



FRM Safety Case: What does 'good' look like?

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Contents

1. FRM safety case design
2. Scientific study design
3. Managing your scientist
4. Conclusion



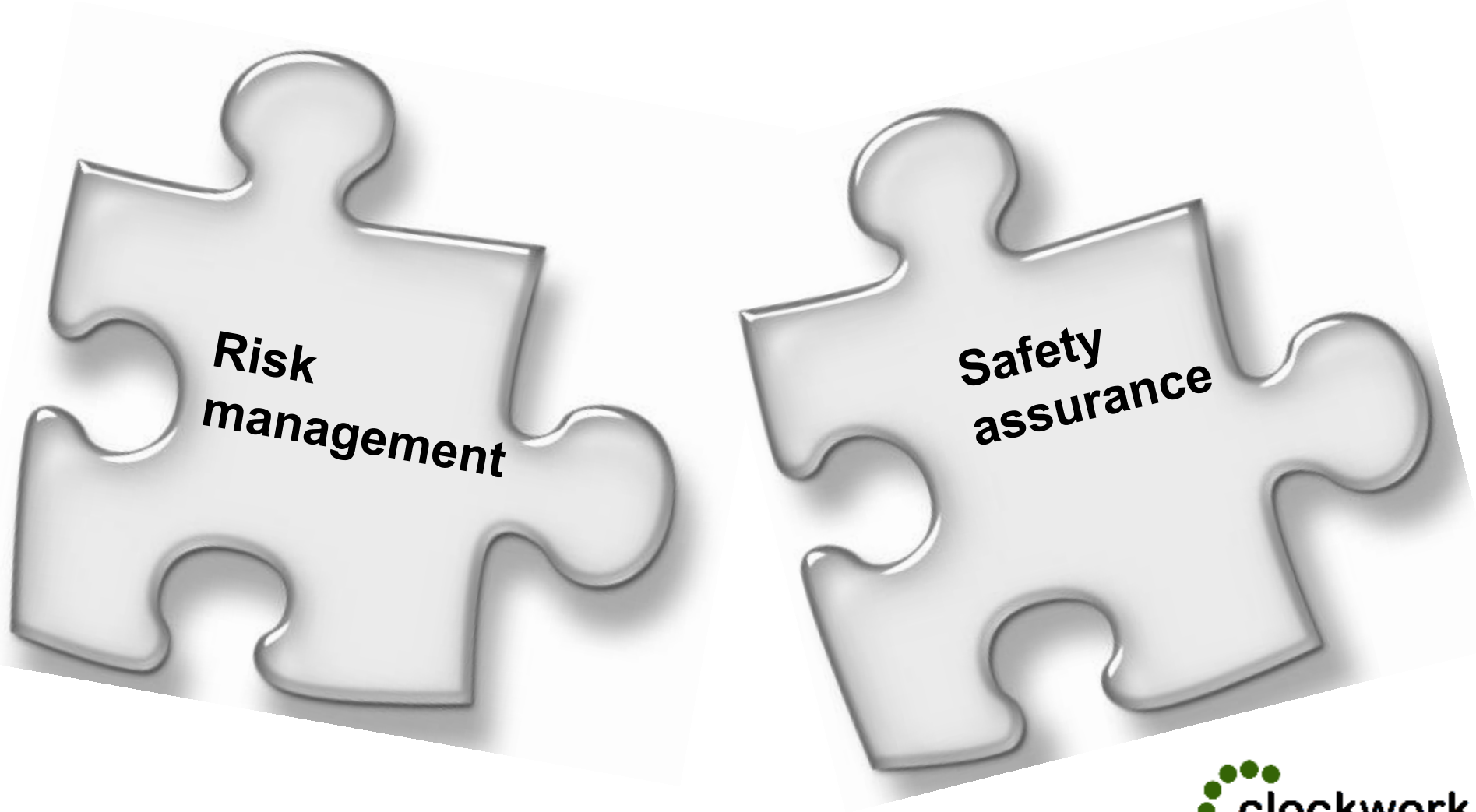
1. FRM safety case design

What is an FRM safety case?

