

SEAFARER FATIGUE

Let's not be caught napping

Powerful new academic research is adding weight to demands for the industry to wake up to fatigue, writes **ANDREW LININGTON...**

Cynics might suggest that we know all that we need to know about the problems posed by seafarer fatigue. But the team behind the three-year Martha research project were determined to take awareness to a new level.

In a report detailing the research results, they note how previous studies — such as the EU-funded Project Horizon — and a growing pile of accident investigation reports have demonstrated 'the serious impact that sleepiness and fatigue may have on the safety and welfare of seafarers'.

But while the evidence has mounted and understanding of the need to manage the risks of fatigue has grown, the Martha team point out that much less is known about the longer term psycho-social effects of the long hours worked at sea.

The US\$3m study, sponsored by the TK Foundation, involved experts in the UK, Sweden, Denmark and China and used a mixture of research methods — including extensive onboard measurements of seafarer performance — to assess levels of sleepiness and long-term fatigue, and the impact on motivation and behaviour.

Researchers said the project has uncovered important new evidence about the way fatigue and



Fatigue was a factor in the grounding of the Antigua & Barbuda-registered general cargoship Danio in March 2013, above. The 1,499gt vessel ran onto rocks in the Farne Islands nature reserve after the OOW fell asleep on the bridge and failed to correct the ship's course Picture: MAIB

stress levels change during a voyage, how they affect various ranks in different ways, and how they ultimately reduce motivation over the length of a tour of duty.

Captains were found to suffer the highest levels of stress and fatigue, and both the quantity and quality of sleep was found to deteriorate over long voyages.

Sleepiness levels vary a little during the voyage, suggesting there are opportunities for recovery, the report notes. However, overall, 'there is a small but significant decrease in the amount of sleep in a 24-hour period over the course of time'.

Four shipping companies, together operating more than 500 ships, took part in the study. The vessels included product tankers running intensive services in NW Europe, containerships on liner routes between the Far East and Europe, and Asia and South America, bulk carriers trading worldwide, and tankers operating in Far Eastern waters.

The research was based on almost 1,000 questionnaires completed by seafarers and managers in Europe and China, as well as onboard diaries filled out by crew members over tours of duty as long as six months.

Detailed measurements were taken from volunteer seafarers who wore special watches recording their activity, along with readings of their sleep and stress levels together with hours of work and voyage data.

Feedback from seafarers suggested officers generally have less sleep than ratings and suffer higher levels of stress. On average, officers reported 7.8 hours of sleep in every 24, compared with 8.4 for ratings.

The average number of normal weekly working hours recorded by all crew was 67 — although the study notes that these figures do not include overtime hours.

Questionnaires and interviews with European and Chinese seafarers and managers examined cultural differences in the interpretation of regulatory frameworks on hours of work and rest and the way in which organisational practices affect seafarer fatigue.

The researchers found that while European and Chinese seafarers may allocate different priorities to fatigue factors, they do share the same perceptions about the major factors that influence fatigue onboard.

They also found evidence of higher levels of fatigue and stress in seafarers from Chinese-managed companies than European-managed ones. 'This suggests that differences in organisational factors are significant in affecting fatigue mitigation onboard,' the report points out.

Data gathered from 110 seafarers during field studies revealed that 61% of all crew consider themselves to be more fatigued at the end of a voyage than at the beginning, irrespective of the actual length of the voyage.

Researchers found perceptions about fatigue and voyage length varied significantly according to rank and role. A majority of day work crews, engineers and cooks reported that they were less fatigued or the same by the end of the tour. In contrast, a small majority of second and third deck officers reported that they felt more fatigued at the end of their tour than at the beginning, and a very large majority of masters said their fatigue levels were higher at the end of their tour of duty than at the beginning.

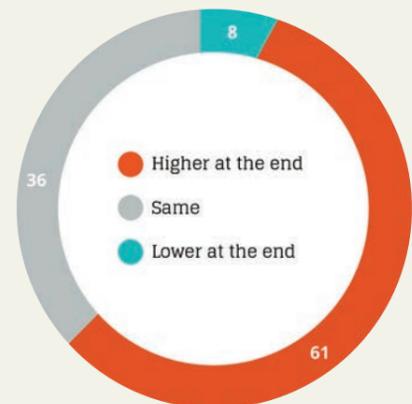
The results from the questionnaires showed that there were some differences between the ideal and actual sleep lengths for officers and ratings, although their perceptions of sleepiness, quality of sleep and levels of stress were quite similar to each other.

