

FTL Effectiveness

How much lower risk? At what cost?
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8 Nov 2023, Paris

The problem...



- FTLs are primarily there to limit fatigue risk
- FTLs spring from rules designed to limit physical (not cognitive) fatigue
- The FTL updates in ≈2010-2020 have been done mostly in a <u>qualitative</u> way:
- "12 h of rest before a flight should be better than just 9 h" (...but we know rest may force crew out of bed)
- "A shorter night duty should be more safe than a longer one" (...but more night duties, disrupting good sleep?)
- We lack a <u>quantification</u> of the effects of rules, on overall fatigue risk, when applied to (complex) crew management processes

Qualitative	Quantitative
'I bought the ice cream be- cause I saw it when I was in the checkout line - I wanted	'20% of survey respondents bought ice cream today'
to treat myself.' 'I like a lot of toppings on my pizza - cheese, sauce,	'The average amount spent on ice cream by 500 respondents was \$5'
pepperoni, olives.'	'50% of people in New York strongly enjoy pizza'
'The grocery store has good options in general but the lines can be long and they are often out of stock of my favorite brands.'	'On average, respondents rate their grocery store a 3.5 out of 5'



- Phase 1 published in March 2019. Found 'an increased probability of high fatigue levels during nights and duty periods with late finishes, among both pilots and cabin crew'
- Phase 2 ongoing. NLR/DLR/scientists. Collecting data to further quantify 'FTL Effectiveness'. At all possible?

The platform



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Example of a pattern produced



• MH 330

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 Planned only using the EASA FTLs

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- Six consecutive nights
 disrupted
- [**NOT** how they operate, but how they would be allowed to operate]

The metrics



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FTL Effectiveness:

The ability of a regulatory flight and duty time ruleset to limit fatigue risk while allowing for crew efficiency.

Figure 1. Probability of an accident as a	However, when	Example: A reduction of 'maximum duty time' for overnight flight duties may seem as a great idea at first for reducing fatigue risk. However, the flights are still present	 Distribute fatigue risk among crew, sharing the Track the risk development over time Direct focus to the right part of the operation Use as a risk 'profiler' by dividing AFR over the lights; a rinetir named NFR (Normalised Fatig)
Anction of self-assessed KSS. [1] Y d during as of During and intra individual d Figure 2 illustrates hx actual accident devel predicted seleptness	predicting future sleepinesa, a fatigue model will have limited are not perfect, models are there are significant inter iliferences among crew. whe odds-ratio for an logs as a function of from a bic-mathematical	In the light includes and will need to be from. The modified in any laid bit he vestion of a to non wright potentially ricking on physicography could improve potentially ricking on physicography could improve consecutive right causes, stacking or beeckeling more legisment of the stacking of the could be particular oppose body at the could operation. The system response body at the could operation. The system response body at the could operation. The system	Figure 4 shows how the same set of fig been planned in two different scenarios a clear difference in risk. Both scenario the same planning rules but we can, by looking at the distributions, aud/or, cont set, the distributions, aud/or, cont set, the distributions, aud/or cont distribution. Our AFR and NFR metrics confirming the same thing but also quar that the risk has been reduced by 45%.
disastrous. model. ents in ing this scus a rily using disastrous. model. The conclusion to dri metric capturing fatig a risk contribution fro predicted sleepiness passing KSS 8. Hum predicted have any	w, is that a predictive ue risk should also include im much lower levels of than those close to, or an physiology, when being linko the future, does not sharp 'thresholds' /	quantifying, tracking and controlling: overall traigue risk, using a metric that adds up all small probabilities for the individual flight assignments, doing as, his logical to use a weighted turn over the set of flights with a 'weight' that accelerates when the predicted dependences increase, reflecting how flague risk develops in individuals (fligure 2 and 3 again).	The AFR/NFR approach described is to by a large number of Jeppesen custom control and reduce overall fatigue risk a airrady established best practice, allow
probabili accelera lower lew predictor developr assesses further b	ty of an accident / tes more slowly, and from rels, when sleepiness is , compared to the risk and to served for self- d sleepiness. Figure 3, elow, based on FDM data,	There is no remail attacked for this, lot slove as ways of anothering the statistical processing of for such a weighting function. Even so, not allowing jurified to become the energy of good', we can approximate a shape that mimics the acceleration of risk we do know exists. At Jappesen, a simple quadratic shape for the risk contribution is used, accelerating from KSS 5	
	Decimp in the energy of the	 bid during the durin	 According to the end bottomatic, the B of includer the end bottomatic and the includer the

Using AFR AFR is now our best practice metric reflecting overall fatigue risk in a set of flights. It takes both frequency (number of flights) and the severity into account and can be used in a number of pful ways when planning crew:

ure 4 shows how the same set of flights h alanned in two different sce been plainted in two different scenarios but with clear difference in risk. Both scenarios respec the same planning rules but we can, by just looking at the distributions, quickly confirm that scenario B is to prefer as It contain much lower risk. (Fower flights in the left tail of the distribution). Our AFR and NFR metrics are

ng the same thing but also qua The AFR/NFR approach described is today by a large number of Jeppesen customers to control and reduce overall fatigue risk and is an adv established best practice, al

link



--- Results ----

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EASA and European-based operators





