A Human Factors Approach to Understanding the Risk Factors Contributing to Fatigue in the Atlantic Canada Shipping Industry

Laura Critch, MSc. Candidate, Memorial University of Newfoundland
Angela Loucks-Atkinson, (PhD), Memorial University of Newfoundland
Captain Jim Parsons, (PhD), Marine Institute of Memorial University
Scott MacKinnon, (PhD), Memorial University of Newfoundland

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Outline

- Introduction
  - Statistics related to fatigue in the maritime industry
  - What is fatigue
- Significance of Fatigue Research
- Implications of Fatigue
- Fatigue Research in the Shipping Industry
- Current Research: What is the situation here in Atlantic Canada?
Introduction

- 90% of world trade makes use of maritime transport, depending on more than 1.2 million seafarers to operate ships
  - International Labour Organization
Based on the 2006 Census, Newfoundlanders Working in the Marine Industry Included:

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Total Number of Workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deck Officers</td>
<td>825</td>
</tr>
<tr>
<td>Engineer Officers</td>
<td>515</td>
</tr>
<tr>
<td>Deck Crew</td>
<td>755</td>
</tr>
<tr>
<td>Engine Room Crew</td>
<td>195</td>
</tr>
</tbody>
</table>
Shipping is a Safety Critical Industry Yet...

40.6% of officers reported falling asleep at work during the last 5 years, with 17.6% falling asleep once during watch duty in their career.

50% of seafarers taking part in the Cardiff Research considered their working hours present a danger to their personal Safety.

In 23 vessels that had grounded, fatigue was considered to be a factor in 82%.

A 2003 study of the Royal Australian Navy revealed that 44% of participants worked more than 80 hours per week.

Marine Accident Investigation Branch, 2004

Härmä et al., 2008

Smith et al., 2006
Implications of Fatigue

- Fatigue has been speculated as a contributing/causal factor in the following accidents:
  - Grounding of the Exxon Valdez (1989)
  - Fire in the cargo tank of the Kometik (2006)
  - Grounding of the Algomarine (2008)
Significance of Fatigue Research

- Fatigue is recognized as a health and safety concern in this industry
  - Acute fatigue has been associated with impaired performance and compromised safety (Smith et al., 2006)

Individual effects of shiftwork resulting in fatigue and other health outcomes:

<table>
<thead>
<tr>
<th>Sleep problems</th>
<th>Cardiovascular complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiredness</td>
<td>Gastrointestinal complications</td>
</tr>
<tr>
<td>Performance decrements</td>
<td>(Menezes et al., 2004)</td>
</tr>
</tbody>
</table>
Implications of Fatigue

Ship Operations

• Accidents
• Collision risk
• Economic Cost
• Environmental Damage

Individually

• Injury
• Poor Health
• Well Being
• Poorer Performance

(Smith, Allen, & Wadsworth, 2006)
Types of Fatigue

Physical Fatigue

Mental Fatigue
Fatigue Can Be Divided Into 5 Factors (Ashberg et al., 2000)

1) Physical Exertion
   - warm, sweaty, out of breath, breathing heavy

2) Physical Discomfort
   - tense muscles, aching, numbness, hurting, stiff joints

3) Lack of Energy
   - exhausted, spent, overworked, worn out, drained

4) Lack of Motivation
   - lack of initiative, listless, passive, indifferent, uninterested

5) Sleepiness
   - sleep, yawning, drowsy, falling asleep, lazy
Defining Fatigue

- Fatigue is generally thought of as a subjective sensation on a continuum with behavioural, emotional and cognitive components (Wadsworth et al., 2008)

- Fatigue is considered to be a generic term of which sleepiness is one of the major subcomponents (Lützhöft et al., 2010)

- Fatigue refers to feelings of tiredness and bodily discomfort associated with prolonged activity (Leung et al., 2006)
Introduction: What is fatigue?

“A reduction in physical and/or mental capability as the result of physical, mental or emotional exertion which may impair nearly all physical abilities including: strength; speed; reaction time; coordination; decision making; or balance.”

Significance of Fatigue Research

- Shipping is a centuries old industry, but research on work-related fatigue is limited in the maritime domain compared to other transport sectors (Allen et al., 2008)

<table>
<thead>
<tr>
<th>Accessing this work population</th>
<th>Work traditions and practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Extended time offshore</td>
<td>• “Strong profession”</td>
</tr>
<tr>
<td>• Dynamically changing work environment</td>
<td>• Expectations to meet high operational demands</td>
</tr>
</tbody>
</table>
International Research on Fatigue

- **United Kingdom** (The Cardiff Research Program, 1999-2006)

- **Purpose:** To consider the prevalence of fatigue in the industry and potential risk factors

- **N=1855, N=177**

- **Results:** Poor quality sleep, age, high job demands & high stress were consistently associated with fatigue
  - Other important factors included frequent port turn-arounds, physical work hazards, working more than 12 hours a day, low job support and finding the switch to port work fatiguing
International Research on Fatigue

- **China** (Leung, Chan, Ng & Wong, 2006)

  - **Purpose:** To examine the differences in fatigue levels of night and day shift officers
  - **N=93**
  - **Results:** Shift pattern, age, experience in craft operation, and perceived voyage difficulty were associated with perceived fatigue
  - Night shift officers reported higher perceived level of fatigue; day shift officers demonstrated a fatigue carry over effect
International Research on Fatigue

- **United States** (Louie & Doolen, 2007)

  - **Purpose:** Consider the causes of fatigue of deck watch officers
  - **N=43**
  - **Results:** Found that inconsistent sleep times and lack of sleep were leading causes of fatigue
    - Fatigue levels do not vary as a result of watch schedule, age, gender or experience.
Purpose: To examine and compare fatigue levels between two watch systems

N=32

Results: Reported sleepiness was higher in the 6-on, 6-off watch system during the night shift.

