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# THE ROLE OF HUMAN FACTORS IN MARITIME CASUALTY INVESTIGATION: PAST, PRESENT AND FUTURE

## 1. INTRODUCTION

Accidents at sea have occurred since man first set sail. The nature of shipping has changed substantially since then, progressing from boats and sailing ships to steam ships and modern day highly specialized ships (e.g., ro-ro ferries, car carriers). The physical environment, however, has not changed and ships still encounter frequently changing atmospheric and oceanographic conditions.

After an accident, there is an inclination to swiftly attribute it to a simple main cause, in a struggle to find an outlet for grief or dismay, and/or to find someone in particular to blame. Accidents at sea, however, are rarely intentional (i.e., the master and the crew do not aspire to have an accident) and therefore accident investigations need to move away from a blame seeking culture.

The human factors discipline attempts to apply the natural laws of human behaviour to the human element operating within the working environment. The aim is to maximize safety, efficiency and comfort by designing equipment and layout of workplaces to the physical and psychological capabilities of the operator. It is also a concept that focuses on how people work and cope (Stanton 1994).

## 2. THE EVOLUTION OF HUMAN ERROR RESEARCH IN ACCIDENTS AT SEA

Statistics on accidents at sea have been collected since the last century. It has now become generally accepted that more than 80% of all accidents at sea are caused by human error. The origin of this statement can be traced back to the late 1970's (Gray 1978) and has been discussed elsewhere in detail (Barnett 1989). These early studies suggest that researchers tried to find solutions to human factors' problems by employing the same methodology used for problems resulting from situational factors. Consequently the human element in casualty reports was examined in detail and the most significant group labelled 'human error'. Initially little further

analysis, other than stating this all-encompassing category, was carried out. It soon, however, became apparent that to introduce accident reducing measures would require a deeper analysis of the factors that induced 'human error'.

### 3. HUMAN FACTORS ON THE SHIP'S BRIDGE AND A LOOK BEYOND HUMAN ERROR

The working environment of the ship's bridge can be broadly divided into two components, the organisational framework and the physical environment of the ship's bridge and associated situational/ navigational activities.

The organisational framework is directly influenced by international conventions or resolutions adopted by the International Maritime Organization (IMO). Its primary role is to develop and adopt regulations to improve safety of international shipping and prevent pollution from ships.

The physical environment can roughly be divided into settings inside and outside the ship's bridge. Settings inside the ship include the physical layout of the bridge, the design of hardware and related information processing. The exterior environment includes the atmospheric and oceanographic conditions and natural hazards that the ship may encounter during its passage.

The concept of navigation has remained largely the same since the introduction of steam ships. The navigating officer's main responsibility is still to determine the position of the ship and avoid collisions. His working environment is further characterised by longer than average working periods (often weeks or months), unconventional working hours and days, and regular and extensive operations during the hours of darkness. Additionally navigation periods of intense activity may be interspersed by periods of relative inactivity.

The individual navigating officer has clearly little direct control over his working environment (shown in figure 1). An error made by an officer resulting in an accident should therefore not be regarded in isolation, but in relation to other factors influencing the navigational system.

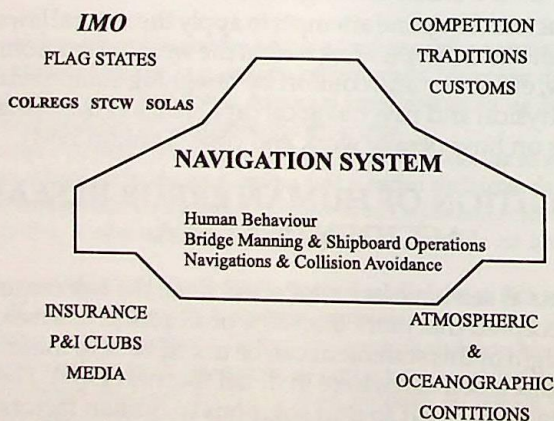


Figure 1 Major factors influencing the human element on the ship's bridge

The relationship between human factors, human errors and causes of accidents at sea is complex and often difficult to appreciate. Human error is likely to be present in the working environment on the ship's bridge, even if it would be operated legally unmanned. The error here would shift to originate completely outside the bridge environment (e.g., design of equipment). To reduce future accidents the shipping industry must move away from focusing on error reducing measures alone, to employing recognised human factor's techniques to design the working environment of the ship's bridge so that it helps the navigating officer to avoid accidents.

