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Human Factors

International Conference on
Human Factors

26-27 September 2018,
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08.55-09.30 COFFEE & REGISTRATION

09.30-10.05 THE HUMAN FACTOR IN THE DIGITAL AGE, *Monica Lundh, Katie Aylward, Yemao Man, Scott Mackinnon, Chalmers University of Technology, Sweden.* The transportation research community perceives automation as the inevitable end of the ¨evolutionary¨ chain, where the human is removed from the physical displacement of persons and goods. From a consumer perspective, autonomous control of ¨smart¨ ships will require a high level of trust in autonomy, with sanctioned practices from the regulatory environments, before they will be widely accepted. The human operator can never be taken out of the operational loop of such systems. While humans will never advance as quickly as the technology it manages, it cannot be superseded by these technologies. The notion that computer-based technologies should be more than decision support systems (i.e. decision-making systems) must be critically examined. The human factors community still reflect that this increasing and rapid focus on autonomy might be opening Pandora's Box, as it is well recognized that the evolution of technology outpaces the resources the human operator is provided to manage these changes. Is automation the panacea that will maximize safety and efficiency, minimize risk to the environment and guarantee the economic sustainability of the transportation industry?

10.05-10.40 HUMAN ROLE IN SAFETY ON AUTOMATED SHIPS, *Johannes Hüffmeier, Research Institutes of Sweden, Sweden.* Today there is an increasing interest in autonomous vessels and automation within shipping, often with arguments for safety and efficiency. But research from other domains suggests that automation can have unintended side-effects. Instead of increasing safety, automation may undermine people's ability to understand the situation and make decisions, introducing new risks to the process. To conclude that the frequency of accidents will be reduced proportionally to the people removed from the system neglects the dynamics of the socio-technical system and the positive human impact on maritime safety. Although shipping around Åland is not free of accidents and incidents, the system has a very good safety performance. Three main players (Eckerö Lines, Viking Line and Tallink Silja) run traffix in difficult waters, with ice and darkness in the winter months and crowded waters with many leisure boats in the summer. The main purpose of the analysis is to analyze human impact on safe operation and performance of the vessels in Åland's ferry lines. The work is done through in-depth risk identification, comparing identified risks and strengths to different future automation scenarios, with action proposals linked to identified risks.

10.40-11.15 WHAT WAS I DOING? PROSPECTIVE MEMORY ERRORS THE IMPACT OF INNEFECTIVE AND UNRELIABLE AUTOMATION IN FUTURE MARITIME PLATFORMS, *Malcolm Cook, BAE System, UK.* There is an interest in implementing automation to reduce the size of crew complements in moving platforms within the maritime environment. Reducing the number of crew required does not alter the number of concurrent tasks on the boat or ship, which results in a problem. The demands arising from concurrent tasks can result in task switching by operators and task switching is known to be a significant performance issue. Task-switching either at a sensory/perceptual or a response output involves executive functions and is associated with frontal brain regions (Rushworth, Hadland, Paus and Sipila, 2002). Baddeley (2012) in reviewing the history of his model of working memory identifies executive functions as reliant upon a serial processing element and this view is in accord with other extant evidence in the literature for more complex tasks. Performance is slower and more error-prone after task switching (Monsell, 2003) and some of the delays may involve inhibitory processes to stop one task and start another (Koch, Gade, Schuch & Philipp, 2010). Evidence suggests that unpredictable task switching is worse than predictable/scheduled task switching (Kiesel, Steinhauser, Wendt, Falkenstein, Jost, Philipp & Koch, 2010). It is clear that multi-modal task switching may be worse for performance because it engages another modality and context (Strayer and Johnston, 2001).This analysis is supported and illustrated by task analysis and GOMS modelling of task durations. It is argued that prospective memory errors and task-switching costs are likely to have a significant impact on joint system-operator performance, which will increase as the reliability of systems decreases, resulting in the need for operator intervention.

