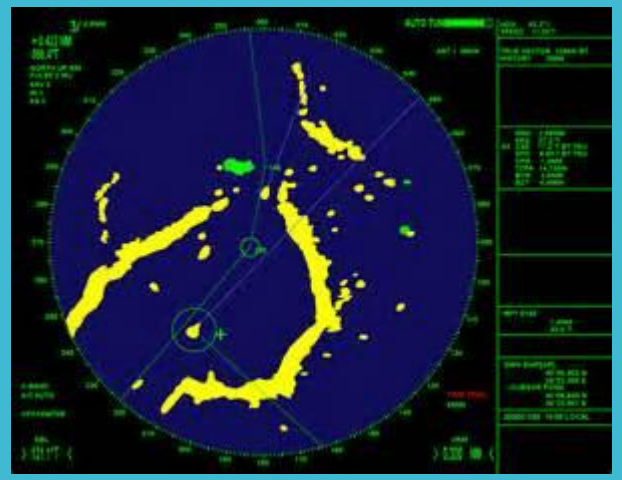
Fatigue in the Shipping Industry

Fatigue in Transportation Forum
Transport Canada
Center for Study and Treatment of Circadian Rhythms

McGill University
June 27-18th
Montreal, Que.

MARINE INSTITUTE
Centre for Marine Simulation

Topics for Discussion



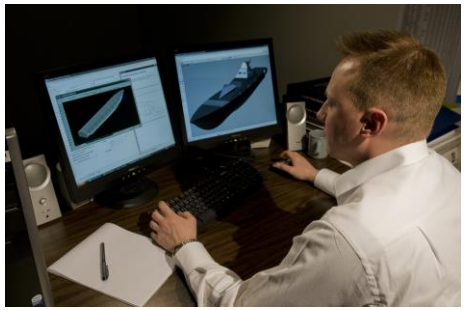
- Ship Operations.. a short introduction
  - Overview of ships and people onboard
- Fatigue and the Seafarer
  - The issues, the impacts, the legislation
- Case Study
  - Shen Neng 1
- Project Horizon..A Wake up Call
  - Large project focused on ship board watch demands and fatigue
- Project MARTHA
  - Project aimed at actual ship board data gathering on fatigue
- Fisheries
- Final Thoughts

Training

Industry Response

Applied Research

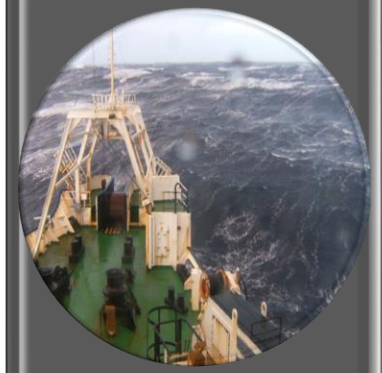
- Centre for Marine Simulation (CMS) special industrial response and applied research unit of the Marine Institute
- Established to provide realistic simulation environments to conduct focused training, risk assessments and operational rehearsal for shipping and offshore oil and gas
- Ocean Ranger (Design, competency, regulatory discord)
- Harsh Environments
- 24 simulators including fully motion capable ships bridges
- Software design including Naval Architecture and GIS databases modelling



Training

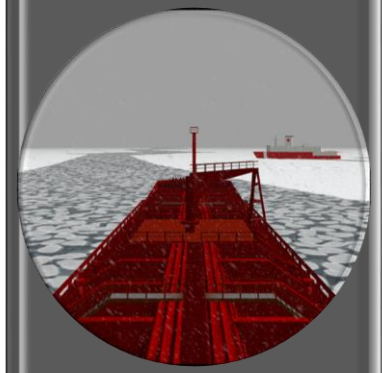
Industry Response

Applied Research



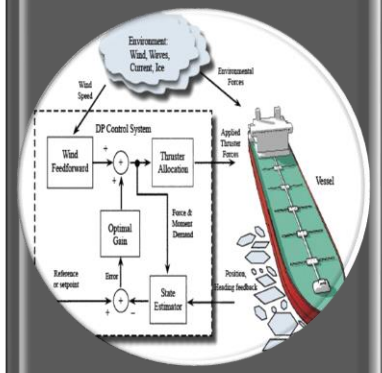
Harsh Environments

- High sea states and moving environments
- Ice navigation and route studies
- Offshore operations in challenging conditions



