University of South-Eastern Norway

Engaging sharp-end operators for organizational learning

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Agenda for Today

"Engaging sharp-end operators for organizational learning"

- Present 3 recent studies:
  - Related to learning from "normal work" and organizational learning
  - Focus on **learning content**

- Structure of Maritime Education and Training (MET)
  - Role of accidents/accident reports
    - Learning from abnormal work
  - Developing learning content used for simulator training scenarios
    - Comparison between 2 safety-critical domains – what can we learn?
  - Differing (simulator) training tools for NTS

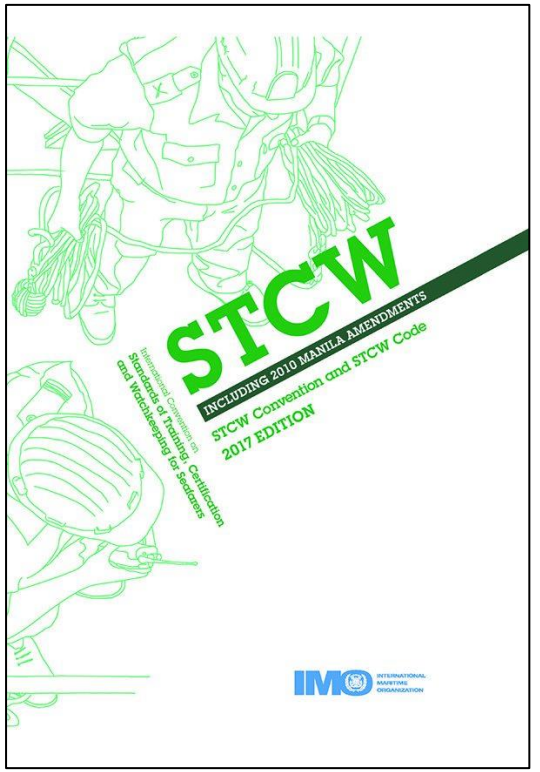
Maritime Education and Training

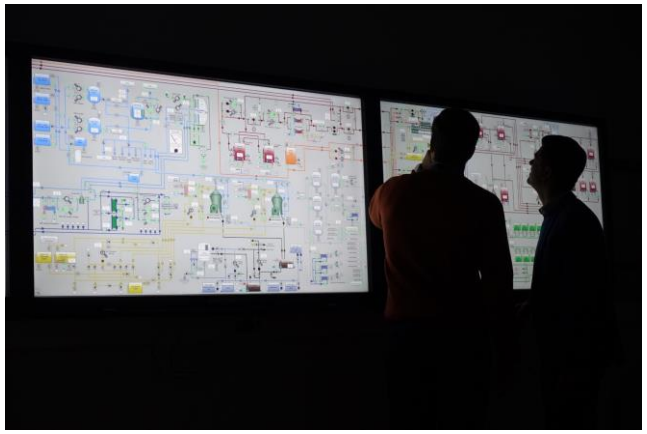
International Maritime Organization:

"International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978"

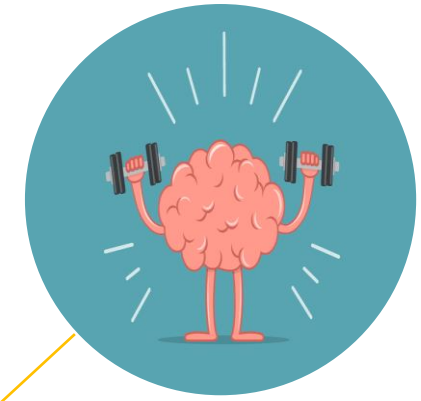
- Guides requirements for differing maritime positions, e.g.
  - Ratings, able seamen, nautical officers, marine engineers, etc.