11.15-11.40 COFFEE

11.40-12.15 SEA USER LAB A: A MULTIDIMENSIONAL TOOL FOR HUMAN FACTORS EVALUATION, *Rozenn Coutellier, Chantal Mais, Hugo Nguma, Naval Group, France.* This paper presents tools used for Human Factors evaluation in a Human Centered approach. The purposes of the SEA User LAB in Naval Group, is to enable the evaluation of Human behavior during Human System interaction in order to avoid rejection and increase operational efficiency. By facilitating:The understanding of how humans manage their resources to respond to situation's constraints. On a cognitive, physiological, affective and biological level. The design of devices adapted to user's characteristics and the context of use. The evaluation of physical's constraints on a simulated workstation. At first, we will present this laboratory, dedicated to the evaluation of uses and human behavior in a multidimensional approach (taking into account objectives and subjectives data). Secondly, we will give examples of evaluation use cases with this LAB in: operational situation, Innovative HIS & research (a current Phd study), Future product (Future Operational Control Room). And finally, we will discuss about the anticipated evolution of the laboratory in terms of tools and methodologies, with the goal of setting up a "HF proven" approach. We will then conclude with the opening of this laboratory for collaborations with external clients.

12.15-12.50 IMPROVING MARITIME USABILITY - USER-LED INFORMATION GROUPING ON NAVIGATION DISPLAYS, *Viet Dung Vu, Margareta Lützhöft, Western Norway University of Applied Sciences, Norway.* This paper presents an application of card sorting to study the way seafarers wish to organise and group information on navigation displays. The purpose is to develop a user-led organisation of navigation display data and functions to make them easily accessible for users. Each study participant was provided with a set of 49 cards. The cards represent all essential information elements from the displays of integrated navigation systems. The participants were asked to arrange the cards into groups based on personal judgement. Complete results from 93 participants were analysed using cluster analysis based on the frequency of which items are placed in the same groups across all participants. We identified nine categories of items, each containing a number of smaller groups of one item or more. The categories include system operational status indications, picture presentation settings, measurement tools, anti-grounding and alert management functions, chart display settings, route management tools, own ship data, target data, and settings for target data presentation. The grouping patterns indicate a task-orientation but also artefact-related (e.g. own ship, target).

12.50-13.45 LUNCH

13.45-14.20 SOLAS V/15 - BRIDGING DESIGN AND WORK, *Linda Sørensen, Margareta Lützhöft, Western Norway University of Applied Sciences, Norway.* SOLAS V/15, or Regulation 15 is called "Principles relating to bridge design, design and arrangement of navigational systems and equipment and bridge procedures". This regulation requires owners, naval architects, manufacturers and administrations to ensure compliance with specified ergonomic principles. Regulation 15 also requires owners and masters to ensure that bridge procedures are adopted which take ergonomic criteria into consideration. At present there is no minimum manning requirement for bridge linked to bridge layout. The most important tasks during arrival and departure (including pilotage) are communication, anti-collision and navigation (anti-grounding). Communication is mainly within bridge, within ship, with some between ships and ship to shore. Navigational equipment, whilst a technical matter, is closely related to number of crew and their role/competence. Each equipment require input or actions from the crew during navigation. The number of staff and their competence may be adequate according to the procedures (e.g. company defined bridge levels for different navigation operations, or regulations) but their roles may not permit safe resource management. Design and layout of space may make task sharing difficult or impossible. We will show that bridge layout directly impacts team work

14.20-14.55 DEMONSTRATING A MARITIME DESIGN SYSTEM FOR REALISING CONSISTENT DESIGN OF MULTIVENDOR SHIPS BRIDGES, *Kjetil Nordby, Synne Frydenberg, The Oslo School of Architecture and Design, Norway.* Many ship's bridges may be considered multi-vendor ship bridges that consists of equipment delivered by a large number of different companies. In later years such equipment are increasingly integrated into the workplace as digital user interfaces. However, the design of these new interfaces that is not coordinated across companies or equipment type. This results in workplaces that offer inconsistent user interfaces and suboptimal workflows for the navigators. Although this problem has been known for many years, the industry has been unable to solve it through current regulatory approaches. We propose an alternative strategy to achieve design consistency by applying methods and technologies from the web industry. We do so by asking: How can we establish a framework for designing maritime systems targeting multi-vendor ship bridges?