Ice Operations

- Realistic ice models
- Ice management
- Feasibility studies
- Operations in ice



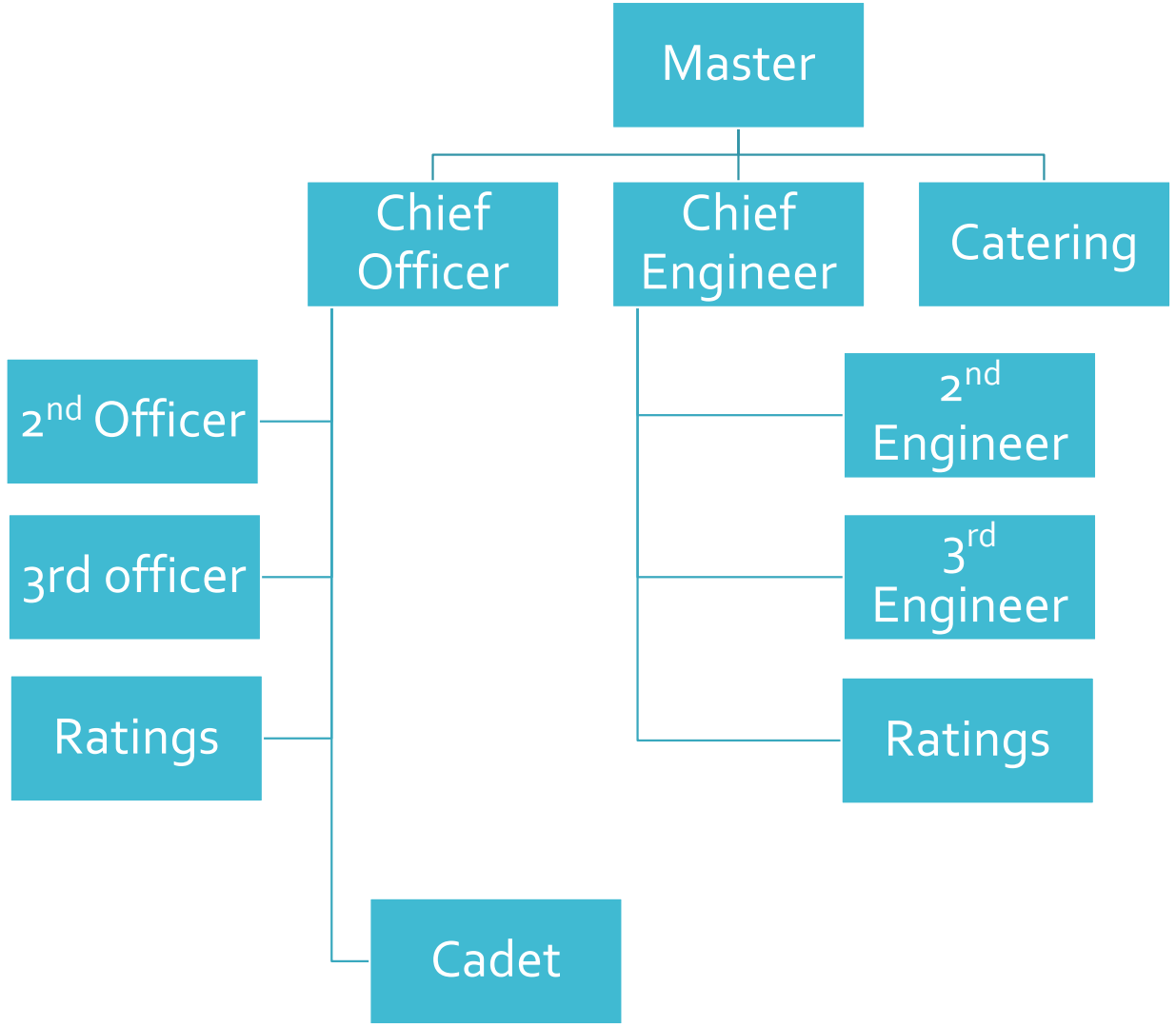
Simulation Development

- Systems integration
- Ancillary systems
- Innovations
- Technology transfer

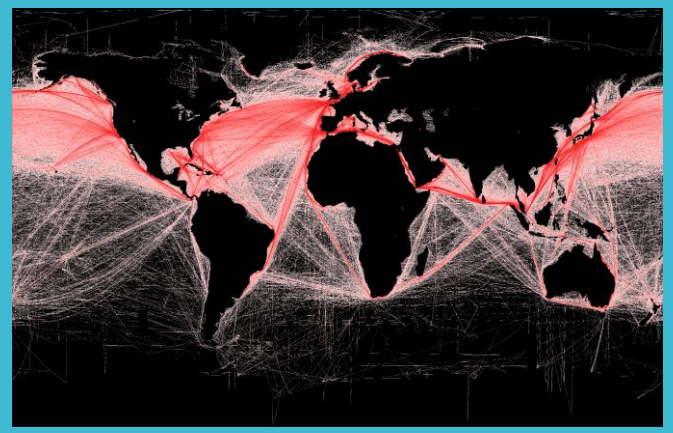
Human Performance

- Human-machine interface
- Fatigue and Stress
- Personnel Interaction

Ships Nominal Crew Complement



Shipping Industry



- 90% of world trade in terms of transfer of commodities and good is done so at sea. The shipping industry is made up of many sectors and facets and is expansive and complex
- Shipping sectors are diverse as the trade or operations engaged in but generally consist of
  - Bulk Trades - oils, grains, ores, gaseous cargos (LNG/LPG)
  - Containerized
  - Rolling cargo
  - Passenger
  - Specialized services – dredging, cable, heavy lift,
  - Offshore Energy- oil and gas,wind and tidal
- Short Sea (Continental) and Deep Sea (Worldwide) Trades
- Liner and Charter services

Life onboard.. A Snap Shot

- Ships operate on 24 hours a day and 7 days a week
- Depending on the type of ship, crew complement, and operation the day is broken into watches (shifts) which divide basic navigation and engineering responsibilities while ship is under way
  - 4 and 8 (4 hours on duty and 8 hours off)
  - 6 and 6 (6 hours on duty and 6
  - 12 and 12 (12 hors on and 12 off)
- While ships are in port loading cargo the vessel will revert to "day work" or to specific cargo watches that ensure officers and crews involved with cargo are involved
- Operations at sea also may require watch standing officers to be involved in addition to their watches . This includes specific operations and necessary admin work or other requirements