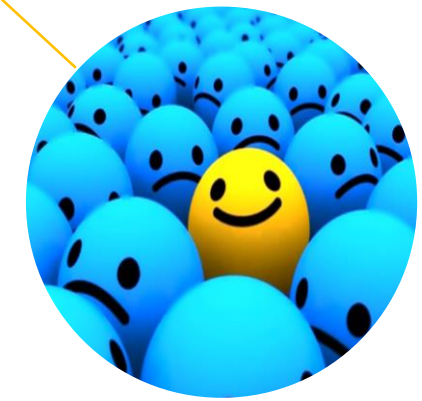
- Classrom lectures
- Simulator exercises
- Real-world experience (i.e. time sailing at sea)






Security
Participants
Chat
Share Screen
Record
Breakout Rooms
Reactions
Ask to Unmute
End





- **Cognitive Outcomes:**
  - Verbal knowledge
  - Knowledge acquistion & organization
  - Cognitive strategies
    - *Taking tests*

- **Skill-Based Outcomes:**
  - Compilation
  - Automacity
    - *Simulations and role play*

- **Affective Outcomes:**
  - Attitudinal
  - Motivational
    - *Personal perspectives & experience*

Kraiger, K., Ford, J. K., & Salas, E. (1993). Application of Cognitive, Skill-Based, and Affective Theories of Learning Outcomes to New Methods of Training Evaluation. *Journal of applied psychology, 78*(2), 311-328. doi:10.1037/0021-9010.78.2.311

Technical & Non-Technical Skills

- **Technical Skills**
  - e.g.
    - Ship stability
    - Planning and executing a mission
    - Mapping a route
    - Reading a RADAR
    - Propulsion and system processes

- **Non-Technical Skills**
    - Social (teamwork, leadership, communication)
    - Cognitive (situation awareness, decision-making, cognitive readiness, task management)
    - Personal Management (stress and fatigue management)

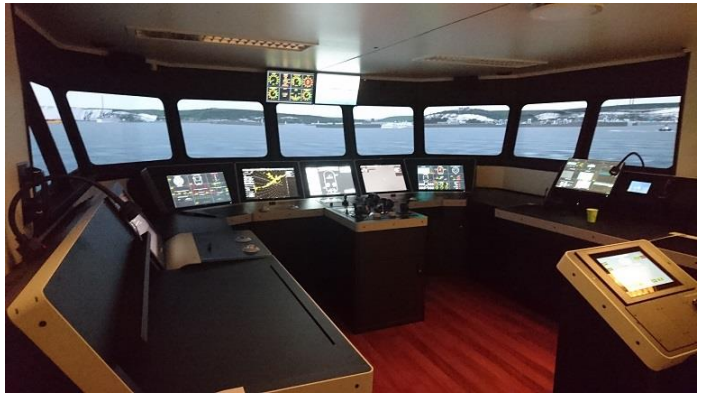
(Flin, O′Connor, & Crichton, 2008, p.1)

How to Use Simulators in Education & Training ?

- In my most cynical/pessimistic moments:
  - "…*trophies to be shown off*…"

- BUT:
  - Unbelievably powerful, flexible and realistic platforms

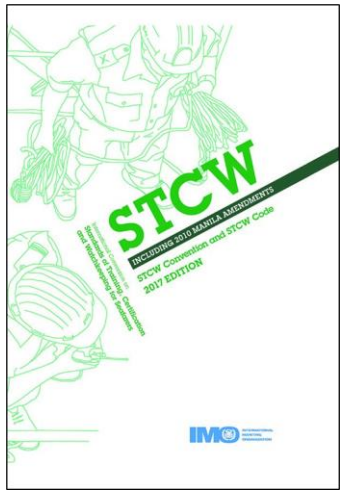
- How are they actually used?
  - Are they effective tools for learning?
  - What are the learning objectives and outcomes?
  - How are learning sessions structured?
  - Content used?...



  - *Chicken and egg situation*

How to Use Simulators in Education & Training ?

- Although we have a standardized international training code (STCW)
  - Many different approaches in how these learning outcomes are achieved



- What is the simulator scenario content?
  - This must be built/created
    - i.e. generate the "content" (training scenarios)
  - What is this based on…?

