Institution: Cardiff University

Unit of Assessment: UoA4

Title of case study: Influencing international legislation, policy and management strategy to improve maritime safety by reducing seafarers' fatigue

1. Summary of the impact (indicative maximum 100 words)

Research carried out by Cardiff University on the causes of maritime fatigue was instrumental in increasing understanding of contributing factors such as long working hours, and the inadequacy of current reporting systems. Because 90% of goods are transported by sea, fatigue influences at the individual and community level, as well as resulting in significant financial penalties for companies when accidents occur. Cardiff research has led to significant changes across industry and government in (a) personal awareness/management, such as improved safety training and (b) new international legislation and company policy aimed at reducing fatigue and improving health and safety at sea.

2. Underpinning research (indicative maximum 500 words)

The potential for fatigue at sea is high due to a range of factors, many unique to the maritime environment, yet there has been very little empirical research concerning this significant safety issue. To fully understand fatigue at sea negative risk factors, such as length of tour of duty, shift-pattern, job demands and speed of port turnarounds, must be considered in combination rather than alone. To address this global problem, a Cardiff University research project (2000-2006) was carried out to establish the case for consideration of seafarers' fatigue as a health and safety problem.[3.1, 3.2] The research involved a multi-method approach (surveys, diary studies, on board testing of performance and physiological measurement), studying over 2,000 participants.

Research team

The Cardiff team was led by Andrew Smith (Professor, School of Psychology, 1999-present), in collaboration with Tony Lane (Professor, Seafarers International Research Centre [SIRC], until 2003), Mick Bloor (Professor, SIRC until 2003), Dr Emma Wadsworth (Research Associate, Psychology, 2003-2009), Neil Ellis (Research Assistant, Psychology, 2000-2003), Paul Allen (Research Associate, Psychology, 2003-present) and Dr Rachel McNamara (Research Associate, Psychology, 2000-2006, Senior Trial Manager, Medicine 2006-present). This work was funded by the Maritime Coastguard Agency (MCA) and the Health and Safety Executive (HSE, total funding: £827,000) and supported by NUMAST (the officers' union, now Nautilus International). Other major stakeholders (the British Chamber of Shipping; Marine Accident Investigation Branch; Det Norse Veritas) were members of the steering committee.

In 2006, members of the International Maritime Health Association (IMHA), and scientific experts in the area of transport fatigue (e.g., Wayne Perkins, New Zealand; Laurence Hartley, Australia) carried out international reviews of the research.

Research findings

Cardiff's research addressed the risk factors and the consequences of maritime fatigue.[3.1, 3.3] The research demonstrated that fatigue was consistently associated with poor quality sleep, long working hours (50% of the seafarers reported working weeks of 85 hours or more), negative environmental factors, high job demands and high stress.[3.5] Other important contributory factors included number of port visits, speed of port turnarounds, physical work hazards (e.g., high amounts of noise), and isolation and low social support, particularly in multinational crews.[3.3] Fatigue was associated with both reduced safety (e.g., nearly half the sample considered fatigue a key factor in reducing collision awareness) and poorer health (both mental and physical).

Crucially, the research also confirmed that:

- Present reporting systems are inadequately designed to record factors relevant to fatigue[3.4]
- Excessive working hours that contribute to crew fatigue are often hidden by falsified audit records[3.4]

- Those who under-recorded their working hours were also found to report higher fatigue[3.4]

Sector-specific research findings

The Cardiff research also determined that certain risk factors were sector-specific.[3.6] For example, in mini-bulkers the combination of only two watch-keepers, 6-on-6-off watch systems, frequent port turnarounds, short port stays, changing cargos (in many cases) and long periods of pilotage all placed crew at high risk of fatigue.[3.6] Fishing vessels were also associated with significant levels of fatigue, with 44% of the crew working to the point of collapse and 41% reporting having fallen asleep at the wheel.[3.2]

Fatigue intervention and management

As well as documenting the causes of fatigue, the Cardiff research demonstrated that the industry could address the problem by treating fatigue as a health and safety issue, with three levels of intervention providing:

1. information about the problem to increase awareness[3.4]
2. tools to allow proper audit of fatigue levels[3.4]
3. guidance on the management of fatigue[3.4]

The project provided the basis for the implementation of all three of these approaches more systematically in the seafaring community.

3. References to the research (indicative maximum of six references)

Final Reports

1. **Smith, A., Allen, P., & Wadsworth, E.** (2006). *Seafarer fatigue: the Cardiff Research Programme*. MCA: Southampton. http://www.seafarersfatigue.com
2. **Smith, A.** (2007). *Adequate crewing and seafarers' fatigue: The International Perspective*. www.itfglobal.org/files/seealsodocs/3193/ITF%20FATIGUE%20REPORT%20final.pdf, International Transport Federation.