14.55-15.30 HARMONIZED DISPLAY OF E-NAVIGATION INFORMATION: WORKLOAD AND NAVIGATIONAL CONTROL, *Thomas Porathe, Norwegian University of Science and Technology, Norway, Margareta Lützhöft, Western Norway University of Applied Sciences, Norway.* As a results of the work with the e-navigation concept, IMO is now working on "a harmonized display of navigation information received via communications equipment" (HDNICE). The availability of a multitude of new important, but possibly complex information on the ship bridge will be a challenge for human factors and design as the risk for information overload is salient. This paper suggests a new way of looking at the design of the information environment on the ship bridge. The paper stars with a brief reference to some maritime accidents where a mismatch between the availability of information and human performance can be detected. Using Hollnagel's theoretical constructs of information processing and cognitive engineering the paper discusses the impact of stress on human performance and present how Hollnagel's Contextual Control Model theory can be used to structure equipment and bridge layout based on operator workload. The intention is to advance HMI design and integration of bridge equipment based on different workload levels.

15.30-15.55 COFFEE

15.55-16.30 THE IMPLEMENTATION OF E-NAVIGATION SERVICES: ARE WE READY?, *Katie Aylward, Chalmers University of Technology, Sweden.* Advanced technologies and services are being developed to improve safety and efficiency of navigation at sea. The Sea Traffic Management (STM) EU Project is one of the largest e-Navigation projects examining the digitalization of the shipping sector. The "STM Tools" are newly developed services that allow ships to share their intentions and routes with other ships, Vessel Traffic Services (VTS) and shore centers. These tools also allow ships to receive navigational warnings, ETA updates, and chat messages from shore center services. The European Maritime Simulator Network (EMSN), consisting of nine EU countries, examines the potential impact of these services through full scale simulations with scenarios involving twenty-nine ships, exploring the feasibility of implementing the STM Tools in real life. Four weeks of full scale EMSN network simulations with seafarers were completed comparing navigation as it is today with navigation using STM Tools.

16.30-17.05 CONTOURS OF A ROADMAP FOR DEVELOPING SCENARIOS FOR THE WORLD OF AUTONOMOUS OCEAN SYSTEMS, *Sashidaran Komandur, Thomas Porathe, Norwegian University of Science and Technology, Norway, Margareta Lützhöft, Western Norway University of Applied Sciences, Norway.* The authors of this paper identify broadly three approaches being taken with regard to predicting developments and anticipating changes in the world of autonomous ocean systems. An expert driven approach, where experts from different domains (technical, legal, human resource etc.) gather for workshops/conferences and take a discussion and consensus based approach to predict how this new world of ocean systems is likely to look like. A second approach is to actually build a prototype (an expensive but a comprehensive approach) such as the Yara-Birkeland autonomous ship project. A third approach is to test out various operational/navigational situations in full scale high fidelity simulators. A common thread amongst all these three approaches is the need for a background story (or) a scenario. It is safe to say that such a scenario must be reasonable to be of any worth in predicting the transition from our current ocean system to this new world of autonomous ocean systems. Yet the systematic approaches to identify these scenarios if any/many aren't yet detailed as a resource for researchers and developers alike. In this paper it is our endeavor to detail atleast one such approach so that there is a clear and systematic path to develop suitable scenarios for testing autonomous ocean systems concepts.