Impetus for Today's Presentation

- Investigation Goals:
  - To better understand the role of accident–related information and how it supports deck officer's work practice.
  - To understand the connection between the individual and organizational level in relation to multilevel learning
    - Identify gaps and opportunities for more effective learning and knowledge transfer.
  - To point to more effective methods of disseminating knowledge from accident investigations to sharp-end operators.

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Reintroducing the sharp-end operator to organizational learning: How accident reports are used by maritime officers

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ARTICLE INFO

Keywords:
Accident reports
Maritime
Professional practice
Organizational safety
Storytelling

ABSTRACT

When accidents occur in the maritime domain substantial efforts are devoted to their investigations in order to improve safety at sea. Investigations often result in detailed and elaborate descriptions of the sequence of events and root cause factors in the form of accident reports. Investigations carried out by governmental investigative bodies are made available in public reports, and typically contain safety recommendations intended to facilitate learning at individual, organizational and institutional levels. Several studies explore how accident reports are used for organizational learning, however, less discuss how sharp-end operators utilize this information as a tool for learning. This exploratory study interviews 18 Norwegian deck officers to better understand how seafarers acquire, use and value maritime accident investigation information as a means for developing their own professional practice. Results indicate a relatively low rate of utilization of original accident reports. The deck officers detailed barriers in format and scope of accident reports that limited their interest in them as a learning tool, favouring alternative sources, formats and transformed information which focuses on storytelling and a narrative-driven style more relatable to their specific work practices and backgrounds.

1. Introduction

The maritime domain and associated operations are an inherently dangerous and complex work environment. While advancements and standardization of regulations, engineering and technology, operational procedures and training have facilitated vast improvements in maritime safety, accidents at sea continue to occur (AGCS, 2012; 2019). Systematic accident investigations seek to understand how and why unwanted events happen, with an objective to prevent future occurrences (IMO, 2008; NSIA, 2020). Thus, an accident investigation and its outputs are tools for reflection, analysis, understanding and learning. Dekker (2014b) argues the prevention of future occurrences is often the most important, if not the only, purpose of accident investigations. When accidents occur, they represent an opportunity for various entities to improve through lessons-learned and experience gained (Hollnagel, 2014; Kjellén, 2000).

Accident investigations deemed significant enough to be initiated by public bodies, such as government agencies, conduct independent investigations in order to identify and communicate important safety deficiencies and create recommendations designed to eliminate or reduce the safety deficiencies discovered (MAIIF, 2019; TSBC, 2020). The International Maritime Organization's Casualty Investigation Code (IMO, 2008) has established criteria for the types of marine accidents requiring investigation, including prescribed procedures to follow for events, such as death or serious injury, the loss of persons from a ship, loss or abandonment of a ship, material damage or damage to the environment.

Sharp-end operators in safety–critical systems, such as seafarers, play an important role in shipping and the management and implementation of safe operations. As such, their competencies and training are an important aspect of system safety. As the primary purpose of accident investigations are to contribute to improving safety and accident prevention (NSIA, 2020; TSBC, 2020) the seafarers themselves are a logical audience for the results and outcomes of accident investigations as a form of knowledge transfer. However, utilization of accident investigation reports (henceforth referred to as "accident reports") by sharp-end operators may be inhibited for a variety of reasons. A major contributing factor for failure of dissemination is that reports are too long and are not written in a sufficiently accessible language (Johnson, 2002), whilst information produced by the various investigation stakeholders can be scattered and difficult to use (Vepsäläinen & Lappalainen,

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Mallam, S. C., Wahl, A. M. & Aas, J. (2022). Reintroducing the sharp-end operator to organizational learning: How accident reports are used by maritime officers. *Safety Science*, *147*. DOI: 10.1016/j.ssci.2021.105632

Why Accident Reports?

- Accidents are opportunities to improve through lessons-learned and experience gained (Hollnagel, 2014; Kjellen, 2000).
  - Identify and communicate important safety deficiencies.
  - Create recommendations (MAIIF, 2019; TSBC, 2020).

