Institution: University of Hull

Unit of Assessment: UoA04 Psychology, Psychiatry & Neuroscience

Title of case study: Employing a stressor-strain framework to change health and safety risk-assessment policy and practice in organisations

Period when the underpinning research was undertaken: 2003 to 2019

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Dr Fiona Earle	Senior Lecturer in Psychology	1997 to present date
Dr Peter Clough	Reader in Psychology	1997-2014
Dr Keith Earle	Lecturer in Psychology	1998-2017
Prof Lars McNaughton	Professor in Sport Science	2003-2010
Dr Adrian Midgley	Senior Lecturer in Sport Science	2003-2012
Dr Jason Siegler	Lecturer in Sport Science	2006-2010

Period when the claimed impact occurred: January 2016 to December 2020

Is this case study continued from a case study submitted in 2014? No

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

Occupational stress research at the University of Hull has led to extensive engagement with industry partners to explore stressors and strains in high stress-risk work environments. This has led to the following impacts:

- Changes in **strategic direction and activities** for UK health & safety (H&S) bodies and consequent **changes to policy** at the company level
- The **development of research-based bespoke tools** to gather industry data
- The **application of these tools** to explore the effects of organisation-specific stress risks on people in particular work environments
- Support for the **development of interventions** to manage identified H&S risks.

2. Underpinning research (indicative maximum 500 words).

The programme of human factors research carried out at the University of Hull addresses the impact of non-optimal working conditions on complex task performance, fatigue and health & safety (H&S) outcomes. This research supports a multi-level approach to understanding the complex human response of exposure to stress risks including patterns of performance breakdown and strain-related aftereffects. The underpinning research includes experimental work using simulations of complex real-world tasks to explore the impact of distinct stressors on multiple aftereffects, and field research in high-risk, real-life, industry settings, to examine the dynamic relationships between specific stressors and H&S outcomes.

Experimental work: The development of fatigue and breakdown of performance when exposed to occupational risks is examined theoretically and experimentally in [P1], [P2], [P3] and [P4]. The central theme of these experiments was to explore task engagement under different conditions and the resulting patterns of complex performance breakdown and aftereffects. The impact of working in challenging conditions is best understood within a complex conceptual framework, because task performance may be protected by investing compensatory effort which can mask performance breakdown. However, this increased effort is at the expense of subjective, behavioural and physiological costs, including fatigue, anxiety and the associated shift towards high-risk individual task strategies. Within the underpinning research, a range of non-optimal conditions was examined, including working at night [P1]; working under conditions of low task control [P2]; working under sustained mental workload [P3] and responses to heavy physical demands [P4]. This research offers novel theoretical developments to understand the human impact of non-optimal working conditions (stressor to strain relationships), as well as demonstrating the critical value of a

multidimensional methodological approach for investigating real-world working conditions and their diverse consequences.

Field research: More recently, field research has extended the experimental work to examine the impact of non-optimal conditions on workers in high stress-risk settings, including (i) the marine transit of Offshore Wind (OSW) technicians which leads to motion sickness, fatigue and risks to safety behaviours - funded by [G1] and [G2] and (ii) fatigue in OSW technicians - jointly funded by Orsted and grant [G3].

The experimental and field research develops our understanding of the complex patterns of risks facing workers in challenging contexts; it also demonstrates the critical value of a comprehensive multidimensional methodology to assess and understand their impacts on health and safety. In applied terms, the research explains how workers exposed to non-optimal conditions are vulnerable to performance breakdown, with potential safety costs, and impacts on their health and wellbeing. As such, the research is highly relevant to industry, particularly in very challenging working conditions, such as the OSW industry (where exposure to stressors is endemic) and safety-critical roles (where the consequences of fatigue are high). Because of this, much of this work is co-produced with industry, either in collaborative research grants (e.g. [G1], [G2], [G4]) or through consulting.