17.05- GENERAL DISCUSSION & EVENING DRINKS RECEPTION

08.55-09.25 **COFFEE & REGISTRATION**

09.25-10.00 **SURVIVABILITY, ESCAPE AND EVACUATION SYSTEMS,** *Dennis Barber, CHIRP Maritime, UK.* The Proposed paper will look at existing systems, lifeboats, liferafts, Marine Evacuation Systems and other potentially innovative methods of escape and evacuation from a ship. The main considerations will be whether such systems are trusted sufficiently by crews and others such as passengers to enable their effective deployment. It will also consider the main issues faced during deployment and whether the regulation approach has sufficiently allowed for the eventualities that are likely. The main view taken is from the end user's perspective but will also examine the links between end users and designers and regulators and whether such links are effective in earning the trust of the users. The experience of the author crosses the boundaries between ship and shore management as well as regulator and is more than just a classic seafarer's perspective. Sufficient sea experience, including command ensures that this perspective is fully understood, albeit tempered by an extensive knowledge of the limited options experienced or perceived by operators.

10.00-10.35 **EVACUATION ANALYSIS OF CARGO SHIPS IN FIRE SITUATION FROM COMPUTATIONAL SIMULATION BASED OF HUMAN FACTORS,** *Andrea Rozendo Moreira, COPPE, Escola Politecnica, Brazil.* Throughout history, offshore accidents involving high percentages of fatalities have shown that an effective evacuation is the last line of defense to avoid catastrophic results. The growth in the number of passenger ships with capacity for thousands of people has driven evacuation issues to the center of attention of the naval sector. For almost two decades, ensuring that sufficient time for people on board cruise ships to be safely evacuated is required by law. However, such certification is not required for merchant shipping cargo ships, although the development of the oil industry and globalization have produced a significant increase in the number of casualties in accidents involving this type of vessel. This paper intends to demonstrate that existing and widely used computer models of passenger ships can be adapted for application in cargo ship projects, helping to evaluate risks and the complex decision making process associated with emergency evacuation. Since fires are the most frequently observed accident in naval voyages, the integration between fire simulation and evacuation tools applied to an oil tanker shall be used for this purpose.

10.35-11.10 **IDENTIFYING UNDERLYING FACTORS CAUSING TASK DEVIATION WHICH LEAD TO DANGEROUS SITUATIONS AT SEA,** *Asanka Rajapakse, Gholam Reza Emad, University of Tasmania, Australia.* Task deviation has been identified as one of the major sponsoring human elements contributing to maritime mishaps. Task deviation is defined as momentary non-engagement in a task resulting in the task not being carried out as per standard procedure by a seafarer. A dangerous situation is inevitable if the period of the deviation from the desired task is long enough to render the reaction time insufficient to take back control of the situation. Understanding why task deviations occur among seafarers is crucial in determining how they can be prevented or recovered from in an appropriate time period which could positively assist in implementing controls to reduce maritime accidents. This paper presents findings from a pilot study as an initial part of wider research which qualitatively investigates why in the maritime domain work as imagined is different from work as done. Six underlying factors causing task deviation which lead to dangerous situations at sea are presented as outcomes.

11.10-11.35 **COFFEE**

11.35-12.10 **APPLICATION OF FUZZY COGNITIVE MAPS TO INVESTIGATE THE CONTRIBUTORS OF MARITIME GROUNDING ACCIDENTS,** *Beatriz Navas, Rafet Emek Kurt, Osman Turan, University of Strathclyde, UK.* Traditionally, an accident was defined as a detrimental event which results in damage humans, assets and/or the environment, hence, a safety increase is a decisive requirement. Historically, the maritime sector has been characterized for introducing new safety measures after an accident occurs, i.e. the (ISM) Code after the Herald of Free Enterprise accident, however, within the last decades a new trend was presented which aimed to switch to which is called Safety-II, focused in both what goes right and what goes wrong, defining safety as the ability to succeed under varying conditions. Safety-II is based on resilience engineering concepts, and the development of resilient systems and abilities has a big potential to improve safety within maritime. This paper aims to assess the factors affecting grounding accidents for increasing safety and resilience by using Fuzzy Cognitive Maps (FCMs), which calculates and evaluates the individual weight of the factors involved in grounding. FCMs appear to be a suitable approach for identifying these factors since it can deal with both, fuzzy data and past accidents experiences, hence, past accidents from the Marine Accident Investigation Branch (MAIB) database are analyzed to identify the contributors involved. The result section do not go beyond this identification.