Watch System Description

Watch System	Duty Time (nominal)	Responsibility	Comment
4 and 8	0000 to 0400 0400 to 0800 0800 to 1200	1st Watch standing Officer 2nd Watch standing Officer 3rd Watch standing Officer	Usually senior watch keeper has middle watch
6 and 6	0000 to 0600 0600 to 1200	1st Watch standing Officer 2nd Watch standing Officer	Used where only 2 watch standers
12 and 12	1800 to 0600 0600 to 1800	Night Crew Day Crew	Commonly found in offshore

- Normally Master does not stand a watch, but is considered to always be available. Master may stand in for a fatigued watch keeper or in case of a 2 watch system (6 and 6) Master may be the other watch keeper
- Ships with an unmanned engineer space (UMS) may assign responsibility of responding to alarms (2 watch stander)
- Ratings (seamen and engine staff) would be part of watches above with responsibilities

Additional points

- **Responsibilities of ship's personnel to time and work demands extend beyond navigational and engineering watches**
- Shipboard routine maintenance and up keep both deck and engineering
- On-board administrative work at each position including daily reporting and paper work or specific operational demands (specials ships)
- Life saving and emergency drills and onboard training
- Port calls often include considerable demands on Master and ships officers including dealing with inspections and visits from Class, Flag State, Insurance, Owners, Charterers, Port State and Customs
- Dealing with suppliers and repairs
- Security requirements driven by port and regulations
- Technology impacts on crew size