- A structured argument, supported by evidence, intended to justify that a system is acceptably safe for a specific application in a specific operating environment¹
- Safety case audience:
 1. Internal
 2. Sometimes the state regulator
 3. Sometimes also EASA (Articles 14 and 22)

¹*Defence Standard 00-56 Issue 4 (Part 1): Safety Management Requirements for Defence Systems.*
UK Ministry of Defence. p. 17.

A good safety case consists of



Safety case design depends on

- The scope of the variation you are seeking
- Size of the operator
- Budget and resources
- Timeline



FDM as the basis for a safety case?

- 'No change in overall FDM events' is not much of an FRM safety case
- Why? Sensitivity and specificity
- We don't yet understand the effects of fatigue on crew performance, let alone FDM
- How do we control for weather, complexity, number of fatigued pilots in the cockpit etc?



fatigue

Advice on measuring fatigue

- Necessary to use multiple measures, for example, surveys, fatigue model analysis, existing safety databases, focus groups
- Usually, the more data the better. Missing data is the enemy.
- Actigraphy is very valuable – objective, continuous, easy to wear
- All measures assess fatigue from a different perspective, don't expect them to mirror each other

Top 3 fatigue risks at one airline

Identified via fatigue report database

- Difficulties with hotels
- Long airport sits between flights
- Add on sectors or duty days

Identified via survey question asking crew to rate fatigue hazards

- Transitions from lates to earlies
- Inadequate rest between duties
- Inadequate rest between duty blocks

Suggestions for writing a safety case

- Describe your operation and the scope of the variation you are requesting
- Don't ask for too much – only what you need and have evidence to support
- **Safety** case should be developed by the **safety** department
- Cite all of your fatigue controls, even the ones that are more a 'fact of life' e.g. airport curfews
- Don't be afraid to ask scientific assistance when you need it.

FRM, what have you done for me lately?



“What have you done for me lately?
Ooh ooh ooh yeah
What have you done for me lately?
Ooh ooh ooh yeah”

Janet Jackson
What have you done for me lately?
Design of A Decade 1986/1996



2. Scientific study design

ULaarrggghh!!!



FRM is not only relevant for ultra long-range (ULR) ops

Scientific study

- A necessary part of most FRM safety cases submitted for regulatory approval
- “Full blown scientific study” essentially means the study is suitable for publication in a scientific journal:
 - ICAO FRMS implementation guides for operators and regulators (2011)
 - Common Protocol for Minimum Data Collection Variables in Aviation Operations (IATA, 2014)

Hypothesis

- Example hypothesis: There is no significant difference in crew sleepiness on an inbound flight after a layover duration of 24h versus 48h
- Can be supported or refuted through carefully crafted experimentation or observation (falsifiability and testability)
- The default position is cynical disbelief and assumption that the claim under investigation is not true
- ...until demonstrated otherwise i.e. the burden of proof is on the operator asserting a the claim, not on the sceptics to disprove it.



RIGHT

WRONG

Study design is a careful advance plan of the analytic approach needed to test the hypothesis

Let's measure some stuff and see what it tells us

Scientific study design basics

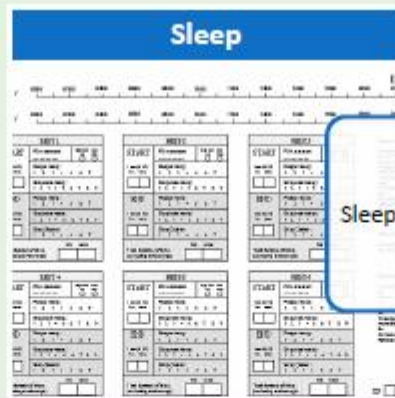
- A carefully formed hypothesis and a clearly stated outcome measure
- Assess the feasibility of study objectives and considering alternate research designs
- Define the study population and how the study will work in operational terms
- Select methods of sampling, data collection, and analysis appropriate to the study's objectives
- Develop realistic budgets and time schedules for each stage of the research