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

P1. Sauer, J., Hockey, G.R.J., Wastell, D.G., & **Earle, F**. (2003) Performance in a complex multiple-task environment during a laboratory based simulation of occasional nightwork. Human Factors, 45 (4), 657-670.
P2. Hockey, G.R.J., & **Earle, F**. (2006) Control over the scheduling of simulated office work reduces the impact of workload on mental fatigue and task performance. Journal of Experimental Psychology: Applied, 12 (1), 50-65.
P3. **Earle, F**., Hockey, G.R.J., **Earle, K**., & Clough, P.J. (2015) Separating the effects of task load and task motivation on the effort–fatigue relationship. Motivation and Emotion, 39 (4), 467-476.
P4. Midgley, A., **Earle, K.**, McNaughton, L., Siegler, J.C., Clough, P.J., & **Earle, F**. (2017) Exercise Tolerance during VO2max Testing is a Multifactorial Psychobiological Phenomenon. Research in Sports Medicine, 25 (4), p480-494.

Indicators of quality of research (grants)
G1. 2016 - 2020 EraNet: H2020 (DemoWind:) **€3.6m (€230,000 UoH)**. Project SPOWTT: Safety and Productivity in Offshore Wind Technician Transit (PI at Hull Fiona Earle). Consortium between University of Hull and six European organisations. Ref: 691732.
G2. 2017 - 2019 GreenPort Growth Fund (SPOWTT match funding) **£124,040** (PI Fiona Earle). Ref: GPR&D/KE1/003**.**
G3. 2017 - 2019 Green Port Growth Fund: Green Port Research and Innovation **£40,959**. PhD student funding. (PI Fiona Earle). Ref: GPR&D/KF/002.
G4. 2020 Ministry for Housing Communicities and Local Government grant **£73,000**. Local Digital COVID-19 Challenge Fund. Stress risk assessment in COVID-19 in collaboration with Hull City Council, East Riding of Yorkshire Council, North Lincolnshire Council and North East Lincolnshire Council. (Lead Academic: Fiona Earle).

4. Details of the impact

The following evidence details impacts of **strategic planning and associated activities for health and safety bodies** and the consequent **changes to company policy,** as well as the development and application of **bespoke risk assessment tools,** and the support for **evidence-based interventions** to manage identified risks.

As a result of the research and industry engagement, our partner organisations now have a significantly better understanding of the unique stress risks in their own work environments, and have been able to act on that knowledge to manage those risks more effectively.

1. Impacts on strategic plans and activities in Wind Industry Health & Safety bodies

The H&S risks for wind industry workers are particularly diverse, including complex mental and physical demands, challenging shift patterns and on/offshore transit to the windfarms. These demands and associated risks map closely to the research focus and insights in [P1-4]. But, as a relatively new industry, wind energy organisations are still developing H&S risk assessment and risk management frameworks.

Consequently, Dr Fiona Earle undertook major engagement with wind energy companies from 2016 to 2020. At more than 150 presentations, workshops and meetings, she promoted multidimensional models of fatigue and a comprehensive psychosocial approach to risk assessment incorporating patterns of performance breakdown and strain-related aftereffects. Significant early interest in her group's research came from a workshop on safe turbine access at an Energy Institute *Safe by Design* workshop (September 2016) attended by 20+ industry-leading businesses, and a presentation at RenewableUK's H&S Conference (January 2017) attended by 60+ international businesses. The Regional Innovation Manager UK from Siemens Gamesa Renewable Energy (SGRE) confirms that "*Attendance [by Dr Earle] at numerous industry events and conferences both here in the UK and in Europe has been notable. These engagements have led directly to a number of specific research programs which are valued and supported by the industry as a whole, and by individual industry partners like ourselves.*" [E1].

The extensive industry-level engagement described above resulted in impacts across the wind industry, including changes to the strategic plans and associated workstreams of the three wind industry H&S stakeholders, which together provide H&S leadership across the wind sector - **RenewableUK** (the renewable energy sector's trade association) **SafetyOn** (onshore wind H&S body) and **G+ Global** (OSW H&S body). Specifically:

Renewable UK incorporated fatigue and psychosocial stress risk into its H&S strategic planning and recommendations for the first time. RenewableUK's Head of Technical Affairs describes this in detail, saying that Dr Earle's work "*has had a significant impact on industry thinking and strategic planning… ensuring human factors considerations were incorporated into health and safety workstreams"* [E2]. Following on from this lead:

G+ Global included a fatigue group in their workshop on safe offshore windturbine access, identifying climbing fatigue as a significant and complex risk. They consequently reported recommendations from Dr Earle including an "*industry standard limit to climbing practices*" due to the implications of fatigue for safety behaviour and health, and that "*risk assessment should incorporate the fatigue-related risks to activities which follow climbing"* [E3 p27-32].

