SAFE MANAGEMENT OF SHIPS – AVOIDING ACCIDENTS RELATED TO AUTOMATION FAILURES

Asst. Prof. Dr. Ergün Demirel,
Piri Reis University
Tel: 0216 581 00 30 Fax: 0216 446 70 05
e-mail: edemirel@pirireis.edu.tr

Abstract

Ships are the largest vehicles ever created by humans. Any failure in the propulsion, communication, command control or cargo handling systems may cause serious, even fatal accidents. Nowadays ship management systems are almost always fully automated and any automation failure may cause unacceptable accidents with damage to human life, the environment, the ship(s), port facilities and the goods being transported.

Automated systems are very capable, they facilitate ship management functions and are comparably better than manual systems, but they do not have common sense. What this means is that automation systems must be controlled by the human element at all times. These systems are products of high technology and users should be aware of the working principals and specifications of them in order to be able to avoid any accidents in case of failure in the systems.

Automation system failures are significantly important for the merchant shipping, as well as for naval ships, sailing in condense traffic conditions. Any failure on navigation and/or command control systems may cause the total loss of a ship or ships.

This study gives a background to existing studies on the development of accident avoidance systems and calls other parties for international cooperation to achieve a common solution to overcome such problems. In the light of the existing studies, some findings for hint points for solutions are also discussed.

Key Words: ***Safe Management of Ships, Automation Failures, Ship Automation, The Human Element versus Automation***

1. INTRODUCTION

There has been a revolution in the design of ships and highly improved technologies have been applied to navigation, communications, command control, propulsion and cargo handling systems on board. The use of automation both for navigation and machinery systems has been enhanced and automation equipment has started to control the ship instead of the crew. The new role of the human element has been reduced to supervising the highly automated systems. This development makes the ship crew extremely dependent on such systems on board.

Although automation has made life easier for the crew, it has also introduced new problems. Automation failures which arise unexpectedly may bring about serious results and even casualties. These results may endanger not only the ship itself but also other ships and facilities in the vicinity, and cause damage to the environment.

Automated systems are more capable than humans for handling management systems but they lack common sense. To fill this gap related to foresight (judgement), we still need the human element for the supervision of automated systems.

2. THE RESEARCH METHOD

The research is conducted in three phases. The first phase is intended to understand the specifications and requirements of the automation era. The second phase is an investigation based on the existing studies on the accidents that happen due to failures of automated systems. And the final phase will cover a deep study to formulate possible/probable solutions to overcome automation related problems, which directly affect the safe management of ships.

3. THE AUTOMATION ERA

We are living in an era in which automation affects our modus operandi in many services as well as in the maritime sector. So we should accept this reality and take necessary actions to reduce the negative impacts of automation.

At the beginning the main aim of automation was to reduce the manpower requirements and provide standardization in the industry. This aim was mostly achieved and it made life easier for everybody in the business. Airline pilots and ship masters are very happy to have automated navigation and communications systems on board and marine engineers are now very comfortable in their engine control rooms instead of being in hot and noisy engine rooms.

The" rapid reaction" and "just on time" concepts have also become very important in the new world order. Automation has also helped industrial and business activities to meet the requirements of these emerging concepts. The banking, logistics, transportation, government sectors have adapted automation systems to their management systems. But improvement has also introduced many negative impacts/side effects because of the complex design aspects of the highly sophisticated real art systems in the business and industry. Today, you do not have to go to the bank for your banking needs. You just go online to get them done. However, if the systems collapse or are locked, there is no way out except for applying manual techniques.

Failures in automated systems on board ships may be more serious and even result in fatalities. If you are unable to use your rudder system due to automation failure during close manoeuvres, that is likely to cause serious damage or even the loss of the ship and lives. The loss of surface picture during a live fire exercise may cause loss of the target ship. The loss of sub surface picture during wartime may cause loss of a highly valuable frigate and her crew.

We are very happy with automated systems on board in both the merchant fleet and naval ships, but we are also well aware of the fact that we are playing with a very dangerous tool which may suddenly cause serious problems for us. So, we should conduct studies to overcome these problems and find solutions to reduce the negative impacts of automation failures.

4. THE MAIN REASONS FOR INCIDENTS DUE TO AUTOMATION FAILURE

Many surveys, studies and research activities have been conducted by many respective authorities and institutions to investigate the main reasons for incidents due to automation failures in the maritime

sector. The most enhanced and comprehensive study was published by the United Kingdom Maritime and Coast Guard Agency (MCA) in 2007 (MCA, 2007). Many studies on these subjects have benefited from this study.