Measuring fatigue in operations

Subjective

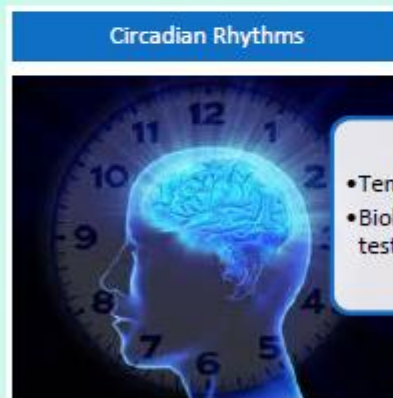


VAS
KSS
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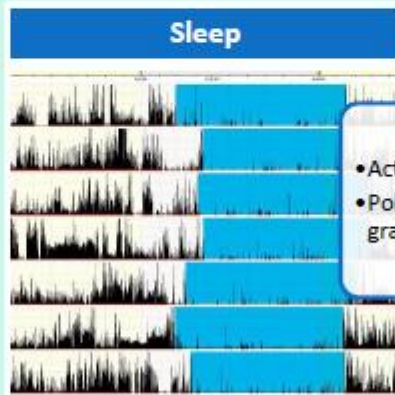


Sleep Diaries

Objective



•Temperature
•Biological
testing



•Actigraphy
•Polysomno-
graphy

Performance



Simple mental
tasks
Complex
behaviours



3. Managing your scientist and understanding statistics

Managing your scientist

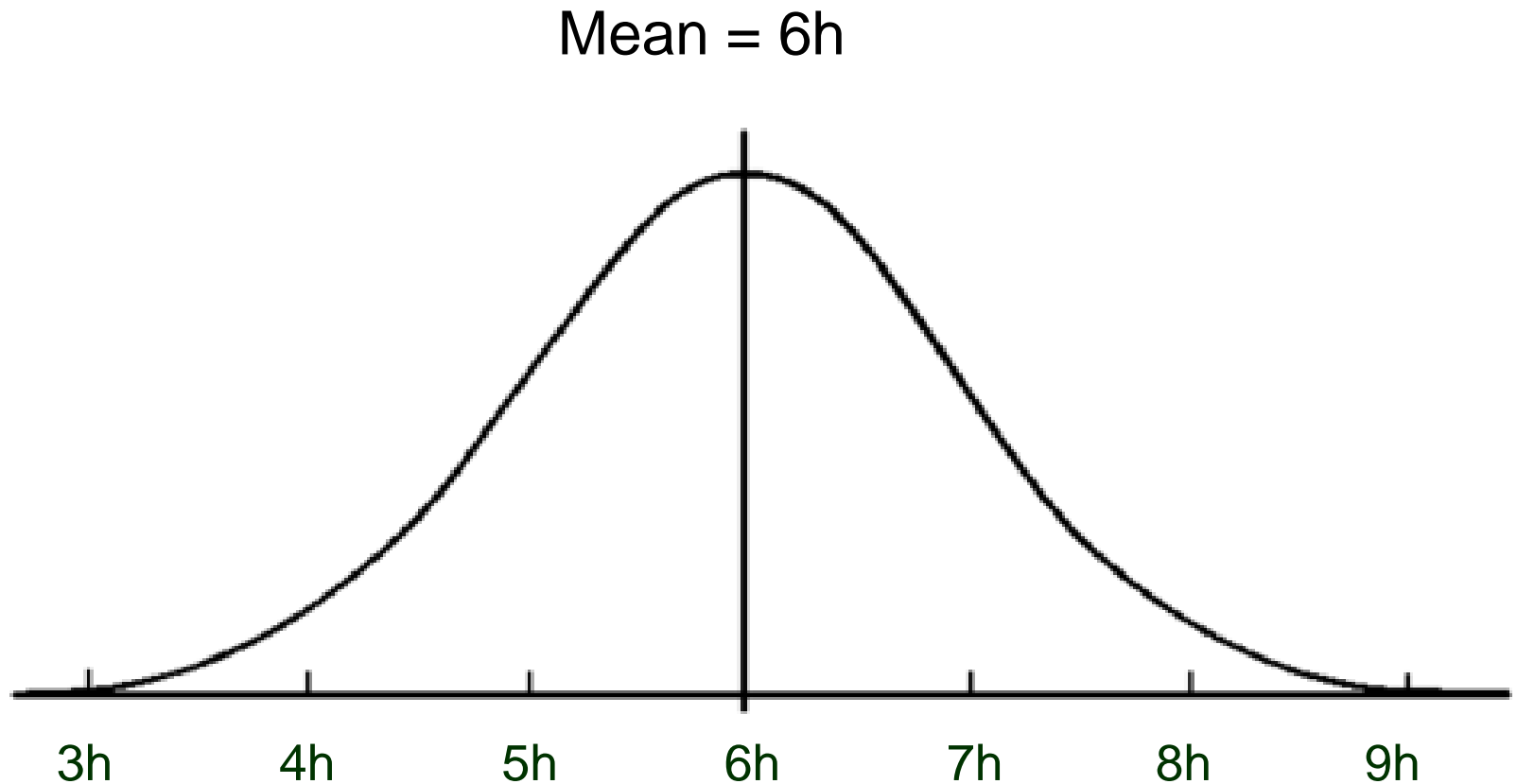
- Experience
- Timeline
- Availability
- Communication
- Statistics
- Ownership of data
- Ability to publish