#### 4. MANAGING SAFETY AT SEA

Traditionally the shipping industry has relied to a certain degree on the operation of market forces to manage safety at sea. For instance, it was noted in the early mid 1830s that the system of marine insurance protected the shipowners from excessive loss. This allowed them to take less care in the construction of ships, less efficiency in their equipment and less security for their adequate management at sea (House of Commons 1836).

The introduction of steam ships resulted in a growing concern within maritime governments for safety at sea due to the increasing number of collisions which seemed to have resulted from the lack of common rules for overtaking, crossing and meeting end-on (Gray 1867). This led to the introduction of the first international collision regulations adopted in 1863 (The Merchant Shipping Act Amendment Act 1862). Other safety related regulations imposed by the maritime governments are, for example, Plimsoll Lines (Merchant Shipping Act 1876) and the International Convention for the Safety of Life at Sea (SOLAS) first introduced in 1914 as a result to the sinking of the *Titanic* in 1912.

The management of the theory and practice of safety at sea must not only focus on the introduction and implementation of international rules and regulations. The underlying principles must be specific, functional relationships must be determined and sufficient research carried out to quantify various components in terms that will allow them to be properly incorporated into a safety strategy (Goss 1989). This requires a more scientific approach and involves identifying the effects of safety measures, quantifying them in physical terms and evaluating them in economic terms.

It is, as yet, difficult to identify the effects of safety or evaluate them in economic terms. Nevertheless, it is suggested that attempting to quantify components that may affect safe navigation is reasonable. Safety at sea is often considered in broad terms, i.e., accidents to all ships are included. The results are likely to provide general answers, i.e., what happened. Knowing what happened is mostly sufficient to propose universal changes in regulations or technology with view to reduce the number of accidents at sea (e.g., SOLAS).

IMO has recognised that a common approach and cooperation between States will aid remedial action. In order to promote a common approach to the safety investigation of accidents at sea, it recently adopted a code for the investigation of accidents and incidents at sea (IMO 1997). This Code provides guidelines to assist investigators in cooperating in accident investigations. Guidelines for investigating human factors have also been proposed, including a list of topics which should be

considered by investigators and procedures for recording, and reporting the results (IMO 1998, Marine Accident Investigators International Forum 1999).

## 5. HUMAN FACTORS IN CASUALTY INVESTIGATION

After the event, an accident at sea may be investigated by several different organisations (e.g., Coastal State, Flag State, P&I Club, etc). This usually takes the form of describing the course of events and identifying the main causes of a particular accident. Rasmussen (1990) suggests that the identification of accident causes depends on the aim of the analysis, i.e., whether the aim is to:

- Explain the course of the events
- Allocate responsibility and blame
- Identify possible system improvements

As previously noted, in the aftermath of an accident at sea, there is a tendency to look for someone to blame. As a result the investigation often focuses on specific errors and perhaps overlooks situations or problem areas that may have provided pathways to the accident.

For example, the grounding of the *Exxon Valdez* (National Transportation Safety Board 1989) attracted worldwide attention from the media which primarily focused on the master of the ship. The fully laden U.S. tankship *Exxon Valdez* grounded on Bligh Reef in Prince William Sound, Alaska on March 24, 1989 resulting in the largest oil spill in U.S. history. The official report published by the National Transportation Safety Board (NTSB) argued, among others, that the intoxication of the master was a major factor in causing the accident. This notion was based essentially on the results of speech analysis. The report and the ensuing media attention is likely to have ensured that in the public mind ten years later, the blame remains with the master (Faith 1998).