Journal Articles

3. **Wadsworth, E., Allen, P., Wellens, B., McNamara, R.,** & **Smith, A.** (2006). Patterns of fatigue among seafarers during a tour of duty. *American Journal of Industrial Medicine, 49, 836-844.* http://dx.doi.org/10.1002/ajim.20381
4. **Allen, P. H., Wadsworth, E. J., & Smith, A.P.** (2007). The prevention and management of seafarers' fatigue: A review. *International Maritime Health, 58,* 167-177. http://czasopisma.viamedica.pl/imh/article/view/26300
5. **Wadsworth, E. J., Allen, P. H., McNamara R. L.,** & **Smith, A. P.** (2008). Fatigue and health in a seafaring population. *Occupational Medicine, 58,* 198-204. http://dx.doi.org/ 10.1093/occmed/kqn008
6. **Allen, P. H., Wadsworth, E. J., & Smith, A. P.** (2008). Seafarers' fatigue: a review of the recent literature. *International Maritime Health, 59,1/4,* 81-92. http://czasopisma.viamedica.pl/imh/article/view/26272

Cardiff University authors are shown in **bold.**

Grant funding

MCA/HSE/Seafarers International Research Centre: A. D. Lane, M. Bloor, A. P. Smith. *Fatigue Offshore: Phase 1.* 1/1/2000- 31/7/2001. £259,000

MCA/HSE/Seafarers International Research Centre: A. D. Lane, M. Bloor, A. P. Smith. *Fatigue Offshore: Phase 2*. 1/8/2001- 31/03/2003 £208,000

MCA/HSE. A. P. Smith. *Fatigue Offshore: Phase 3.* 1/4/2003- 31/3/2006. £360,000.

ITF. A. P. Smith. *Seafarers' fatigue: The International Perspective*. 1/4/2006-30/9/2006. £11,375.

ESRC. Allen, P. H. & Smith, A. P. Producing a video to disseminate research on seafarers' fatigue. 2010-2011. £9,950.

4. Details of the impact (indicative maximum 750 words)

The main message from the research was that the maritime industry should treat seafarers' fatigue as an occupational health and safety issue, which could be addressed using established methods. Evidence of initial impact comes from the finding that fatigue-related accidents have decreased

since publication of the research. Fatigue was associated with 62% of groundings prior to 2007 and with 55% of groundings in more recent years (Lohrman, CASCADe, 2013).[5.1]

Changes to international legislation and company policy
Maritime safety is a global transport problem affecting all seafaring countries, and key stakeholders have used Cardiff's research findings to inform changes to maritime practice and policy.

In the UK, the Maritime and Coastguard Agency (MCA) have included fatigue as part of their "human element strategy."[5.2] An initial part of this strategy has been to monitor ships' records in order to identify false entries and non-compliance with hours-of-rest requirements.

The research has also been used to support measures to deal with fatigue at both the national (presentations by Smith to the UK Transport Minister, 2009) and international level (presentations by Smith to the International Maritime Organization, 2008).[5.3] Additionally, the Cardiff research on seafarers' fatigue was followed by major revisions to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (the STCW Convention) at the IMO conference in Manila in 2010.[5.4] These involved revised requirements on work and rest. Minimum rest periods in seven days were increased from 70 to 77 hours and seafarers must now have 10 hours of rest in any 24-hour period. It is now mandatory to maintain records of each individual seafarer's rest hours. These rest hours now apply to most seafarers, not just to watchkeepers. These amendments came into force in January 2012.

Implementation of Cardiff fatigue audit
A fatigue audit (survey of risk factors, perceived fatigue and fatigue-related outcomes) developed by the Cardiff research team has been used by several shipping companies (e.g., P&O Ferries, Dutch Dredging, BP Shipping). The audit has involved all stakeholders and has been linked to the development of fatigue training and countermeasures (e.g., the P&O cross-channel ferries survey[5.5]). The research has also helped the development of services in other countries; for example, it was used to help develop fatigue management guidance for seafarers in New Zealand.[5.6, pp.228-9]

The research was also instrumental in the formation of a World Health Organisation (WHO) Maritime Health Group in 2009, and Cardiff's lead PI (Smith) is a member of this group. The WHO group has played an active role in the dissemination of information about the prevention and management of seafarers' fatigue.