SafetyOn developed a new Human Factors Work Stream [E4] prioritising fatigue and stress risk assessment. Dr Earle had a direct influence on establishing these strategic priorities as testified by [E2].

Alongside this strategic activity, Dr Earle worked with Siemens Gamesa to develop **SPOWTT (Safety Productivity in Offshore Wind Technician Transit).** The aim of this collaborative research project was to address the specific H&S risks of marine transit [G1 & G2] (2016 to 2019). Earle and Siemens Gamesa assembled a consortium comprising the University of Hull and six European organisations in Germany, UK and the Netherlands, to gather and exploit stressor-strain field data on the human impacts of different sailing conditions. SPOWTT subsequently developed a decision support tool to incorporate human factors research into the sail/no sail decisions currently made daily by all marine coordinators at all offshore windfarms. The main industry output of this work was *Atlantis*, a sail/no sail decision support software platform for field-based marine coordinators to risk-assess operational decisions, supporting the management of personnel health and safety. *Atlantis* is now incorporated as a bolt-on to the commercial software *Atlas*™ [E5] developed by SMC (Specialist Marine Consultants), whose Business Development Manager testifies "*Atlantis, in conjunction with Atlas, has been utilised on 7 windfarms in the UK, Belguim, Germany and Taiwan for operational sail/no sail decision making*" [E6].

2. OSW company-specific impacts on H&S and fatigue risk management and assessment

The underpinning research, industry engagement and project SPOWTT led subsequently to specific impacts on H&S policy in leading wind energy companies:

Siemens Gamesa Renewable Energy (SGRE) made evidence-based changes to its policy and practices for fatigue management and its models for the recovery of OSW technicians after transit to and from its turbines. SGRE's UK H&S Manager OSW Servicing testifies: "*The work done by Fiona (Earle) and her team… in the areas of fatigue and the physical and psychological impacts of sailing to and from work every day (SPOWTT)… [has] changed the way we think and plan day to day operations…*

- *SGRE introduced strict policies limiting the number of climbs in a set time frame that are considered a maximum, and this has since been implemented across our Northern Europe and Middle East Offshore regions;*
- *We have given technicians the ability to take a paid fatigue day, should they meet certain criteria;*
- *We now include the health (physical and mental) of our technicians in our decision to even sail on a given day, and will alter the work to alleviate the effects of fatigue if we can".* [E1]

Orsted Energy also drew on the University's research when it needed to fully understand how the introduction of a two-week-on, two-week-off shift system would affect the health, safety and wellbeing of technicians who operate and maintain the Race Bank windfarm from a Service Operation Vessel (the collaborative project was quickly expanded to form the basis of what is now a global project for fatigue risk management for the whole of Orsted Energy) [E7].

The fatigue research foundations [P1-4], were applied to the OSW industrial context through a two-phase study [E7] – Phase 1 involved interviews and analysis of employee's experiences of fatigue, followed by Phase 2, a sleep study incorporating psychometric and physiological tracking of activities, perception of coping, fatigue and health-related symptoms. Dr Earle's recommendations to Orsted led directly to [E7]:

- The company developing a unique '4 Pillars Model' for fatigue risk management based on Education & Training, Prevention, Detection and Mitigation strategies, which in turn led to significantly increased knowledge regarding fatigue.
- Increased reports to line managers of pre-shift fatigue concerns and increased requests for fatigue recovery days.
- Improvements in the way Orsted plans maintenance activities, to reduce fatigue risks.
- The development of much more robust risk assessment protocols in respect of fatigue.
- The establishment of the Orsted East Coast Hub Health & Wellbeing Group, which has taken information from the study to help understand how the company supports employees with mental health issues and workplace stress.
- The introduction of a mobile phone app that allows technicians to confidentially report mental health and stress issues, resulting in confidential external psychological support being offered within hours rather than at the end of the shift.