- Accident investigations and reports are a form of knowledge capture and tool for knowledge transfer leading to learning and future prevention

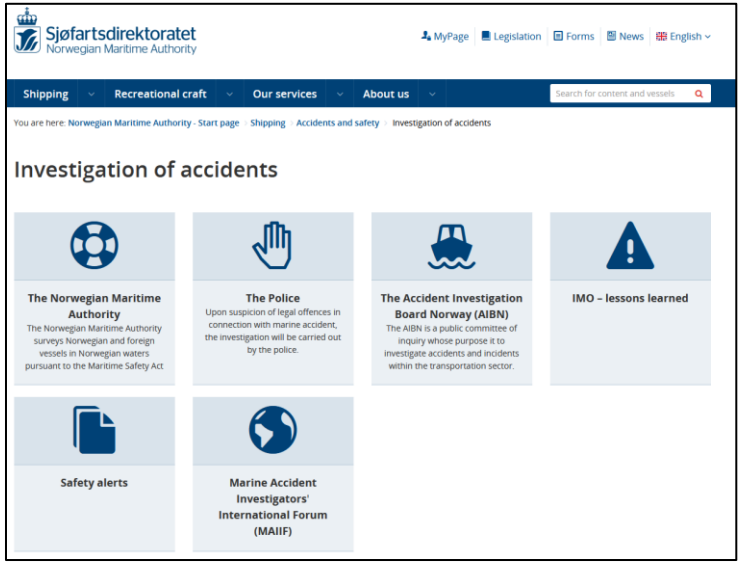
(Dekker, 2014).

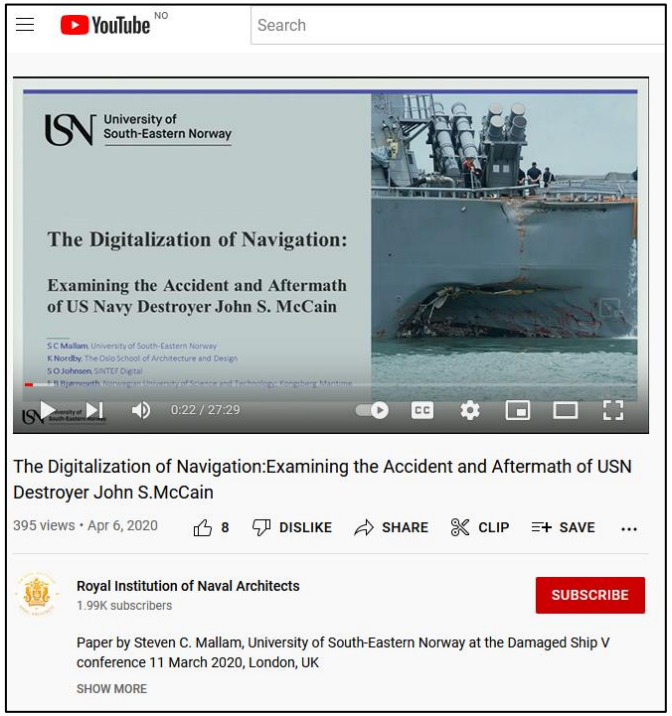
  - Historical "Artefact"

- Accident reports mainly aimed at providing statistics for managers, rather than being a source for learning (ESReDA, 2015).
  - Less research on how they reach and are used by sharp-end operators

(Lindberg et al., 2010; Vepsalainen & Lappalainen, 2010)

    - How to support/increase knowledge transfer???





Using Accident Reports for Learning

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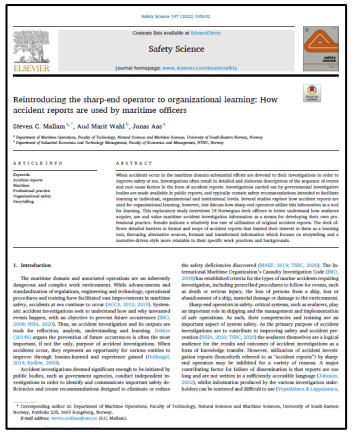
- Context of licensed navigation officers

Research Questions:

- RQ1: How do deck officers ***acquire*** accident reports?
- RQ2: How do deck officers ***use*** accident reports?
- RQ3: How do deck officers ***perceive*** the value of accident reports?