It is not intended here to argue the merits of the technique of speech analysis for the determination of possible intoxication, nor to criticize a very comprehensive and thorough report, but to examine factors affecting the human element that perhaps received less attention. There is, for example, another possible explanation to the master's speech patterns, i.e., that it resulted from a deep emotional shock caused by the grounding itself. Particularly as the master was not onboard the bridge at the time immediately before the grounding.

Consequently, his performance is likely to have had a lesser, *direct* effect on the outcome of the events. This fact does not exonerate his behaviour, but draws attention to other factors which may also be relevant, e.g., why did he feel sufficiently confident to leave the third mate in charge? It should be noted that the third mate had served 6 trips on the *Exxon Valdez* with this master and one trip with a relief master. He had also served previously about two years as third mate on five other Exxon vessels.

Other data extracted from the *Exxon Valdez* report show that the Vessel Traffic Centre (VTC) agreed to the diversion from the traffic lanes to avoid ice which eventually led to the grounding on Bligh Reef. This was an accepted practice as evidenced by the tankers *Arco Juneau* and the *Brooklyn*, which deviated around the ice, the evening before and the same morning, respectively.

Examination of the interaction of the human element and the steering control system of the ship is considered essential from a human factor's point of view. The

*Exxon Valdez* was equipped with a centralized multi computer integrated steering control system. Four steering modes were available: (1) Helm, or hand steering (2) Gyro, or automatic pilot (3) NAV mode and (4) Rate-of-turn mode.

The role of human factors in the main events leading to the grounding is summarised in Table 1. The summary shows that the total time from when the master left the bridge until the grounding was approximately only 20-25 minutes.

A simple human factor's analysis of the summary indicates that there are at least two possible reasons for the third mate's inability to bring the vessel safely around the ice: (1) he began the swing to the starboard too late, or (2) that the autopilot was still engaged and therefore the helmsman's application of the helm did not engage the rudder.

The NTSB report states that carrying out the proposed manoeuvre involved careful navigation and frequent position fixing. The master had made well over 100 trips through the Prince William Sound which may have resulted in a certain degree of complacency and over confidence. He may not have realised that the third mate did not have sufficient experience to carry out the proposed manoeuvre on his own. On the other hand, the master also expected the third mate to hand over the watch to the second mate. It must also be noted that according to Exxon company regulations, the master or chief mate should have been in charge of the watch, when the vessel was navigating through confined or busy waters.

Examining the above scenario from a human factor's point of view, the following should be considered:

- (1) Design of User interface - The course recorder suggests that the steering may have remained in gyro mode. The steering could easily be switched between gyro and helm without providing appropriate feedback (e.g., sound). The report does not state clearly the extent of sleep deprivation, but it is accepted that fatigue can result in substantial decline in performance (Neville et. al. 1994). Thus if the third mate was fatigued, he was more likely to make a mistake, i.e., not note consciously whether the autopilot had swithed to manual helm as intended.
- (2) Manning - The *Exxon Valdez* operated with a reduced crew complement approved by the Coast Guard. The minimum crew requirements had been established for the Valdez-Panamanian trade but the vessel was now operating regularly between Valdez and ports in California. This trade was more demanding due to more frequent port calls, and it is possible that a re-evaluation of the manning requirements would have been useful in reducing the risk of fatigue.
- (3) Onboard supervision and management - Traditionally training has focused mainly on navigation and other shipboard skills and to a lesser degree on formal training in managing people, understanding human factors, fatigue management, evaluating other crew members' experience/skills or managing reduced crew complements.

