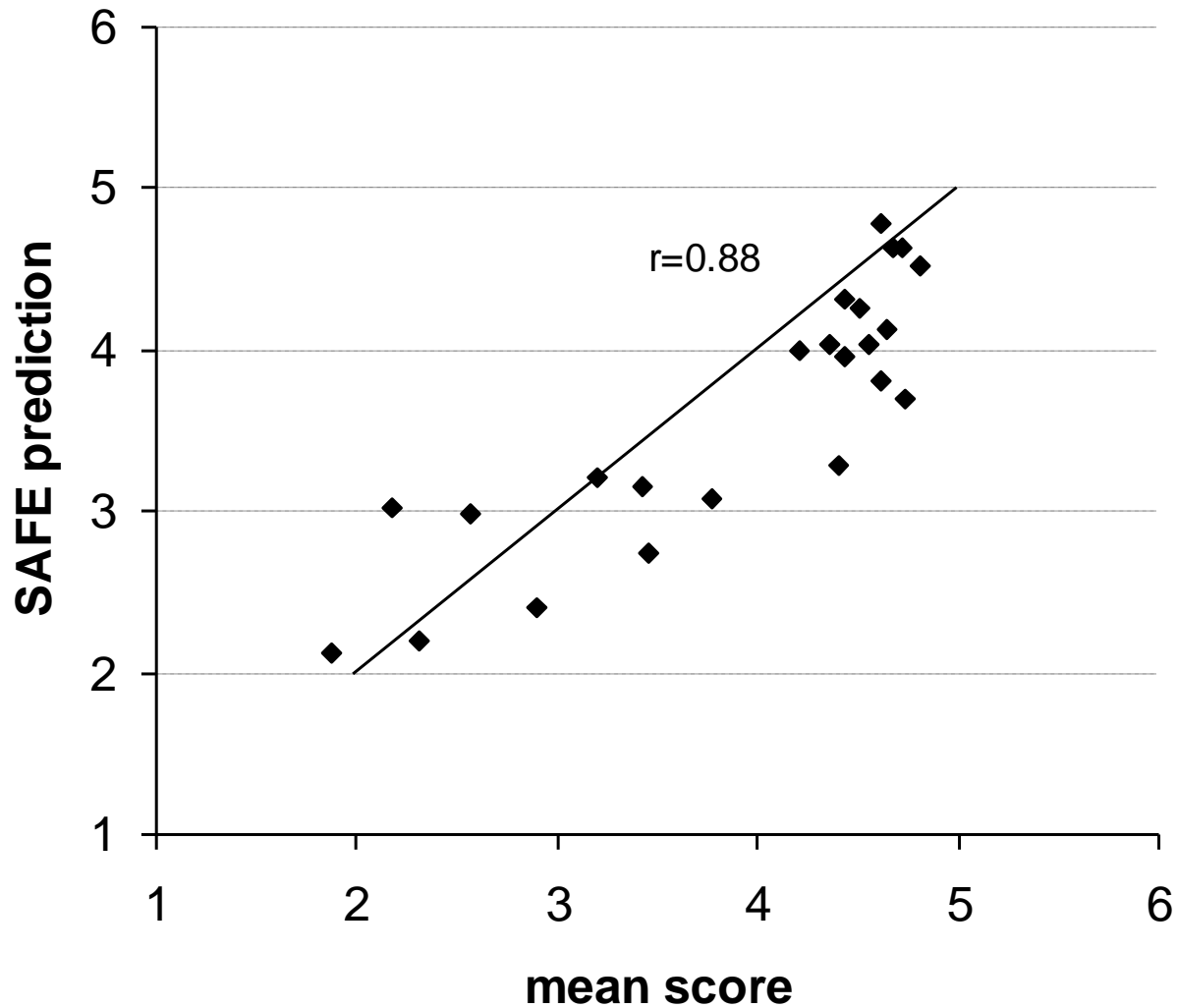
- The two-crew flights were in very close agreement
- The scores on the augmented flights were lower than predictions based on previous two-crew results
 - except for the two daytime flights



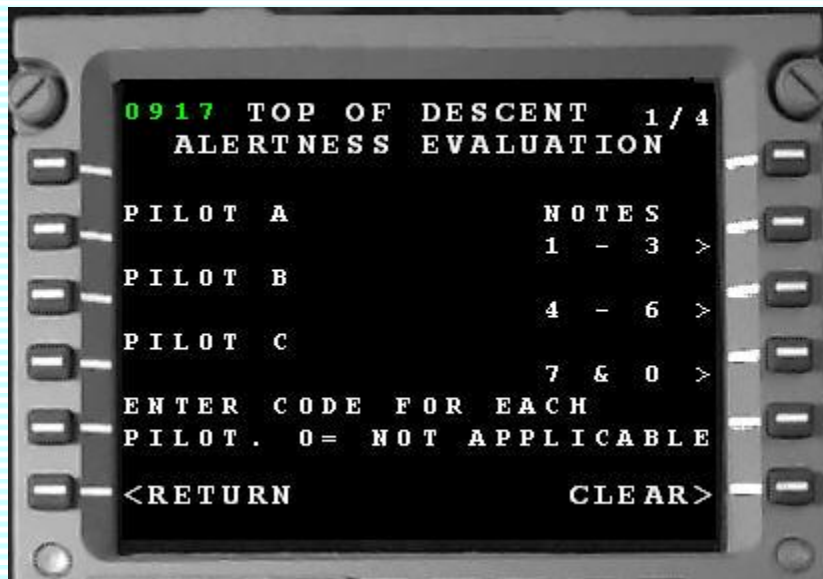
Comparison with predictive model (SAFE)



Comparison with SAFE predictions



A320



Potential applications

- Monitoring operation
 - New routes
 - Other changes
- Avoiding formal studies
- Integrating with safety monitoring – FOQA
- What else?