Mallam, S. C., Wahl, A. M. & Aas, J. (2022). Reintroducing the sharp-end operator to organizational learning: How accident reports are used by maritime officers. *Safety Science*, *147*. DOI: 10.1016/j.ssci.2021.105632

Using Accident Reports for Learning


Safety Science

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Highlights:

- How deck officers acquire and use maritime accident investigation information is multifaceted.

- Deck officers report learning from accidents is valuable for professional practice.
  - Professional "identity" plays a strong role in maritime
  - "reflective practice"

- Original reports are seldom read, rather information acquired via adapted material.
  - Employers play a primary role in the dissemination and "transformation" of accident-related information to operators.
  - Media and peer discussions emerge as valuable sources for debate and learning.

- Current report style and format creates barriers for learning amongst deck officers.
  - Prefer storytelling and a narrative-driven style more relatable to their specific work practices and backgrounds.
  - Who/what are the reports for? Intended purpose, intended audience…

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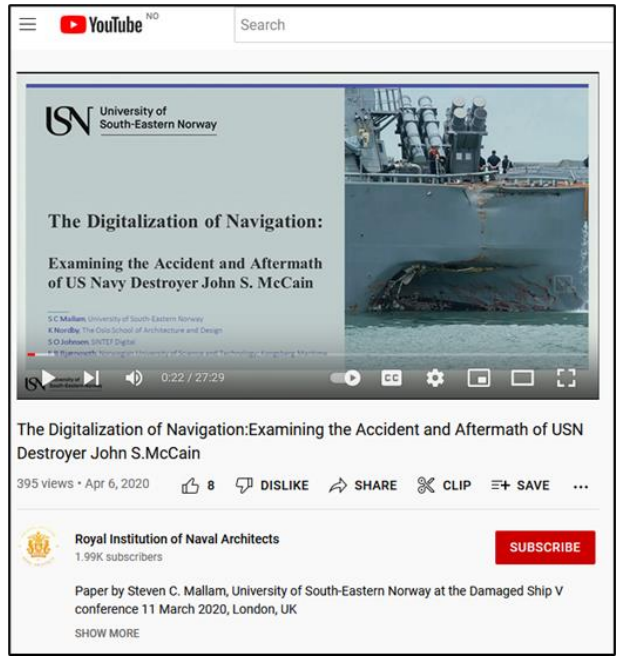
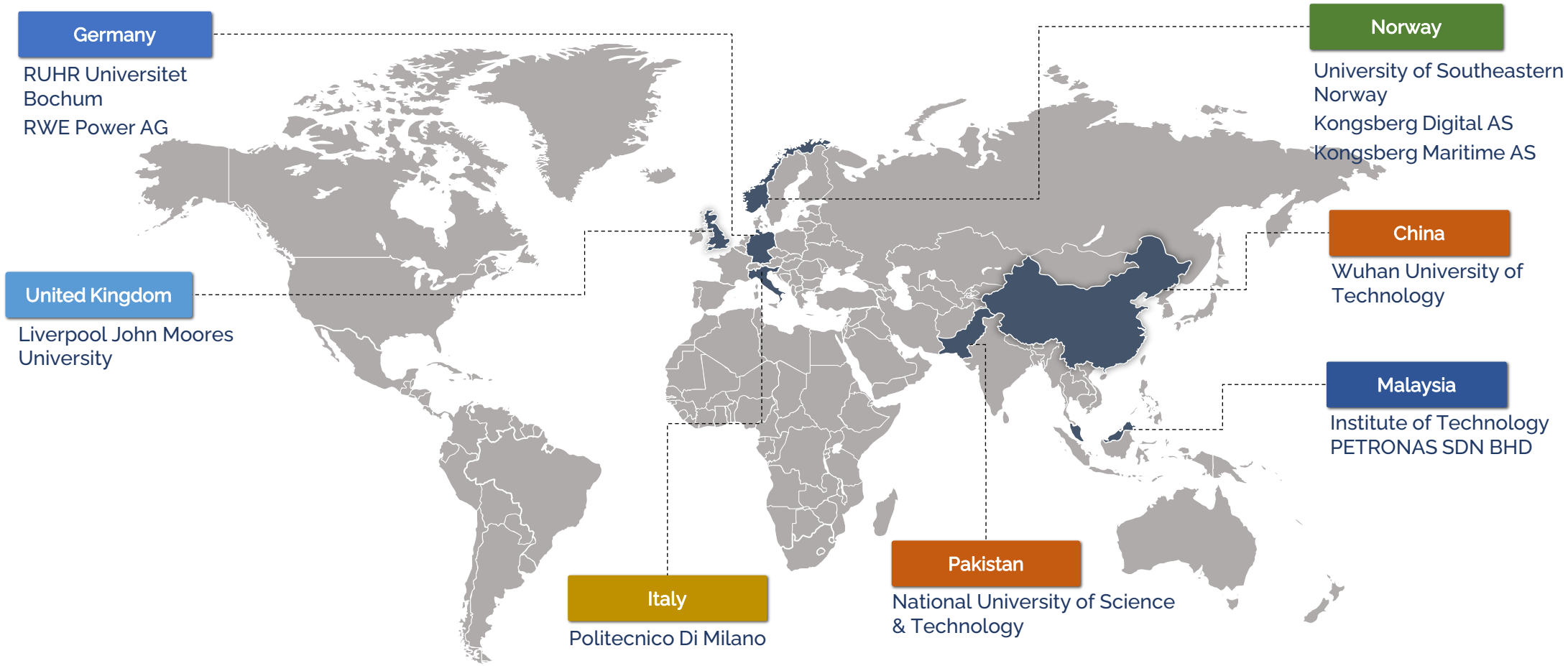
Using Accidents for Learning