- European-based operators
- AFR: volume & severity, proxy for the probability
- Planned with current EASA FTLs only
- [NOT how they operate, but how they would be allowed to operate]

EASA and European-based operators





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- AFR: volume & severity, proxy for the probability
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EASA FTLs, NFR per fleet

IPA2 Absolute Numbers





Risk of a fatigue-related incident/accident:

47/53% Short haul/long haul

Shift in Efficiency and Risk Subpart Q \rightarrow EASA FTLs



Sun Express737

242

223

(-7.9%)

-1.2%

249

(+2.9%)







Long-haul (Europe)

Subpart Q \rightarrow EASA FTLs

NFR: 380.2 → 350.4 (-7.8%)

FT/TAFB: 17.30% → 16.10% (-7%)

Elasticity in long haul – it's there!







- Weighted, remaining, potential in EASA FTL on these three fleets:
 - -16,1% fatigue risk, OR
 +18,0 % crew efficiency !!!
- …to be compared with the overall change with Subpart Q → EASA FTL:
 - -7.8 % risk
 -7.0 % crew efficiency
- [Note: The 16 & 18% are for only one (1) mechanism. Then there is acclimatisation, minimum rest...]

Discussion. Next steps?



- Hold here for a moment. Is anyone (at all) interested?
- Then:
- What are the rules to praise/blame?
- What can be learnt from FAR and CAAC?
- Add CAP 371, CAO, CAR... and learn also from them?
- Add more planning periods?
- Measure with one more fatigue model?
- Add also Embraer fleets?
- What-if analysis to reformulate and improve the rules on a few selected problems.
- *Pressure-test* the rules? Direct the optimizer to produce the worst legal patterns allowed...

FTL Effectiveness. How much lower risk? At what	cost?
Chapter 1: A bold ide	a
the safety and cost differences between different re working patterns for crew governed by these rules, actual flight schedules, both before and after COVI tems. This will be followed by suggesting and appl	s Flash, where we will step by step take on quantifying sigulatory rule sets. We will do so by building realistic for a huge number of different aintine fleets. We will use 0, and perform the planning with real production sys- sying a crisp definition of FTL effectiveness - to finally are rules deliver?, and i' At what cost to the industry?"
In February 2016, the new EASA FILe came into effect. All European-based optimition were then received route these new nulse for planning their crew, instead of the previous Subgent C plank. The more rules had been steep and optionmance sciences and were designed to do a better job of limiting crew fatigue.	
new rules better, and if so, by how much?	
In March 2019, EASA published the first of two reports attempting to establish the <i>effec-</i> tiveness of the new EASA FTLs [1]. The ex- ecutive summary concluded:	a star and
This first phase of the research assessed the impact of "night duise larger than 10 hours" and dist- ruptive schedules' on the largue of aircrever. The re- search found an increased probability of high largue es, among both plints and cabin crew. Na significant increase of probability of high levels of fatigue at TOD was found for early start TDPs. A marginal increase are softward for early start TDPs. A marginal increase was found for movies of disruptive schedule FDPs. ⁴	rules will need to also allow for operators to (at all) move passenges and cargo (b, II first aspect is not considered, but infinities effectiveness could sately be maximum number of block hours to be zero. That hale would avoid fight-instender collecties and accodents all together - as all airplanes would be parked. Perfect effectiveness. Not:
The research study was designed such that various 'fatigue-related' data was collected from pilots and cabin crew, to then try to connect that back to prove, or disprove, the effectiveness of the regulatory rules themselves.	A batter definition of FTL effectiveness could be some bring live ability to limit failigue risk, white allowing for a contain level of crews afficiency. A two-dimensional met- ric. That would be helpful in order to measure on con- tinuous scales, so that we can make detailed compar- tions. Because what would in their live, for example,
Evaluating rules, by collecting data from volunteering crew, comes with a number of challenges. Let's look a little closer at some of these.	isons, Because what would it help if we, for example, were to find both the new rules and the old rules to be just 'effective'? We would like to know by how much they are better or worse, relative to each other. We will go further into detail on a possible metric in later chap-
The definition of effectiveness	tors.
If we are to evaluate the effectiveness of a set of nuise, would in to be helpful to start by defining what, in this context, we actually mean with the term effec- tiveness? Would staring on terms of other used here, hereass? Would staring on terms of the used here, nessonaby practicable', be an option? Yell, such description do not easily and thermankves to be quantified. They are more digital in nature; yea?n. A more crisp definitor would be needed in order to perform measurements.	Sample size and bias Collectory of plasmin and data for once in a sharp official. If other requires asserting a scaled write survey form will require asserting the state of the description of the state of the state of the description of the state of th
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Chapter 4 - Had we not hoped for more?







Acknowledgements:

- Magnus Ek and Eduardo Furuzato, Jeppesen
- Joji Waites, BALPA
- Loukia Loukopoulou, SWISS
- Our other external partners...



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