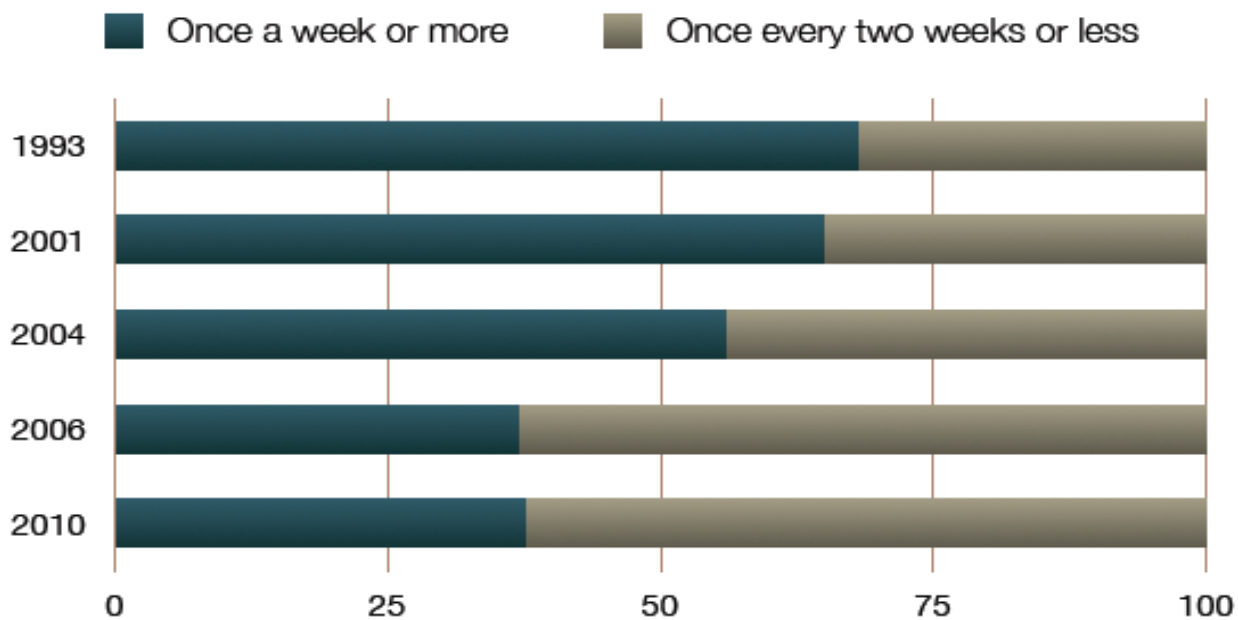
Feel free to copy it!
Potential problems

FRMS Elements – ICAO Draft Guidance

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Surveys

Significant fatigue from the job - changes since 1993



What about safety?

- How much fatigue = how much effect on safety?
- What are the validated measures of safety performance?
- What has been studied so far in this regard?

Studies to date

- easyJet – LOSA
- Qantas – Simulator study
- Thomas – LOSA compared to prior sleep
- French regional airlines – FOQA
- Moore-Ede – unstable approaches

More work is required....

Where to now?



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Questions?

- Fatigue Self-Management Strategies and Reported Fatigue in International Pilots. Petrie KJ, Powell DMC, Broadbent EA. Ergonomics 2004; 47(5):461-8
- Fatigue at the Top of the Drop: A programme for monitoring fatigue in long-haul commercial operations. Powell D. Flight Safety Foundation Proceedings of 57th Annual International Air Safety Seminar (2004).
- Avoiding involuntary sleep during civil air operations: validation of a wrist-worn alertness device. Wright N, Powell D, McGown A, Broadbent E, Loft P. Aviat Space Environ Med 2005; 76(9):847-56
- Pilot fatigue in short-haul operations: effect of number of sectors, duty length and time of day. Powell D, Spencer M, Holland D, Broadbent E, Petrie K. Aviat Space Environ Med 2007; 78:698-701
- Fatigue in two-pilot operations: implications for flight and duty time limitations. Powell D, Spencer M, Holland D, Petrie K. Aviat Space Environ Med 2008; 79:1047-1050.
- Fatigue in airline pilots after an additional day's layover period. Powell DMC, Spencer MB, Petrie KJ. Aviat Space Environ Med 2010; 81:1-5
- Fatigue risk management: organizational factors at the regulatory and industry/company level. Gander P, Hartley L, Powell D, Cabon P, Hitchcock E, Mills A, Popkin S. Accident Analysis and Prevention 2011; 43(2):573-90
- Automated collection of fatigue ratings at the top of descent: a practical commercial airline tool. Powell D, Spencer M, Petrie K. Aviat Space Environ Med 2011; 82:1-5