- Accident investigations, methodologies and subsequent results have weaknesses and limitations.
  - Reactive vs proactive approaches
- Learning from previous events, and training for known dangers creates cognitive biases (Gaba et al., 2001; Park et al., 2014)
  - Trained repeatedly on specific scenarios, contexts and information - more biased, less resilient to adapt to new or unforeseen events
- Forward facing approaches - "*learning without the incidents*" (Pomeroy & Earthy, 2017)
  - Especially in the context of introducing new technologies





2018-2024

ENHANCE

Enhancing Human Performance in Complex Socio-Technical Systems:
Developing and Implementing NewTraining and Assessment Solutions for Improved Safety

How to Train for Everyday Work - A Comparative Study of Non-technical Skill Training

Gesa Praetorius[1,2(✉)], Steven C. Mallam[1], and Salman Nazir[1]

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Abstract. This paper presents a comparative study of training of non-technical skills in the maritime and lignite power domains. Non-technical skills (NTS) are the cognitive, social and personal resource skills that complement technical skills in operations within high-risk domains. Training NTS is essential to maintain safety in operational contexts, such as onboard a merchant vessel or in the operation of a lignite power plant. Contextual interviews and observations have been conducted across 8 operator training courses, three maritime and five lignite power. The results indicate that the training approaches and their execution differs greatly despite having a common theoretical basis. While training in the observed maritime courses often combined longer theoretical lectures with group exercises and high-fidelity simulations, the focus of the training remained on the use of specific NTS techniques or tools to prevent accidents and incidents. In contrast to this approach, the training in the lignite power domain primarily focused on how to integrate selected NTS into daily operations. While the lignite training also utilized incident examples and shorter lectures, the focus remained on simulating everyday work tasks and to apply newly learned practices as part of routine operations and standard operational procedures. Further, trainees in the lignite training courses were empowered to take charge of their learning processes, as parts of the training let them recreate situations from their work within the simulator. This article highlights lessons learned from each domain with the goal of improving training practices for NTS in high-risk operations.