Minimum Safe Manning

IMO
A 27/Res.1047

TC Marine Personnel Regulations

- The objectives are to ensure that a ship is sufficiently, effectively and efficiently manned to provide safety and security of the ship, safe navigation and operations at sea, safe operations in port, prevention of human injury or loss of life, the avoidance of damage to the marine environment and to property, and to ensure the welfare and health of seafarers through the avoidance of fatigue.
- Minimum Safe Manning assessed on many criteria including:
  - Size and type of ship, number and type of propulsion
  - Construction and equipment of ship, method of maintenance
  - Cargo carried, frequency of port calls, length and nature of voyage
  - Degree of shore side support and training
  - Levels of automation
  - Amicable work hour limits and/or rest requirements

Fatigue and the Seafarer

IMO MSC/Circ.1014

- Fatigue is an issue in any 24 hour transportation mode or industry
- There are unique aspects to the shipping industry that add additional consideration for seafarers
  - "Captive" of the work environment. Crew can spend average 3- 6 months onboard. Living away from family in hierarchal system.
  - Vessel is subject to unpredictable environmental conditions
  - Life onboard - no clear separation between work and recreation
  - Many ship have multiple nationalities/culture expected to live/work together for long periods
  - Operational aspects, ship type, length and pattern of voyages
- The results of fatigue is impaired performance and diminished alertness"

Factors That Categorize the Causes of Fatigue

IMO MSC/Circ.1014

- **Crew Factors** including sleep and rest, psychological and emotional, health and diet, personal and interpersonal issues, age, work load, and stress
- **Management Factors** (both company and shipboard) including rules and regulations, economics, staff retention, resources, traffic density.
- **Ship Factors** including ship design, equipment reliability, inspection and maintenance, location/quality of quarters, ship's motion
- **Environmental Factors** including temperature, humidity, excessive noise levels. Ship motion, challenges to maintain physical balance in heavy sea states of bad weather, nausea.

Fatigue-legislative

- Fatigue was long consider a part of more senior position given responsibility, especially mental fatigue. Cultural acceptance.
- Regulations concerning seafarers hours of work/rest were decided by individual flag state administrations. Hours of work could be in excess of 95 hours per week!
- Rise of accidents and incidents of increasing severity coupled with shrinking crew size pushed legislative bodies to enact specific regulation governing hours of work and hours of rest onboard ships
- International Labor Convention (ILO) 180
- International Maritime Organization (IMO) Standards of Training, Certification & Watch keeping (STCW) 2010 Manila Amendments
- Maritime Labor Convention (MLC) 2013