Table 1 Summary of the events leading to the grounding of the Exxon Valdez

(1)	The master asked the helmsman to steer 180° and engage the automatic pilot. The helmsman pressed the gyro button to engage the automatic pilot.	<i>Why did the master leave it on automatic? How long did he intend to steer it on automatic?</i> <b>Time 23.39</b>
(2)	When the helmsman was relieved he advised the third mate that the vessel was steering on automatic pilot.	
(3)	The third mate acknowledged this but did not expect this as the vessel was not normally operated in automatic mode when navigating in traffic lanes. He did not discuss this with the master.	<i>Why didn't 3M query the decision to operate the vessel on automatic?</i> <b>Time 23.50</b>
(4)	The third mate decided not to call the second mate as scheduled but decided to remain on watch until the vessel was clear of ice.	<i>Was 3M over confident? Was it typical?</i>
	The master asked the mate whether he felt 'comfortable' to continue on his own to which the mate replied that he did.	<i>Master accepted 3M's response</i>
	The third mate then went to the steering stand and pushed the hand steering button. The helmsman claims he observed the indicator illuminated showing it was engaged.	<i>Conflicting information on whether the manual helm was engaged. When in auto mode the steering wheel is electrically disconnected during gyro mode and may be turned without affecting the steering or causing any alarms to sound!</i> <b>Time 23.55</b>
(5)	The helmsman offered two different versions (1) he was unable to recall whether it was in automatic when he arrived on the bridge and (2) that it was in gyro mode and when he was going to push the hand steering button the third mate pushed the button as well.	
(6)	The third mate ordered the helmsman to put the rudder to right 10° - he did not recall watching the rudder angle indicator to ensure that the rudder was actually applied.	<i>3M did not confirm visually the rudder angle</i>
(7)	He phoned the master to inform he had started to turn the vessel. He was standing with his back to the rudder indicator. The master asked whether the second mate had arrived on the bridge. He was informed that the second mate had not been called.	<i>3M was unable to confirm visually the rudder angle.</i>
(8)	The third mate then went to the port radar to check ranges and noticed that the vessel had not moved to the right and the heading had not changed.	
(9)	The third mate then ordered rudder increase to right 20° and then hard right rudder.	
(10)	He then called the master and said 'I think we are in serious trouble'.	<b>Time 00.05</b>

## 6. MARINE HUMAN FACTORS CLASSIFICATION

After the accident, the first priority is generally to develop measures that will ensure that a similar accident cannot occur again. To this end the accident is generally viewed singularly, i.e., what recommendations for system improvements can be proposed based on the investigation of a single accident such as the grounding of *Exxon Valdez*.

Research is needed to provide information to improve management of the theory and practice of safety at sea. Accidents grouped together provide a broader base for analysing common denominators and perhaps trends and the effectiveness of preventative measures over a period of time. The more detailed an investigation, the more useful data it can provide. The type of information available from a singular accident report was outlined in the above example.

Analysis of accident groups is generally based on final reports which may have several disadvantages:

- The report is edited and relevant data may not be included
- Data may be missing, perhaps because its importance was not realised during the investigation
- Lack of consistency, e.g., time of accident, number of people onboard the bridge, etc. may not have been recorded in each individual report

Traditionally analysis of accident groups has been based on some form of causal groupings. Based on such groupings used by other researchers, the actions of the second mate in the collision between *Galaxy* and *Alam Tenggara* could be grouped under causes shown in Table 2.

The Malaysian cargo vessel *Alam Tenggara* collided with the fishing vessel *Galaxy* early in the morning of 6 September 1996 off high Peak Island, Queensland, Australia. The *Alam Tenggara* was overtaking the *Galaxy* on a similar course and had the duty to stay clear of the fishing vessel. The report shows that they were probably converging at an angle of about 20°.

The report concludes that the 2nd Mate on *Alam Tenggara* did not make full and effective appraisal of the situation and the risk of collision. The ship was equipped with radar, ARPA and a separate look-out as required by the COLREGS (Rule 5). Knowing that the 2nd Mate did not appraise the situation and risk of collision correctly does not explain why he failed to avoid the collision. The report shows also that he was well aware of the other vessel approximately 80 minutes before the impact.