Sleepiness increased more during the watch in the 6-on 6-off system compared to the 4-on, 8-off and sleep was more often spilt into 2 episodes for this shift
Research on Shiftwork Scheduling

4-on, 8-off Vs. 6-on, 6-off

Research Findings

- Difficult to make definite conclusions and causal inferences between studies in the literature

Risk Factors Associated with Fatigue:

- High work stress
- Work Demands
- Job security
- Shift length
- Poor sleep quality
- Shorter tour length
- Age/Experience

- Difficult to make definite conclusions and causal inferences between studies in the literature
What is the situation in the Atlantic Canada shipping industry?

International literature demonstrates that worker fatigue is a significant concern in the shipping industry...
The current study will examine the risk factors associated with fatigue identified by officers working in the Atlantic Canada shipping sector.

- Evaluate fatigue as a “process” (Smith et al., 2008)
  - Begins with identified risk factors for fatigue
  - Subjective perception of fatigue by participants
Question: Do work related factors along with individual and environmental factors influence perceived fatigue in officers working in the Atlantic Canada shipping industry?

Consider the associations between:

- Navigational watch scheduling and fatigue
- Shipboard activities and fatigue
- Officer demographics and fatigue
- Length of seagoing trip and fatigue
- Potential coping mechanisms used to deal with fatigue
- Environmental conditions and fatigue
Design & Participants

- **Research Design:** Descriptive time series momentary assessment survey study

- **Target Participants:** Officers in the Atlantic Offshore Industry (N = 60)
  - Work and reside in rigid 24 hour environment
  - Responsible for:
    - Navigational watches (shift work)
    - Meeting operational demands
    - Safety of the crew
    - Overseeing port activities
    - Unanticipated repairs and voyage delays
    - Emergency drills and Regulatory compliance
Data Collection

- Questionnaire that was adopted from Smith, Lane, Bloor, Allen, Burke and Ellis (2006)
- Includes three sections:
  1) Pre-voyage Questionnaire
  2) “Before Shift” Logbook Questionnaire
  3) “After Shift” Logbook Questionnaire
Pre-Voyage Questionnaire

<table>
<thead>
<tr>
<th>Questions Examining:</th>
<th>Example:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work Demographics</td>
<td>What hours do you typically stand watch?</td>
</tr>
<tr>
<td>Participants Work at Sea</td>
<td>Do you experience feelings of nausea brought on by motion effects?</td>
</tr>
<tr>
<td>Participants Life at Home During Leave</td>
<td>Does your job reduce the amount of time you would like to spend with the family?</td>
</tr>
<tr>
<td>Individual Health and Well being</td>
<td>Have you had any accident, injury or poisoning, needing hospital treatment or a visit to casualty in the past 3 months? CFQ, GHQ, SF-36</td>
</tr>
<tr>
<td>Questions Examining</td>
<td>Example</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Sleep</td>
<td>Approximately what time did you go to bed last night?</td>
</tr>
<tr>
<td>Eating Behaviour</td>
<td>Did you eat a meal before watch?</td>
</tr>
<tr>
<td>Alcohol Consumption</td>
<td>Did you consume any alcohol yesterday?</td>
</tr>
<tr>
<td>Caffeine Consumption</td>
<td>How many cups of the following drinks have you had since the end of your last watch?</td>
</tr>
<tr>
<td>Medication</td>
<td>Have you taken any medication in the last 12 hours?</td>
</tr>
<tr>
<td>Smoking</td>
<td>How many of the following have you smoked since your last watch?</td>
</tr>
<tr>
<td>Perceived Fatigue</td>
<td>Physical Mental Fatigue Scale</td>
</tr>
<tr>
<td>Questions Examining</td>
<td>Example</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Breaks During the Watch</td>
<td>When did you take your first break?</td>
</tr>
<tr>
<td>Eating Behaviours</td>
<td>Did you have a meal during your watch?</td>
</tr>
<tr>
<td>Caffeine Consumption</td>
<td>How many cups of the following drinks have you had during today’s work period?</td>
</tr>
<tr>
<td>Workload</td>
<td>Could you please indicate on the scale below the amount of physical effort you have put into doing your job today.</td>
</tr>
<tr>
<td>The Work Environment</td>
<td>Sea State (On a scale of 1-10)</td>
</tr>
<tr>
<td>Perceived Fatigue</td>
<td>Physical Mental Fatigue Scale</td>
</tr>
</tbody>
</table>

*Hurricane Force*
Physical-Mental Fatigue Scale

1. My concentration is very bad at the moment. (M)
2. Sitting for a long time makes me very sleepy. (P)
3. I have problems thinking clearly. (M)
4. I have less strength in my muscles. (P)
5. At the moment I am very aroused. (M)
6. The surrounding temperature is very comfortable to me (P)
7. At present, I feel very bored. (M)
8. I need to rest more. (P)
9. At the moment I feel very stressed. (M)
10. I feel physically very strained. (P)
11. I have problems concentrating on these questions. (M)
12. I am lacking energy. (P)
13. I feel mentally very strained. (M)
14. I feel sleepy or drowsy. (P)
15. I feel that my current activities are diversified. (M)
16. I feel much fitter now than after awakening. (P)

(Pietrowsky & Lahl, 2008)
Results

- Will generate conclusions about associated risk factors for fatigue in officers working in the Atlantic Canada shipping industry

Development of guidance notes

- Describe findings and suggest best practices for mitigating officer fatigue
- Knowledge mobilization plan
Conclusion

- Fatigue will continue to be an occupational health and safety concern in the marine industry.
- The current research has the potential to narrow the gap between researchers and industry.
- Provide direction for future research in the area.


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