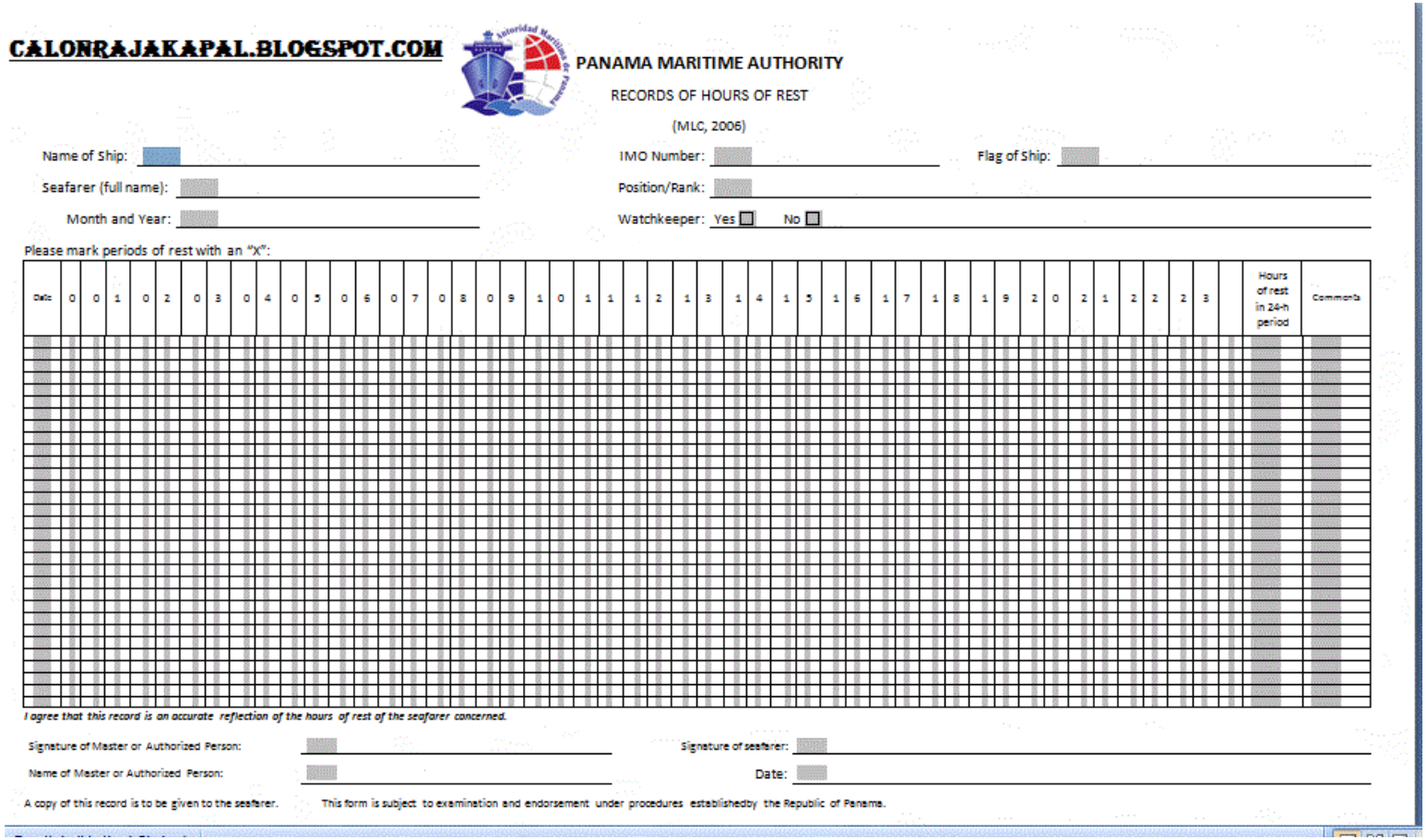
Hours of Rest

- Minimum Hours of rest not les than 10 hours in any 24 hour period
- Minimum of 77 hours in a seven day period
  - The hours of rest can be divided in a maximum of two periods, one of which should be at least six hours in length.
  - Two such consecutive periods should not be separated by more than 14 hours.
- Drills held to minimize crew disruption
- Hours of work and rest for crew displayed
- Log of hours of work and rest kept for review
- Exceptions - Master can suspend for safety of ship
- Regulation do not apply to certain vessel (under 500 GRT and fishing vessels)

Issues

- Need to balance ships commercial demands and charter expectations angst reality of managing fatigue
- Ship operations are governed by a multitude of regulations and standards that in some cases overlap and compliance with tehse regulation can cause issues.
- Key attribute to many charters are the legal requirements to ensure effective load carriage and discharge
- Vessel is expected to remain seaworthy during entire process
  - Seaworthiness includes competency of crew
  - Fatigue effects on crew members
  - Possibility of loss, damage ,or delay
- The highly competitive nature of shipping places pressure on ships Master and crew to ensure operational capacity and readiness
- Fatigue is a still consider a subjective study
  - Some report no effects
  - Some afraid to report
  - Some go through motions of report
- Guidelines and strict requirements to report when you work and when you sleep
- Measuring effectiveness of fatigue management processes

Fatigue Log



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PANAMA MARITIME AUTHORITY

RECORDS OF HOURS OF REST

(MLC, 2006)

Name of Ship: _____ IMO Number: _____ Flag of Ship: _____

Seafarer (full name): _____ Position/Rank: _____

Month and Year: _____ Watchkeeper: Yes ☐ No ☐

Please mark periods of rest with an "X":

Date	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Hours of rest in 24-h period	Comments

I agree that this record is an accurate reflection of the hours of rest of the seafarer concerned.