Improved public awareness of a health risk or benefit has been raised, and public behaviour has changed (auditing)
Dissemination has involved collaboration with maritime unions and other bodies that aim to communicate with individual seafarers. For example, the research recommendations were included in newsletters that went to all members of Nautilus (UK national union, 24,000 members)[5.7] and the International Transport Federation (660,000 members worldwide).[5.8] The Nautical Institute (a charity providing information about seafaring issues to the international community) covered the research on their 'Alert' website (over 10,000 hits).[5.9] The organisations that have run these campaigns perceive that the research has been of great benefit:

"The Cardiff research took knowledge and understanding of the issue from a relatively unmeasured level to the point at which the problems could be quantified. Nothing of this depth and scale had been done before. It made the case for action stronger than it had ever been and it has been of immense assistance in pursuing representations on behalf of seafarers." – Andrew Linington (2012), Director of Campaigns and Communication, Nautilus.[5.6, p.228]

The research team also created a film to highlight key issues emerging from their research. Cardiff made this publicly available at www.seafarersfatigue.com (over 7,200 viewings in a year, covering 25 countries).[5.10] The film is also being used for training purposes by a number of organisations, including Warsach Maritime Academy (cadet training) and Shell (as part of their ship management operator reviews). Organisations that have run these campaigns perceive that the research has been of great benefit:

"Fatigue and the limitations on human performance (including situational awareness) that result are an important element of the Marine Crew Resource Management (MRCM) training course. The ability to reference back to the Cardiff research, the fact that it was done on working vessels not in

the lab, the analytical rigor and the widespread publicity through the Cardiff seminars delivers the necessary evidential 'punch'." -- Rob Miles (2012), Principal Specialist Inspector Human Factors, HSE Offshore Division.[5.6, p.231]

5. Sources to corroborate the impact (indicative maximum of 10 references)

A paper[5.6] on the impact of this research provides information corroborating the claims made here. It was awarded the prize for best paper at Ergonomics 2012. The two quotations cited above were published in that paper.

1. CASCADe: Model-based co-operative and adaptive ship based context aware design. FP7-SST-2012-RTD1 http://www.offis.de/technologiecluster/dependable_system_design/projekt/projekte/cascade.html. A relevant paper from this website, corroborating the claim that fatigue-related accidents have decreased, was downloaded and saved as pdf on 18/11/13 and is available on request from HEI.
2. The Maritime and Coastguard Agency Human Element Strategy: http://www.dft.gov.uk/mca/mcga07-home/workingatsea/mcga-healthandsafety/dops_-_all-newpage-2.htm (also saved as pdf on 18/11/13 and available on request from HEI). Corroborates claim that fatigue is now included as part of MCA Human Element Strategy; note the link to 'Guidance on Fatigue'.
3. Smith, A. P. Seafarers' Fatigue. IMO, London. March 2008. http://www.imo.org/blast/mainframe.asp?topic_id=103&doc_id=8869. (also saved as pdf on 18/07/13 and available on request from HEI). Corroborates claim that the research has been used to support international measures to deal with fatigue.
4. IMO Manila: Conference of Parties to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, Manila, the Philippines, 21-25 June 2010. http://www.imo.org/MediaCentre/PressBriefings/Pages/STCW-revised-adopted.aspx (also saved as pdf on 18/07/13 and available on request from HEI). Corroborates claim that major revisions were made to STCW convention.
5. P&O survey: http://www.bbc.co.uk/news/uk-england-kent-19366359 (also saved as pdf on 18/07/13 and available on request from HEI). Corroborates claim that fatigue surveys are used by shipping industry.
6. Smith, A. P. & Allen, P. H. 2012. Assessing the impact of the Cardiff Seafarers' Fatigue Programme and Seafarers' Fatigue Film. In M. Anderson (Ed), *Contemporary Ergonomics and Human Factors* (pp. 227- 234). London: CRC Press, Taylor & Francis. ISBN 978-0-415-62152-6 (pdf available from HEI on request). Corroborates claim that the Cardiff research forms the basis for fatigue guidance in other countries.
7. Work at Nautilus: http://www.nautilusint.org/Campaigns/pages/Fatigue.aspx (also saved as pdf on 18/07/13 and available on request from HEI). Corroborates claim that the dissemination has involved national seafarers' unions.
8. Work at the International Transport Federation: http://www.itfseafarers.org/ITI-fatigue.cfm (also saved as pdf on 18/07/13 and available on request from HEI). Corroborates claim that the dissemination has involved international transport unions.
9. Work at The Nautical Institute: http://www.he-alert.org/objects_store/alert_13.pdf (also saved as pdf on 18/11/13 and available on request from HEI). Corroborates claim that the research has been used to support campaigns aimed at prevention and management of fatigue.
10. Seafarers Film links: http://www.esrc.ac.uk/my-esrc/grants/RES-192-22-0009/read (also saved as pdf on 18/07/13 and available on request from HEI). Corroborates claim that the film on seafarers' fatigue has been used to disseminate knowledge and for training purposes.