Almost 50% of seafarers said their stress levels were higher at the end of a voyage, 41% said they

Issues which were repeatedly mentioned by seafarers as contributing to their fatigue and sleepiness levels were (in no particular order of priority):

- new regulations and more requirements placed on seafarers
- increased inspections and more paperwork
- the bad condition of ships' accommodation
- the lack of proper maintenance
- work in port
- working onboard a new ship
- the quality and professionalism of colleagues

Fatigue: is it higher or lower at the end of a voyage?



The report highlights the serious risks presented by fatigue:

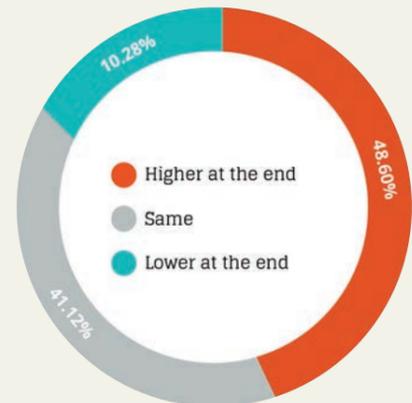
The health effects of fatigue also cover mental fatigue, and there can be at least four recognisable symptoms: being fretful, irritable, unhappy and finding it easy to get into conflict with others.

Incidents of insomnia and homesickness are more serious when seafarers are fatigued. The effects of sleepiness and fatigue can also be a significant and contributory factor in accident causation, which can result in environmental pollution, machinery damage and fire.

Chronic effects of fatigue include:

- sleeping disorders
- insomnia
- sleep apnoea and hypopnoea
- delayed/advanced sleep phase syndrome
- cardiovascular disorders, myocardial infarction, strokes and hypertension
- gastrointestinal disorders, peptic ulcers, and irritable bowel syndrome
- metabolic disorders, such as diabetes and hyperlipemia
- mental disorders, depression

Stress: is it higher or lower at the end of a voyage?



Sleepiness and fatigue: what's the difference?

- | | |
|---|--|
| Sleepiness | Fatigue |
| ■ healthy individuals | ■ may cause health disorders (physical & mental) |
| ■ rapid onset | ■ insidious onset |
| ■ short duration | ■ persists over time |
| ■ short-term effect on daily activities | ■ significantly affects behaviour and wellbeing |

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SEAFARER FATIGUE

Pictured presenting the Martha Project findings at the International Maritime Organisation last month are, left to right: Michelle Grech, from the Australian Maritime Safety Authority; Professor Mike Barnett, from Southampton Solent University; and Captain Kuba Szymanski, secretary general of InterManager
Picture: Southampton Solent University



were the same, and just over 10% said they were lower.

The project team used two specific and validated measures of sleepiness and long-term fatigue to assess seafarers at different stages of their voyage. They found that the risk of falling asleep through tiredness on watch is present at all stages of the voyage — and very high levels of sleepiness were found to increase after six months onboard.

The report says the findings indicate that motivation decreases with time at sea. 'This is a significant finding because it offers an explanation for recent reports of casualties occurring on vessels where the crew, including the captain, have been onboard for longer than six months,' it adds. 'Reduced motivation may lead to complacency, individuals taking short-cuts and "work-arounds" and not following the correct procedures.'

Results from the 'actiwatches' worn by 70 seafarers on 12 different vessels in the study provided data on the total amount of sleep gained and the quality of the sleep obtained. Important findings from this included the fact that both the amount of sleep and the quality of sleep — as measured by wake bouts and fragmented sleep — decreased over time for all crew.

The results reveal that while captains and day workers get more sleep than watchkeepers, captains are more at risk of fatigue than other ranks. Night watchkeepers (second officers) were found to get significantly less sleep than others and to be most at risk of falling asleep on duty.

The project team held a series of workshops around the world to gather feedback on the findings and to consider the causes of fatigue at sea and some of the ways in which the problem could be tackled (see box) and the report concludes that there are a number of 'simple operational solutions which can ensure sleep is easier for those onboard through fatigue risk management'.