Signature of Master or Authorized Person: _____ Signature of seafarer: _____

Name of Master or Authorized Person: _____ Date: _____

A copy of this record is to be given to the seafarer. This form is subject to examination and endorsement under procedures established by the Republic of Panama.

Case Study

The Shen Neng 1 2010

- 750 foot Bulk Carrier runs aground on the Great Barrier Reef off Australian Coast
- 3-4 tons of fuel release as a result. (threat of over 700 tons)
- Damage to reef included 2 mile grounding scar and other ecological damage
- Owens's settled for $29 million in fines
- The Chief Officer on watch during grounding has slept approximately 3 hours in preceding 38 hours due to various responsibilities and interruptions in sleep

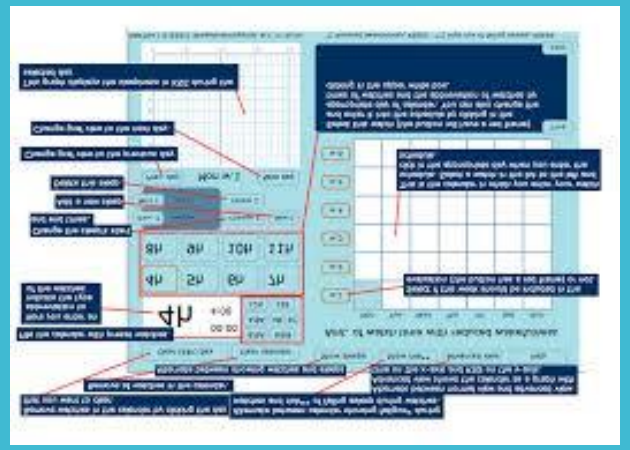
Project Horizon

2012 Joint Research Project on Watchkeeper Fatigue

Project Horizon

- Define and undertake scientific methods for measuring fatigue in various seagoing scenarios using bridge, engine room, cargo control simulators
- Determine the effects of watch systems and components of watch system on fatigue
- Gather data on cognitive performance within realistic scenarios
- Assess the impact of fatigue on decision making performance
- Develop a tool for evaluating potential fatigue risk of different watch systems
- Determine arrangements for minimizing risks to crews, ships and environment

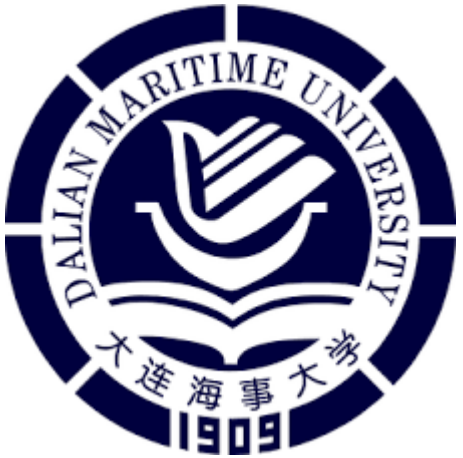
Project Horizon



- 90 ships officers and engineers, mixed nationalities and genders in good health. Group was sequestered in accommodations similar to ship.
- Focus on 2 watch types 6 and 6 and 4 and 8. additional work interruptions including port call, cargo , drills, emergencies for disturbed periods (off watch) at random for subjects
- Data gathered through subjective and objective methods. Including activity measurements, vigilance and performance tests and brain activity, participant sleep diaries
- Results showed the 4 and 8 averaged about 7 ½ hours sleep per day, generally sufficient for effective recovery
- 6 and 6 averaged about 6 hours sleep per day (cumulative) likely to led to sleep debt. Effects of off watch disturbances noted
- Development of a computer fatigue management tool kit. MARTHA (Maritime Alertness Regulation) will provide interface with watch schedules. User enters schedules to help predict.