Table 2 Causal groupings of 2nd Mate's actions

Published Reference	Causal Groups
Quinn P.T. & Scott S.M., (1982), <i>The Human Element in Shipping Casualties</i> , 2T 550/551/552, The Tavistock Institute of Human Relations, London	Rule Violation/Use of equipment
Tuovinen P., Kostilainen V. & Hämäläinen A., (1984), <i>Studies on Ship Casualties in the Baltic Sea 1979-1981</i> , Baltic Sea Environment Proceedings No 11, Helsinki Commission	Human Factors and Actions
Wagenaar W.A. & Groeneweg J., (1987), <i>Accidents at sea: Multiple Causes and Impossible Consequences</i> , International Journal of Man-Machine Studies, 27, 587-598	Cognitive and Situational System
Wagenaar W.A., Groeneweg J., Hudson P.T.W. & Reason J., (1993), <i>Promoting Safety in the Oil Industry</i> , Ergonomics Society, 7.1-7.24	Navigational/Situational

Table 2 shows clearly that existing causal groupings provide data of limited practical value, particularly for recognising the role of the human element. Existing

causal groupings and classification frameworks are useful for identifying and categorising what happened, i.e., the origin and type of decision or task that led to the accident. From a practical point of view, to improve proposed measures to prevent further accidents, where it happened is considered a stepping stone to further examining why it happened. Where it happened shows the situation or problem area associated with the mistake e.g., the second mate did not assess the situation correctly.

In an attempt to overcome the limitations of existing accident report analysis and other research into safety at sea, an alternative approach for research was considered. The study focused on situations on the ship's bridge WHERE problems occurred, i.e., situations which may have provided pathways that resulted in a grounding or collision. Data was collected primarily from the following sources: (1) 98 published accident reports (from seven different countries) and (2) 105 Marine Incident Reporting System (MARS) reports.

The basis of the study was to combine the theories of examining causal factors and task analysis into a method which would show situations and problem areas. These situations were termed 'catalysts' and defined as factors in a chain of events that may provide a pathway for an accident to occur. More than one 'catalyst' can therefore be assigned to each accident.

The 'catalysts' were derived through carefully noting problem areas rather than being based directly on the reporter's conclusions. They were first extracted directly from the accident reports and then listed under an appropriate sub-heading. The 'catalysts' were grouped initially under 17 sub headings eventually grouped under 6 main headings as shown in table 3.

The MARS reports were initially grouped into three navigation related categories, i.e. crossing, overtaking and communications. 'Catalysts' were then extracted using the above method. As far as can be ascertained the MARS reports have not been analysed in this manner before.

Applying this marine human factors classification scheme to the grounding of the Exxon Valdez suggested two principal 'catalysts' (shown in Table 4):

Table 4. "Catalysts" extracted from the Exxon Valdez Report

Problem Area/Situation	"Catalyst"
It was possible to turn the wheel when in auto mode with no effect on steering and no alarm	User interface
The master left 3rd Mate alone in charge of the watch	Did not fully assess the situation

Further examination of the 98 accident reports shows that there were 5 other incidents where the design of the user-interface of the steering control system had been a problem area (e.g., the autopilot changeover could be operated by the helmsman without knowledge of the pilot or the autopilot did not sound an alarm when the turn was not carried out when operated in NAV mode).

Problems relating to user interfaces have been indicated in previous studies but these have not shown which user-interfaces may have caused difficulties. A systematic approach focusing on problem areas can show 'trends' such as problems with steering control systems.