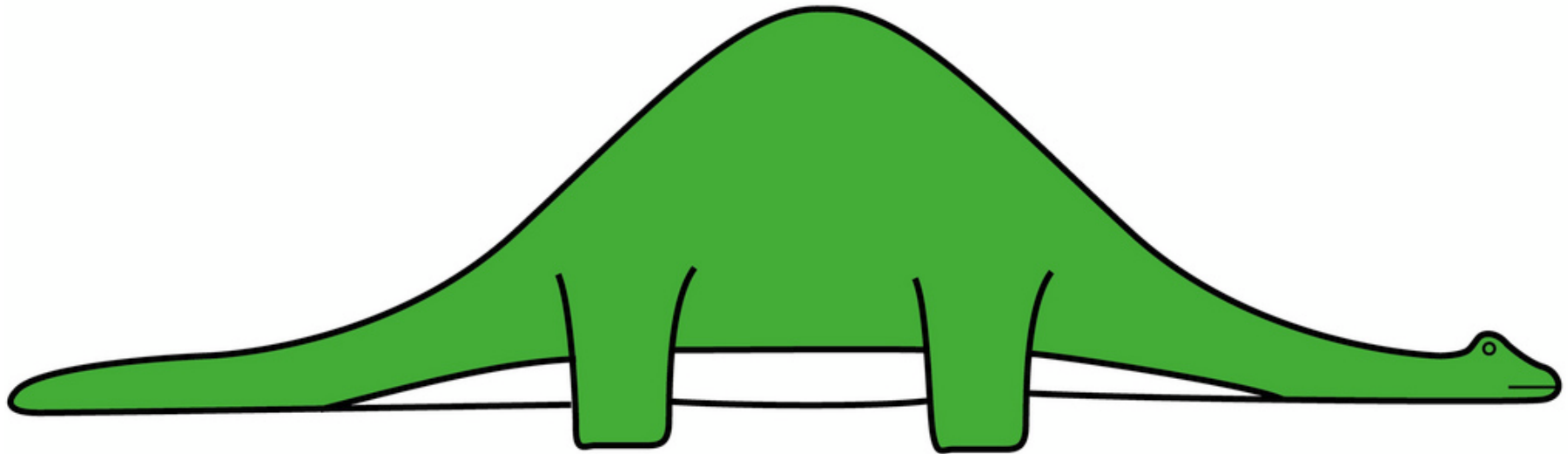
Understanding means and the normal curve

- Mean (average) results are simple and useful...and sometimes misleading
- Always consider the how the raw data is distributed, minimums, maximums and outliers.