These solutions should involve seafarers and those agencies ashore which impact on shipboard operations, the report adds.

The study highlights the role that Fatigue Risk Management Systems (FRMS) could play in addressing the problems. Such techniques are used in other safety-critical workplaces and in aviation, road and rail, the report notes. However, it points out, 'evidence from recent marine accident investigations indicates that the use of FRMS in the shipping industry is less mature than in other safety-critical transport industries, and less advanced in exploring such concepts in practical operational settings'.

The researchers said there is evidence from several safety-critical industries revealing 'a conceptual move away from prescriptive regulations — which seek to mitigate the risk of fatigue through limiting the hours of work — to a more goal-based system that involves the employment of FRMS'.

FRMS presents an integrated systems approach to managing the risk of fatigue, the report explains, covering policies, operational aspects and quality assurance. 'It requires ownership by all in the company, changes in culture and can be introduced in a gradual process as the company develops its own approach.'

The Martha team reported positive feedback from seafarers and managers on the concept of FRMS and the report suggests how successful implementation of such systems could be used to shift attitudes and raise awareness.

Fatigue incident reporting is another important element of the systems approach, and needs to be part of a transparent and blame-free culture, the report argues. 'Employees will be reluctant to report incidents which may be caused by sleepiness or gen-

eral fatigue if they think that there will be recriminations.'

FRMS can form part of a 'continuous improvement cycle' for a safety management system, it adds, and it can be developed to provide a more interactive approach where schedules can be set using biomathematical prediction tools and, ultimately, where seafarers can take more ownership of the system themselves by reporting incidents, and keeping a check on their own and colleagues' fatigue levels.

The researchers end on a positive note, suggesting that the development of new data collection, transmission and analysis techniques will accelerate the process of improved fatigue risk management. And in the longer term, improved vessel design will make a significant impact in reducing the effects of sleepiness and fatigue, the report adds. 'The technology exists now to combine the power of big data and predictive analysis with the science underpinning fatigue, stress, health and wellbeing to provide better health and welfare services to seafarers wherever they may be,' it concludes.

The report also outlines a number of other areas for potential future research. These include:

- what is the optimum tour of duty length? Should there be a maximum shorter than the MLC requirement?
- how long should recovery time between voyages be?
- how does cognitive performance deteriorate over time due to fatigue and stress?

- how does 'mood' change over time? Does this have a significant effect on the psychological well-being of seafarers?

Other areas of research include the further development of FRMS concepts for the shipping industry. Specific goals are:

- the development of improved fatigue prediction models
- the development of instruments to survey psychological wellbeing over the long term
- the development of models of how long-term fatigue and recovery may be predicted

Speaking about the future impact of the study, Southampton Solent University Emeritus Professor Mike Barnett said: 'The shipping industry has been following Martha's progress with interest, as the momentum for revising the guidance on fatigue has grown at the International Maritime Organisation.'

'Of particular interest for future research are our findings on individual mood, team-working and social cohesion, all of which appear to deteriorate after about six months onboard. We need to know more about these phenomena. I am very excited about the possibilities of using wearable technologies to collect and transmit data on both physical and psychological aspects of seafarers' health and wellbeing.'

'The use of technology to create smart shipping is on the increase,' said Captain Kuba Szymanski, from the international ship managers' association InterManager. 'We are entering a phase when big

What can be done to combat the problem? Feedback gathered from seafarers and managers by the research team included the following suggestions:

Working conditions

- Participants sought improvements in:
- safe manning levels
 - nutrition and good food onboard
 - hours of work and rest
 - stress onboard through harassment and bullying

Vessel design and living environment

- Participants sought improvements in:
- noise and vibration levels
 - temperature
 - quality of accommodation spaces
 - bedding (eg change of mattresses)
 - exercise facilities onboard
- Some of these issues are covered in the Maritime Labour Convention, to apply to new vessels, and the report says that measures will need to be evaluated further as the requirements come into force.