Orsted's Race Bank Operations Manager confirms: "*The development of this study was ground-breaking, no other study had been done in our industry that compared fatigue between employees working from a Service Operations Vessel and those working from a Crew Transfer Vessel on two different shift patterns… Dr Earle and the Hull University Centre for Human Factors Research have been a significant and extremely valuable part of the development of a Fatigue Risk Management Plan for Orsted. Put simply, we could not have done this without the expert knowledge, support and study undertaken".* [E7]

3. Impacts on Stress-Risk Assessment practices within Local Authorities and the Health & Safety Executive (HSE)

The impacts outlined above were established in the context of a high-risk and rapidly developing industry, in need of applied research and customised tools. In contrast, the working context within Local Authorities (LAs) is relatively low risk. The psychosocial risks for LA workers are well understood within the stressor strain framework and supported by widely available standard risk assessment tools, such as the HSE's 'gold standard' Stress Indicator Tool (SIT). However, COVID-19 required the UK network of LAs to maintain essential service delivery under unprecedented conditions. This change was rapid and immense, coupled with extremely high workload, and little prepared resource or infrastructure. For many this included enforced remote/home working, with well over 10,000 LA workers in the Humber region alone required to work remotely.

In recognition of these emerging stress risks, Dr Earle was invited to collaborate with four regional Local Authorities in a Government-funded project [G4] working with funding from the Ministry for Housing, Communities and Local Government (MHCLG). This project, known as 'Future Work Design', built on Earle's research insights [P1-4] to study the risks of remote working for employee health, safety and well-being. The two major outputs of this project were a 'White Paper' guidance report, to support strategic decision making, and a Remote Working Stress Risk Assessment Tool [E8]. These documents were targeted at LAs, but are useful for any organisation wanting to assess remote working stress risks. While only recently finished, these outputs have already impacted on LA recovery plans, as testified by the East Riding of Yorkshire Council (ERYC) [E9]:

- Within ERYC the tools have been used to: Inform and guide their five key Strategic Plans including People and ICT strategies; inform the Heads of Service in their 'Becoming a more Agile Council' group; establish and guide a new Workforce Wellbeing group to support organisational policy, ensuring effective wellbeing mechanisms are in place [E9].
- [E9] also details the impact on wider LAs, who have utilised the outputs to influence recovery planning/policy – including Hull City Council's new guidance for managing vitual meetings, and North East Lincolnshire's briefing paper on Agile Working Principles.
- 6 UK Local Authorities are now using the Remote Working Stress Risk Assessment Tool to examine the prevalence and patterns of stress risks and health outcomes *"These [project outputs] are a key tool in the recovery of the organisation and enable us to understand the challenges and opportunities as we move forward'* [E9].

In addition to direct impacts on LAs, the HSE (national regulatory body for H&S) became aware of Hull's Remote Working Stress Risk Assessment Tool and the synergy with its own (generic) stress risk assessment tool, the SIT. In recognition of the value of this work for supporting organisations (particularly in the current COVID-19 crisis), Hull's Remote Working Stress Risk Tool has now been been adopted by the HSE's Science Division and incorporated into their digital platform. This platform is the HSE's commercial tool, recommended for assessing work-related psychosocial stress risk. As testified by the Head of HSE Human Factors [E10] "*This is a very valuable complement to HSE's stess indicator tool … This tool is now the foundation of a new formal collaboration between the HSE and the University of Hull, positively impacting Health & Safety at national and global levels".*

5. Sources to corroborate the impact (indicative maximum of 10 references)
All available as pdfs on request

E1. Testimonial from SGRE: UK H&S Manager OSW Servicing & Innovation Manager
E2. Testimonial from RenewableUK: Head of Technical Affairs
E3. G+ Safe by Design Report
E4. Published workstreams for SafetyOn
E5. SMC Altas™ Commercial decision support tool
E6. Testimonial from Specialist Marine Consultants: Business Development Manager
E7. Testimonial from Orsted: Race Bank Operations Manager
E8. Future Work Design Outputs: Guidance Report and Risk Assessment Tool
E9. Testimonial from ERYC: Future Work Design Project Lead
E10. Testimonial from HSE: Head of Human Factors