12.10-12.45 **HUMAN FACTORS INVESTIGATION IN MARITIME INCIDENT ANALYSIS FOR IMPROVED SHIP SAFETY: AN INNOVATIVE APPROACH BASED ON SYSTEM THEORY,** *Paola Gualeni, C. Bongermino, University of Genoa, Italy.* Notwithstanding an increasing trend toward the proactive safety approach, the effort to learn from incident is still at the base of ship safety. In this paper the complexity of Human Factors and safety issues implications will be addressed by means of the STAMP*/CAST** approach, that is already increasingly applied to this aim in several fields like aviation, defense, healthcare, but not yet in the maritime field (* STAMP= System-Theoretic Accident Model and Processes; ** CAST= Causal Analysis using System Theory). Accidents reports are usually written from the perspective of an event-based model in order to describe the events and identify the root cause(s). However, it is very frequent that the analysis of why those events occurred is incomplete, because it stops after finding someone to blame, usually a human operator, and therefore in some occasions the opportunity to learn important lessons is lost. CAST can provide a framework to understand the entire accident process and identify the most important systemic causal factors, including the systemic socio-technical ones, since it provides the capability to spot weakness in existing safety control structure and elucidate possible improvement. The application of CAST in the maritime field will be discussed, thanks also to a selected representative incident, with focus on its effectiveness in assessing the complex Human Factors interaction with the ship safety control structure and in providing input to continuously enhance the ship safety and the ship resilience by design.

12.45-13.40 **LUNCH**

13.40-14.15 **ADOPTING NEW TECHNOLOGIES - REDUCING RISK OR INTRODUCING NEW THREATS,** *Vaughan Pomeroy, University of Southampton, UK.* The global demand for maritime transport continues to evolve as the new world order is established. The maritime industry is introducing new technology at an increasingly rapid pace. The capability that is available has advanced quickly but the pace of change in the maritime sector is hastened by challenges for reducing costs and improving environmental performance. The likelihood is that future changes will be based on disruptive solutions. The introduction of novel solutions can deliver significant benefits but also bring unexpected outcomes. The paper considers the evidence from past introduction of new technology and the associated risks. With the human element, generally limited to the performance of seafarers, featuring prominently amongst the causes of incidents the proponents of increased use of automation often suggest that removing the people will lead to a reduction in risk. The paper considers whether adoption of novel technologies could introduce new threats that will place unrealistic demands on the people in the system, recognising that the human element in also a major contributor to risk mitigation. The issues discussed relate to the human element at organisation and individual levels, encompassing the whole life cycle - concept, design, construction, maintenance and operation.

14.15-14.50 **SOME ERGONOMIC ISSUES OF DP VESSEL CONTROLS,** *Meyrick Hadfield, Health and Safety Executive, UK.* A semisubmersible DP drilling rig lost control of position for several minutes. During this time it was obliged to shear the drill pipe and disengage the lower marine riser package, LMRP. The initial loss of control was due to accidental disengagement of the DP system. The crew immediately noticed loss of position but did not appreciate that DP was disengaged. They initially believed there was a technical fault with the DP and it took 6 minutes before they realised the DP was disengaged. Both the loss of position control and the inadequate initial crew response were due to poor ergonomic design of the control system. Firstly, the button for transfer from DP to manual control was not protected against accidental operation. Secondly, there was no clear indication at the DP desk that DP was no longer engaged, and that the vessel was then under manual control.