Project MARTHA

2013-16
2nd Phase
Research Project on Watch keeper Fatigue



UNIVERSITY OF Southampton

Stress Research Institute

MF Shipping Group

Project MARTHA

Description

- The aim of the study was to explore the levels of sleepiness and the psychosocial issues associated with long term fatigue and motivation, using a sample of volunteer seafarers in the naturalistic setting of work onboard their vessels.
- 4 shipping companies 2 European based and 2 Chinese
- European company a involved in short sea products tankers. European company b involved in deep sea container ships
- Chinese company a involved in deeps sea bulk carriers. Chinese company b in tankers operating far east.
- Process over 3 years includes initial interviews, followed by onboard observation of crews and analysis of hours of work, stress, voyage details, workshops, fatigue training session, and final reports

Project MARTHA

- Questionnaires and interviews with managers and seafarers in the four shipping companies. (Nearly 1,000 questionnaires were completed).
- Onboard diaries of volunteer seafarers from the four shipping companies over a tour of duty. (The highest number of continuous weekly diaries was 17 weeks, but depending when the diary started, they covered as long as up to 6 months of a tour of duty).
- Actigraphy data from selected volunteers. The wearers were requested to wear the watches continuously for two weeks at the start of their tour and two weeks before signing off at the end of their tour.

Project MARTHA

The Results

- Both sleepiness and fatigue are important issues for seafarers and managers: they both have safety and long-term physical and mental health implications;
- Long tours of duty (over 6 months) may lead to increased sleepiness, loss of sleep quality and reduced motivation. Any of these outcomes could result in 'near-misses' and accidents onboard;
- Night watch keepers are most at risk from falling asleep on duty;
- Captains feel stressed and fatigued at the end of their tours of duty and need recovery time.
- .There are simple operational solutions which can ensure sleep is easier for those onboard through fatigue risk management. These solutions should involve seafarers and agencies ashore which impact on shipboard operations.
- The introduction of Fatigue Risk Management Systems, as already used in other safety-critical transport systems, presents an integrated systems approach to managing the risk of fatigue. 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 development of new data collection, transmission and analysis techniques will accelerate the process.
- In the longer term, improved vessel design will make a significant impact in reducing the effects of sleepiness and fatigue.

Project MARTHA

Further Questions

- 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 wellbeing 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