*Table 3. Authors' classification of 'catalysts' grouped under 6 main categories (A-F) and 16 sub headings. 'Catalysts' have further been identified and coded within their main category.*

A HUMAN PERFORMANCE	C6 VHF agreement resulted in incorrect manoeuvre/not agreeable advice
1. Assumptions	C7 VTS did not provide information/advised delay
A1 Assumed other vessel's intentions	C8 Poor VHF transmission
2. Error of Judgment	C9 Use of different VHF channels by different classes of ship
A2 No collision had both ship's maintained course and speed	C10 Different language
A3 Mistook position/land marks	C11 Same language
A4 Incorrect change of course/Passing too close	C12 Failed to impart urgency
A5 Failed to assess course and manoeuvre of other vessel	C13 No sound signals
A6 Did not fully assess the situation	12. Charts/Passage Planning
3. TSS (MARS reports only)	C14 Poor passage planning
A7 Incorrect heading	C15 Failure to use adequate charts/Did not appreciate warnings on chart
B ENGINEERING/DESIGN	D SAFE MANNING
4. Automatic steering/Auto pilot	13. Bridge Manning
B1 Auto Pilot/Gyro Error	D1 W1 - Bridge Unmanned/No Look-out
B2 Autopilot response affected by external conditions	D2 Fell asleep - more than one on the bridge
5. Bridge/Ship layout	D3 W1 - Distraction caused by VHF
B3 Restricted view forward	D4 Long Pilotage
B4 Position of equipment - Bridge Layout	E NAVIGATION CONTROL
6. Manuals/Documentation	14. No Radar Involved - Visual Look-out
B5 Manuals in foreign language/Poor manuals	E1 Difficult to distinguish extern navigation aids
B6 Drawings not 'as fitted'	E2 Failed to see due to impaired vision forward
B7 Manuals only for individual components, not the complete system	E3 Did not see other ship
7. Mechanical & Manoeuvring	15. Position Discrepancy
B8 Total Black out	E4 Position not fixed accurately
B9 Unexpected manoeuvring characteristics	E5 Relied on radar bearings, etc.
8. Technology - Other	E6 Using GPS as sole position fixing method
B10 Echo sounder not in use	16. Radar
9. User Interface	E7 No radar parallel indexing used/incorrect use of radar parallel indexing
C BRIDGE PROCEDURES	E8 Failed to plot course/speed of other vessel/made decisions based on initial data
10. Bridge Resource Management	E9 Blind sector
C1 Poor communication between Bridge Team members	E10 Did not see other ship
C2 Did not monitor other actions of other Bridge Team members	E11 Other radar related
C3 Master's orders not complied with	E12 Radar off
11. Communications	F OTHER
C4 Agreed manoeuvre (VHF) before near miss or collision	F1 Exhibiting inappropriate lights
C5 Did not exchange information with other vessel/Unable to contact other vessel	F2 Operational demands
	F3 Pilot did not act professionally (speed)
	F4 Master did not as advised
	F5 Other

The marine human factors classification system outlined here, provides improve detail which shows that each 'catalyst' or group of 'catalysts' are likely to require a different approach to determine the most effective remedial action.

'Catalysts' involving the steering control system suggest a need to improve the design of the user interface and corresponding manuals. Additionally, some form of verification is required to show that each officer has received adequate training in the operation of the navigation aids on the specific ship.

The 'catalyst' *did not fully assess the situation* was grouped under the subcategory Error of Judgment which falls within the main group of Human Performance. These 'catalysts' are best addressed through education and training.

The marine human factors classification system outlined here can be used to analyse the human element in collisions and groundings. It focuses on problem areas and provides a method for collecting human factors data systematically. This paper shows the need for an alternative classification system focusing on human factors specifically on the ship's bridge. Accident investigations and voluntary incident reports can be useful for collecting data on human factors. However, other methods must also be employed, e.g., personal observations which can provide information that would be difficult to acquire using any other method, e.g., changes in behaviour due to unexpected delays. Therefore it is suggested that employing several different data sources can be effective and it can result in a better representation of human factors on the ship's bridge

The objective is not to try to eliminate the 'catalysts' but to be aware of how they affect the navigating officer. The aim is to encourage further research thus ensuring that the human element does not invalidate the intended effect of remedial actions (e.g., introducing new technology or rules/regulations).