14.50-15.25 **FROM STEM TO STERN - SAFETY STARTS WITH DESIGN,** *Helle Oltedal, Margareta Lützhöft, Western Norway University of Applied Sciences, Norway.* The objective of a safety management system is to create and support an organisational process based on individual learning from operations, to discover system flaws and weaknesses - such as poor design - to prevent future accidents and failures. A significant, but largely unrecognised, contributor to many accidents and incidents are the misconceptions that marine engineers and designers tend to have of the boundaries of safe operation as well as about design and its rationale. An efficient safety management system should incorporate knowledge about how misconceptions and poor design have contributed to incidents and failures. The maritime community should have mature safety management systems by now; where risk and hazards are relatively well known quantities, the accompanying safety measures have been tested over time, and work in accordance with their intention. Despite that, shipping companies are repeatedly facing the same risks and hazards, which raise the question why safety management systems do not work as intended. By using the example of Hoegh Osaka incident, we argue that a fundamental weakness of current safety management is that managers do not address the core nature of these risks in their development of safety measures. Human error is still far too often used as a causal factor with following safety measures as new procedures and checklists, instead of improving poor design. We also argue that one critical factor is the lack of seafarers' participation in management of SMS, and introduce the concept of user/human centered safety management

15.25-15.50 **COFFEE**

15.50-16.25 **VIRTUAL REALITY FOR VESSEL WORKSPACE DESIGN,** *Ken Goh, Knud E Hansen Australia P/L, Australia.* Naval designers and operators can often underestimate the practicalities and demands of man and machine space requirements in their never-ending quest to optimise vessels into the smallest possible package. As a result, crews and operators are becoming increasingly frustrated at work spaces that do not function correctly due to insufficient space, poorly arranged equipment and lack of spatial comprehension. What might seem to work on a computer screen or on paper may not work as intended when built and in operation. This paper demonstrates, through a number of examples, how ShipSpace Virtual Reality tools has enabled naval architects at KNUD E HANSEN to more effectively design vessel workspaces. Proven benefits include better collaboration and shortening of the design process, improved accuracy compared to legacy simulation systems and physical mock-ups, and proving team operations through group user testing. By designing with the aid of ShipSpace VR, rework costs are reduced and work spaces are can be more comprehensively designed to ensure optimised solutions.

16.25-17.00 **TAKING A HUMAN PERSPECTIVE ON MANNING EFFICIENCY AND WORKLOAD ON BOARD CHEMICAL TANKERS,** *Stephanie Mclay, Lloyd's Register EMEA, UK.* Lloyd's Register's (LR) Human Factors team is currently undertaking a project to investigate crew performance and efficiency on board chemical tankers. The aim of which is to determine an optimised on-board manning structure for selected shipping routes and vessels with due consideration of seafarer performance and fatigue in accordance with ILO MLC and STCW guidance. This paper describes the work undertaken to date, and presents some interesting observations and human factors considerations identified on board. In addition, early conclusions from the project are discussed. LR performed a detailed review of the company's procedures before embarking on a number of vessels. On each vessel visit detailed personnel interviews were conducted, subjective workload assessments were recorded and task-related observations were made. All operational activities were included in this project: e.g. Cargo operations, Tank Cleaning, Planned and Unplanned Maintenance, Paperwork, Navigation, Pilotage. Manning and workload-related issues were recorded in a Human Factor's Issues Register (HFIR) to inform an efficiency analysis. Using this data, LR developed detailed scenario-based activity maps for the operational activities on-board, detailing the associated roles and responsibilities of officers and crew and team dynamics - mapped using the RASCI model. Specific activities with high or low workload and those with barriers to efficient operations were also identified. Although still underway, LR is able to share some initial results in this paper. Ongoing work will test out the feasibility of potential changes to the manning structure across the vessel in light of the operations and safety risks already identified.

17.00 - **GENERAL DISCUSSION**

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