Environmental Conditions and Effects

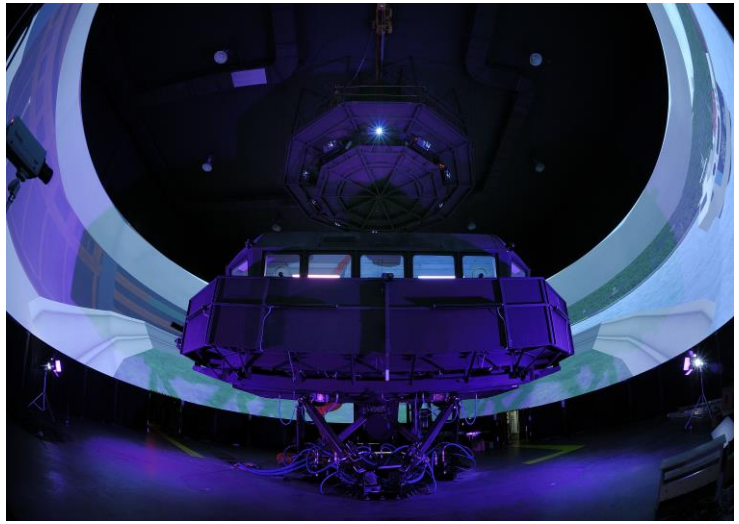
Environmental Conditions and Effects

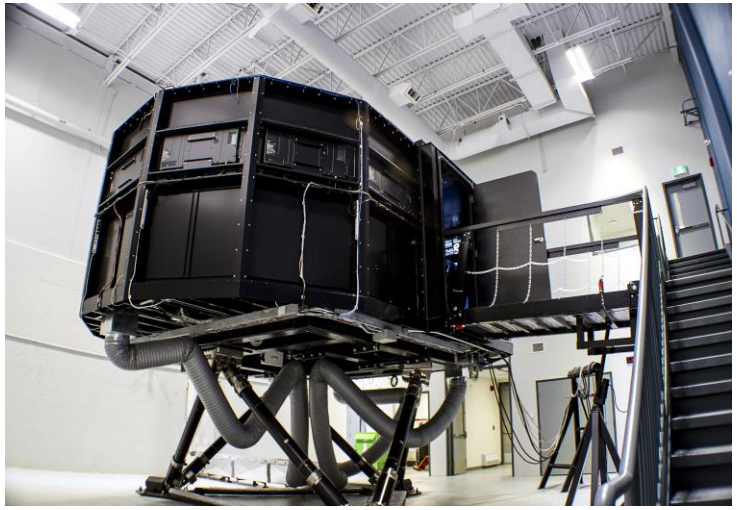
- Ships sailing through areas of bad weather can be exposed to extreme conditions that force crew to take additional physical and mental effort.
- Bad weather and high sea states can last for days
- The movement of vessel in sea states will affect life on board including lack of sleep, interrupted sleep, impact on meals, stress
- Concern for crew, ship and cargo, or operation.
- Other environmental issues include ice, cold or heat, restricted visibility , resilience of shps equipment to conditions
- Offshore energy vessels are a special case as they maybe in operations that expose them to conditions, as opposed to passing through areas of bad weather.
- Cumulative effects on personnel in terms of stress and fatigue can impact situational awareness and decision making

Exposure to heavy sea conditions can have considerable effects

CMS Harsh Environment Capacity

A Tool to Explore Extremes





Fisheries and Fatigue

- World wide commercials fisheries make up a considerable part of vessel on the oceans, ,any are small or near shore. In Canada significant fisheries activities occurs on all three coast and Lakes
- Vessel under specific tonnage are not covered by stringent crewing regulations
- The work can be intensive with exposure to demanding environmental conditions
- Crew often work around the clock during fish recovery/processing and sleep between sets of gear.
- Crew members injuries or death have occurred due to fatigue
- Fishing vessels drifting between sets with no one on watch
- Cultural acceptance and reluctance to admit condistions

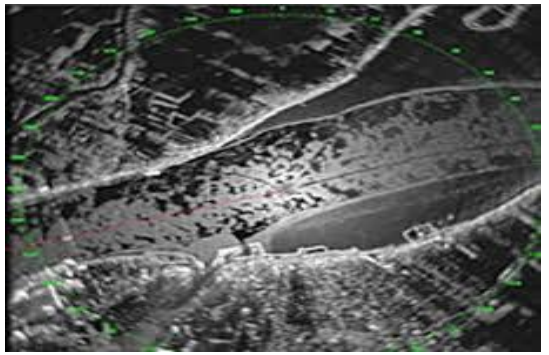
Some final thoughts

- Generally the Shipping Industry remains a vast complex international operation that has little interface with research in areas such as fatigue
- Fatigue is an issue and remains so.
- The impacts of fatigue on seafarers performance as likely as old as shipping itself
- The industry continues to try an find a practical middle ground between commercials pressure and need to be innovative and social responsible.
- Engagement with organization seeking to improve the situation is important and while slow can have an meaningful effect
- Resources and expertise that can be brought to bear are important. We all want to see people go home to families and stay in the industry

CMS

A Partner in Research and Development

- CMS has strong linkages in shipping industry and a facility that carries out training and applied projects seeking to improve safety
- Ability to develop and carry out simulation scenarios that include elements of risk or danger to people, ships, and environment
- Experience in past human performance focused marine projects
- Incorporate new technology assessment and usage in operations
- Combination of operational and technical expertise
- Part of the Marine Institute with additional areas of expertise in Safety/survival , Navigation and Engineering, and Fisheries
- Part of Memorial University
- Strong applied project management and collaborative nature



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