Seafarer Sleepiness and Fatigue
What have we learned?
What should we do?
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Project "MARTHA": Research Design

Background questionnaire

Weekly questionnaires

Time at sea (≥ 8 weeks)

Actigraphy (2 w) n=4/ship

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Data collected from each vessel: 110 volunteer crew members

- Background questionnaire for each volunteer
- Weekly diaries (including KSS and MFI*) for each volunteer
- Actiwatch data for two weeks at beginning and end of tour for selected volunteers.
- Voyage reports of vessel to cover period of study
- Official hours of work/rest for each individual volunteer

*KSS = Karolinska Sleepiness Scale
MFI = Multidimensional Fatigue Inventory
## Distinguishing Sleepiness from Fatigue

<table>
<thead>
<tr>
<th>Short-term Sleepiness</th>
<th>vs</th>
<th>Longer-term Fatigue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy individuals</td>
<td></td>
<td>May cause health disorders (physical and mental)</td>
</tr>
<tr>
<td>Rapid onset</td>
<td></td>
<td>Insidious onset</td>
</tr>
<tr>
<td>Short duration</td>
<td></td>
<td>Persists over time</td>
</tr>
<tr>
<td>Single cause</td>
<td></td>
<td>Multi-factor causes</td>
</tr>
<tr>
<td>Short-term effect on daily activities</td>
<td></td>
<td>Significantly affects behaviour and wellbeing</td>
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</table>
What have we learned?

Some results from the analysis of Weekly Diaries and Actigraphy*

*With acknowledgements to Dr Anne P Hillstrom and Gemma Hanson of University of Southampton, Centre for Vision and Cognition
Fatigue: is it higher or lower at the end of a voyage?

A closer look at the 3 ranks (Third officer, Captain, AB) for which there is the highest number (i.e.: n>10)
Is Stress higher or lower at the end of a voyage?
High levels of sleepiness at all times

Several other weekly diary items potentially increase with time at sea (including *reduced motivation*)
Example of Actiwatch data:
A Bosun on Day work

The ActiWatch was set up to start recording on 4th of May, at midnight BST. However, the Bosun took it at midnight local time in Manzanillo (Mexico).

Eventually, the Bosun remembered to press the Event Marker Button.

The Bosun switched off the light and went to sleep.

The Bosun remembered to press the Event marker Button about an hour after waking up.

Period of sleep

Period of work
Actigraphy: Example of a Master – disturbed sleep?
Average Sleep by Rank
Sleep over course of study
The effect of voyage time on wake bouts

- Significant when anchored at start of contract

- Error bars represent 1 sem
What should we do? Fatigue Risk Management Systems (FRMS)?

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https://www.eurocontrol.int/sites/default/files/article/content/documents/nm/safety/safety-fatigueriskbrochureweb.pdf
Two Ways to Mitigate the Fatigue Risk:

- “Hours of rest” - STCW and MLC
  - Prescriptive
  - Negotiated Contract
  - Compliance culture: minimum standards
  - Reactive
  - Control
  - Inspection and audit

- FRMS within the IMO revised guidelines on fatigue
  - Non-mandatory
  - Goal-based approach
  - Scientific basis: data driven
  - “Best practice”: aspiring to excellence
  - Custom-built to own company
Three Core Elements of Fatigue Risk Management

1. Fatigue Awareness training and cultural change programmes;

2. Fatigue reporting system within a just culture;

3. "Data-driven" predictive analysis for fatigue risk assessment, workload management and monitoring adequate sleep*

*Tools may include subjective reporting, actigraphy, and fatigue prediction models
Fatigue Prediction models

- Bio-mathematical modelling - not to be confused with fatigue management software which shows compliance with hours of rest regulations.

- Predicts fatigue level or risk of falling asleep for different work hour patterns.

- Some also show decrement in performance against fatigue.

- Models include SAFTE/FAST (USA), FAID (AUS) and MARTHA (Sweden).

- Project HORIZON added novel information on off-watch sleep patterns and validated the MARTHA model for use in shipping operations.

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A Vision for the Future...?

Unmanned vessels?

The Cyborg Crew?

Or crew “condition monitoring”?

Measure physical health and mental wellbeing variables at a distance?

Big data and predictive analytics?

Ethics: “Big brother” or self-ownership?