How much sleep did you get last night?



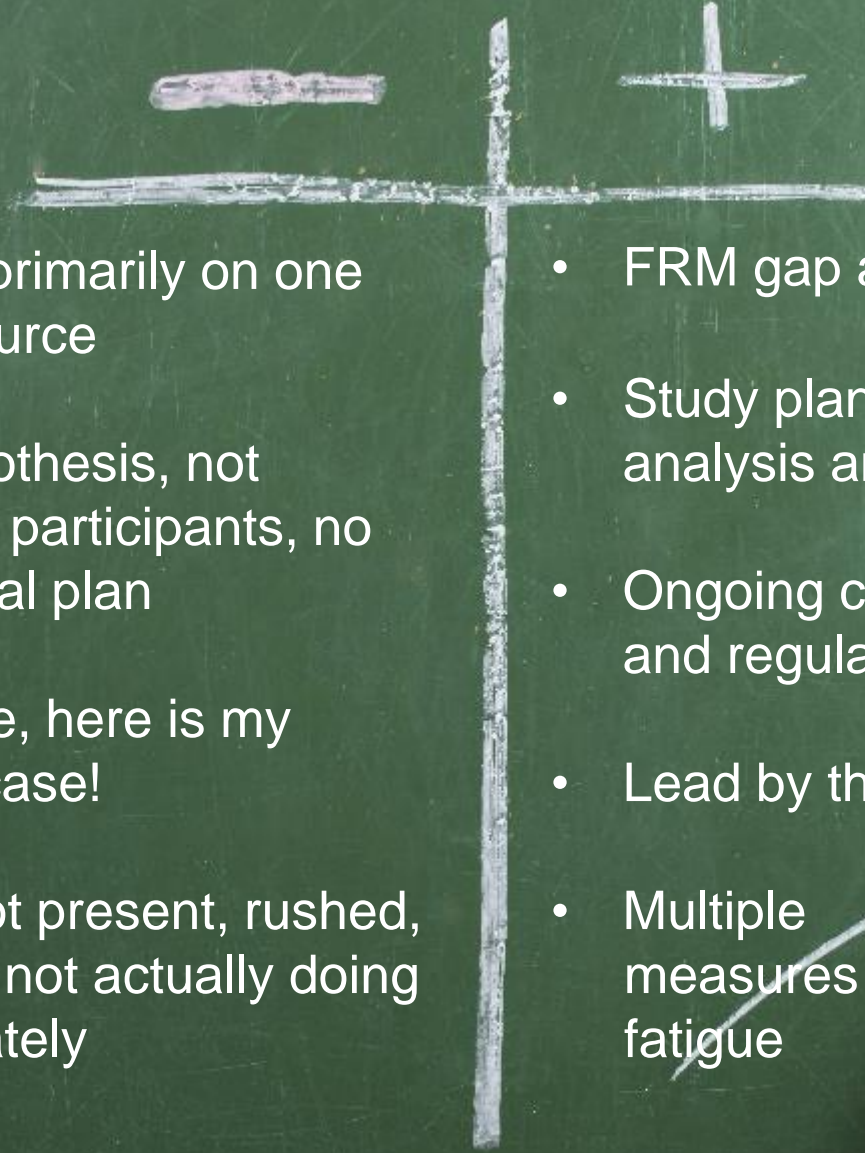
How much sleep did you get last night?



Normalcurvisaurus



4. Conclusion

- 
- Based primarily on one data source
 - No hypothesis, not enough participants, no statistical plan
 - Surprise, here is my safety case!
 - FRM not present, rushed, copied, not actually doing much lately

- FRM gap analysis, implementation plan
 - Study plan, risk assessment, power analysis and timeline
 - Ongoing consultation with crew, scientist and regulator
 - Lead by the safety department
 - Multiple measures of fatigue
- 