Keywords: Maritime Resource Management · Crew Resource Management · CRM · Non-technical skills · Safety training · Training simulators

Praetorius, G., Mallam, S. C. & Nazir, S. (2021). How to train for everyday work – A comparative study of non-technical skill training. In Black N. L., Neumann W. P., Noy I. (Eds.) *Proceedings of the 21st Congress of the International Ergonomics Association (IEA 2021)*. IEA 2021. Lecture Notes in Networks and Systems, vol 219. Springer, Cham. DOI: 10.1007/978-3-030-74602-5_74

PROCEEDINGS OF THE 30th European Symposium on Computer Aided Process Engineering (ESCAPE30), May 24-27, 2020, Milano, Italy

Operator Training for Non-Technical Skills in the Process Industry

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[b]*Kalmar Maritime Academy, Linnaeus University, Sweden.*
[c]*Liverpool Logistics, Offshore and Marine Research Institute, Faculty of Engineering and Technology, Liverpool John Moores University, UK.*
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Abstract

The increasing levels of automation have redefined the nature of human-machine interactions in the process industry. The changing nature of work demands that Control-Room Operators and Field Operators are competent with the use of new and emerging methods and technologies in order to perform their tasks safely and effectively. A critical aspect of complex socio-technical systems is the requirement for humans to successfully interact with, and manage, both technical systems and team dynamics of human-to-human operations. Non-technical skills, such as communication, leadership, decision making, and teamwork are considered vital for safety in high-risk domains. Training has traditionally played a crucial role to instill the required technical and non-technical skills to the operators. Recurring training is also necessary for maintaining the knowledge and competencies required to face challenging operational environments. In this paper, four examples of non-technical skills training approaches used by an electric utility company for their operators are presented. This article reveals differing aspects of design and implementation of non-technical skills training in the process industry. It also demonstrates the necessity for research into the analysis of future training needs and assessment methods.

Keywords: process industry, training, safety, simulator, virtual reality

Tusher, H. M., Mallam, S., Praetorius, G., Yang, Z., Nazir, S. & Stock, W. (2020). Operator Training for Non-Technical Skills in the Process Industry. *Computer Aided Chemical Engineering, 48*, 1993-1998. DOI: 10.1016/B978-0-12-823377-1.50333-5

Non-Technical Skills and NOTECHS

- "*The cognitive, social and personal resources skills that complement technical skills, and contribute to safe and efficient task performance*"

(Flin, O'Connor, & Crichton, 2008, p.1)

- NTS originally evolved in aviation in late 1980s
  - Prevalent in nuclear power plants, healthcare and maritime domain

- Became mandatory in maritime training (STCW Manilla Amendments, 2010)
  - Bridge Resource Management
  - Engine Room Resource Management

Aims & Research Questions

- Focus on how NTS are trained in each domain (maritime & lignite power):
  - Aim to identify potential improvements and lessons to learn for NTS training approaches in complex settings.

- The following questions guided the data collection and analysis:
  - How are NTS trained within each of the two domains?
  - What are the commonalities and differences in the training approaches among two domains?
  - What lessons can be learned to inspire NTS training approaches in high-risk environments?

Methodology

- Explorative in nature
  - Observations
  - Contextual interviews
    - w/ instructors and trainers

- **3 maritime NTS training courses (Sweden)**
  - n=65
    - Bridge officers, engineers, deck personnel, Navy officers and reserves, maritime students
    - Approx. 82 hours total observation

- **5 lignite NTS training courses (Germany)**
  - n=18
    - Lignite powerplant control room operators, plant supervisors
    - Each course 4-5 days in length
    - Approx. 50 hours total observation

Overview of Results

Maritime Nautical Courses

- Mixture of teaching methods used:
  - Lectures focused on theoretical concepts of NTS
  - Group discussions
  - Simulator exercises (approx. 2/3 of course time)
    - Heavy weather conditions
    - Fire in the engine-room
    - Equipment not functioning properly, etc.
- All 3 courses used accidents and incidents as examples to emphasize the importance of NTS in operations
- No formative or summative assessment to evaluate the training in relation to the desired learning objectives

Lignite Control Room Courses

- Focused on operator training through:
  - Short lectures (15-30 minutes)
  - Group exercises
    - Decision making, communication and leadership
  - Simulator exercises
    - Focused on technical skill training through simulations rather than NTS training specifically
- Simulation exercises **NOT BASED** on extraordinary, safety-critical or accident scenarios:
  - Normal operations – e.g. regain control and return to normal operations after a low frequency event
- Participatory content generation
  - Parts of the training simulation were based on the trainees' own experience and curiosities.
- No formal assessment framework (Peer feedback)

What Do Trainers Say?