## 7. THE FUTURE OF HUMAN FACTORS IN MARITIME CASUALTY INVESTIGATION

The role of human factors in investigations of accidents at sea is gaining increasing attention from the shipping community and the IMO. It is expected that this will result in an increasing acceptance of the role of human factors in future management strategies for improving safety at sea. The introduction of a code for the investigation of accidents and incidents at sea is considered a major step forward in improving safety at sea.

The present lack of a standard human factor's terminology in the marine environment, limits the possibility of comparing different studies (e.g., establishing the effect of safety measures through the analysis of accident reports). It is unlikely that significant progress in understanding human factors will be made until the shipping community:

- Adopt a standard marine human factors classification system for the analysis of collisions and groundings. The above research shows that such a system can provide functional data thus improving our understanding of human factors on the ship's bridge.
- Develop a human factors training scheme for marine accident investigators.

- Make a united effort to coordinate and share funding for human factors research within the international research community. The added benefit is a reduction of duplication and cost of studies.
- Encourage the investigation of all accidents, major or minor. All accidents must be investigated in depth and the complete reports made available to the public for research and training purposes.
- Work towards an agreement to fit all ships with voyage data recorders (VDR's). These have been used successfully in the aviation industry. In the event of an accident they provide unbiased technical data that can aid the evaluation of human factors data collected through interviews.
- Encourage Voluntary Incident Reporting (e.g., MARS). The information provided can be categorised according to the proposed marine human factors classification system and thus increase the available knowledge base of human factors in the working environment.

## 8. CONCLUSION

This paper discusses human factors on the ship's bridge and their role in investigating accidents at sea. Two accidents, the grounding of the *Exxon Valdez* and the collision between the *Alam Tenggiri* and the *Galaxy* were discussed briefly. It was suggested that the human factor's discipline provides a useful tool for analysing accidents specifically relating to the working environment of the ship's bridge.

A marine human factors classification system was proposed moving away from a blame seeking culture to examining problem areas affecting the navigating officer during navigation. The application of this classification system and identification of 'catalysts' provides improved practical data, which will assist in the analysis of future accidents. It is expected that this results in better methods for measuring the effectiveness of measures introduced to reduce accidents at sea.

It must be recognised that there is more than one definitive strategy for preventing collisions and groundings at sea. It is not expected to have a single best recommendation, nor a single dominant dimension to focus on. The key to preventing collisions and groundings is to understand the theory of the individual components and focus on their interaction within the entire navigational system on the ship's bridge.

The marine human factors classification system outlined in this paper presents data in form of 'catalysts' that can be used, for example to determine future research areas, assist in designing ships' bridges and provide useful data for establishing human factors training within the shipping industry.

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### Sažetak

## ULOGA LJUDSKOG FAKTORA U ISTRAŽIVANJU POMORSKIH NESREĆA: PROŠLOST, SADAŠNOST I BUDUĆNOST

*U radu je prikazana analiza pomorskih nezgoda uzrokovanih ljudskom greškom i to ponajprije nautičkom greškom zapovjednika odnosno časnika palube. Pritom se posebice razmatraju utjecaji korisničkog sučelja te načina upravljanja i rukovođenja. Na temelju stvarnih primjera i dosadašnjeg iskustva, u radu se predlaže klasifikacija čimbenika koji utječu na pojavu i posljedice ljudske greške pri upravljanju brodom u plovidbi. Prikazana raščlamba i zaključak rasprave svoju primjenu očekuju u prvom redu u istraživanju pomorskih nezgoda, posebice u dijelu osiguranja objektivnih zaključaka o uzrocima pomorskih nezgoda odnosno ispravna prosuđivanja budućih mjera pomorske i plovidbene sigurnosti.*