Operational issues

- Participants sought improvements in:
- being relieved on time and having a KPI to measure it
 - revision of company reporting requirements in order to reduce bureaucracy
 - communication between ship and shore
 - logistics: port calls to be better organised and discussed with sea staff
 - timings of inspections onboard by external parties
 - time management — for example, the timing of Notices of Readiness
 - recovery time during the voyage — for example, going to anchor

'Participants also recognised that there needs to be a cultural change in the industry's attitude towards fatigue by both seafarers and shore management,' the report points out. 'The response: "but it's always been like this" was no longer seen as acceptable.'

Awareness and cultural change also apply to the agencies ashore who interact with ships and personnel — charterers, agents and port state officials — the report stresses.

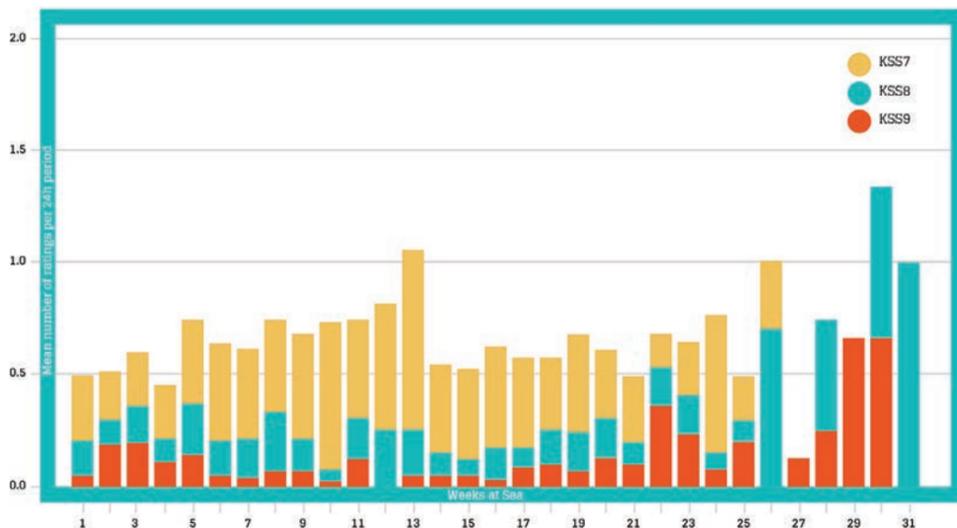
data and analytical processes allow us to pass information on the ship's equipment to the office — so why not the crew too? We are close to developing means by which individual seafarers can monitor their own wellbeing onboard and this will help to raise awareness of fatigue and the importance of healthy living onboard.'

Claire Pekcan, Professor of Maritime Applied Psychology at Warsash Maritime Academy, said she is also interested in the impact of assistive technologies onboard. She is engaged in other projects related to autonomous vessels, and wonders whether ships in the future may have technologies which intervene when seafarers show signs of fatigue. Basic research is needed which indicate these states, she adds.

Prof Pekcan has also just finished a major study on the effects of ego depletion and safe behaviour, which relates to the findings of Martha. 'Our individual energy levels work like a battery,' she points out. 'As long voyages make us more fatigued, the battery drains and we need to re-energise. We need to know more not only about the optimum lengths of tours of duty, but also how long recovery should be during and between voyages. And what activities promote recovery?'

KSS The Karolinska Sleepiness Scale

- | | |
|-----------------------------|---|
| 1. Extremely alert | 6. Some signs of sleepiness |
| 2. Very alert | 7. Sleepy, no effort to stay awake |
| 3. Alert | 8. Sleepy, some effort to stay awake |
| 4. Quite alert | 9. Very sleepy, great effort to keep awake, fighting sleep. |
| 5. Neither alert nor sleepy | |



The diagram above shows the KSS scores over 7 for all 110 seafarers who completed them at different stages of the voyage.

The scores were calculated using an anchoring mechanism, so they show comparable scores at various weeks into a voyage for each

individual. Consequently, the KSS scores cover from week 1 to over 6 months.

From previous research, a KSS score over 7 indicates a high risk of falling asleep. The most significant results, which the diagram illustrates, are as follows:

- the risk of falling asleep through tiredness is present at ALL stages of the voyage, making it a safety risk at all stages of the voyage
- very high levels of sleepiness (KSS of 8 or 9) are apparent and increasing after six months onboard

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