”I am like a conductor for an orchestra – I give them the tools to be able to adapt to each other and to the circumstances”

”Simulators are a tool – it is the participants that create realistic work settings”

”I am not the expert, they are the ones working with the plant, with the equipment everyday, I am just a facilitator”

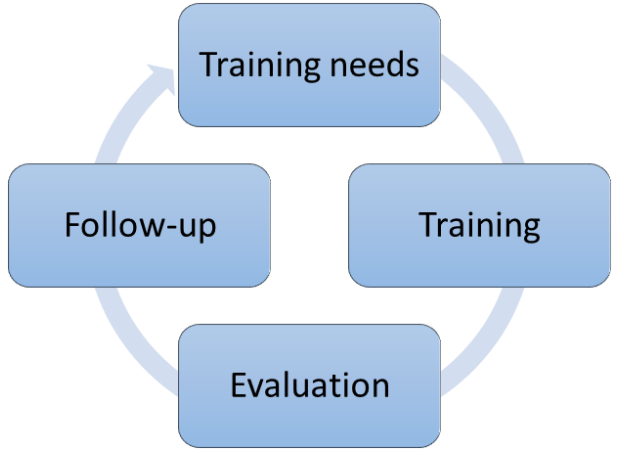
Investigation Outputs

- Despite a common theoretical basis the two domains approach the training of NTS quite differently
- Maritime NTS training focuses on the connection between theoretical knowledge and demanding operations that are typically less common:
  - Addressing the complexity of everyday work in relation to NTS is limited
    - Focus of the simulations and exercises was mostly on how to avoid incidents and accidents through the use of NTS in operations
- The lignite power domain may serve as inspiration
  - More focused on anchoring knowledge on NTS in everyday operations at a plant
  - Focus on three of the NTS: communication, leadership and decision making

An Alternative Example Currently Used

Tusher, H. M., Mallam, S., Praetorius, G., Yang, Z., Nazir, S. & Stock, W. (2020). Operator Training for Non-Technical Skills in the Process Industry. *Computer Aided Chemical Engineering, 48*, 1993-1998. DOI: 10.1016/B978-0-12-823377-1.50333-5

(My) Two Main Takeaways



- **Adopting more "normal" work in training scenarios**
  - More focus on learning from positive examples instead of accidents
    - ”Formalised storytelling"
  - Complexity in everyday work should be utilized more
    - Also less frequent tasks (but non-emergency):
      - Cold start up of plant
      - Docking/Port maneuvering activities
- **Participatory approaches for developing training content**
  - Engaging and empowering trainees
    - Facilitate learning
  - Exploring their personal questions, problems, curiosities
    - Alternative ways to accomplish a task?
    - "*Let’s try it and see what happens*”
  - Implications/appropriateness for trainee skill/experience level: experienced vs. novice?

Journal Article Currently Under Development

- Co-author with Dr. Gesa Praetorius, VTI
- Expanding our simulator training content/curriculum analysis
  - Including additional data sources
    - Additional maritime and process courses from Norway, Netherlands, Sweden, Germany
- Deeper investigation:
  - Across industries (i.e. maritime and energy)
  - Within industries (i.e. differing sectors within maritime and energy)
  - Experienced workers vs. students/cadets
- NTS content
  - Safety I vs Safety II approaches in training
  - Connect training design, structure, followup and role in overall system safety

Further Reading

- Mallam, S. C., Ernstsen, J. & Nazir, S. (2019). Safety in Shipping: Investigating Safety Climate in Norwegian Maritime Workers. In *Proceedings of the Human Factors & Ergonomics Society 63rd Annual Meeting*, *63*(1), 1844-1848. DOI: 10.1177/1071181319631007

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