The resume of the main MCA findings are as follows:

a. The over-reliance on automation by crews
b. Ship crews are often overconfident in the data presented to them by automated control systems rather than the data provided by other manual methods, which is considered more time consuming.
c. There is often a lack of understanding by ships' crews of automated control systems and any inherent weaknesses they may have
d. Automated ship-borne maritime systems do not always have optimal ergonomic design considerations.
e. Maintenance and calibration errors when setting up automatic control systems can lead to catastrophic consequences
   Man machine interface in particular on some screen-based automatic control systems, the human-computer interface can be very confusing to the user
f. Some current automated systems do not adequately support the system operators in developing and maintaining situation awareness which is highly important to handle a vessel
g. The crew are overloaded with information provided by automated systems which is not easy to comprehend by human perception
h. Any careless maintenance and calibration may create improper operation of the system which cause misconception

Additionally there are some other factors which have been reflected in the other studies: These are;

a. The existing education and training systems do not sufficiently cover the main principles, limitations and weaknesses of automation systems and the students are not capable of understanding this critical knowledge when they meet automated systems on board.
b. There are not a sufficient training courses and supporting tools to introduce trainees better understanding the emergency operation procedures and required actions in case of such failures (IMO MSC, 2001).
c. The automation equipment is mostly based on electronic/electric systems and used by navigation and marine engineering officers and ratings. But the existing education programmes for deck and engine officers do not cover these subjects sufficiently to make them fully understand automated systems.
d. There is not an internationally recognized or recommended special training model course related to crew training on automation failures (Ziarati and Ziarati, 2010).

Many studies on sea accident investigations prove that 60 % of accidents are due to human error, 19% structure/mechanical failure and 10% equipment failure (Figure 1). Another fact is that sometimes it is not easy to clearly define the reasons of accidents because of the complexity of highly advanced systems on board. Although we do not have a reliable study on accidents related to automation failures, we can assume that this kind of accidents is distributed in the human error, structure/mechanical failure and equipment failures. So studying on automation failure will be a good solution to reduce the number of accidents.

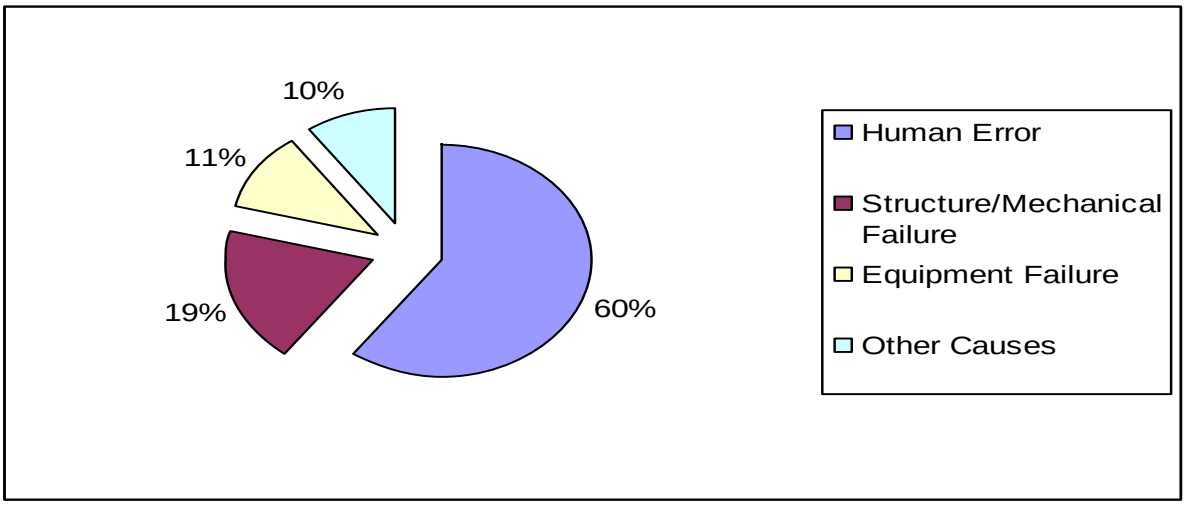

Figure 1: Reasons for Accidents (Source: Ziarati, 2011)

All these studies on the merchant fleet are open to the maritime community. We believe that the navies of different countries have also done similar studies but these are not accessible due to security considerations.

5. A RELATED PROJECT- SURPASS

The SURPASS (Short Course Programme in Automated Systems in Shipping) is a European project to provide special training to seafarers for them to understand the automation systems and enable them to realize the weaknesses and limitations of such systems. The project also gives support to industries so that they realize human-related problems when they require or design and produce automated systems (www.surpass.pro).

The course can be delivered in a classroom environment but also using e-learning systems. The assessment of the course can be conducted in both dimensions. These two types of delivery method facilitate the delivery of the course to crews working on board as well.

The project has been completed as a result of two years of study in six countries. The course programme has been created in four steps:

- Over 300 accident report synopsis were reviewed
- Questionnaires were developed and results were reviewed
- 6 of them were chosen for scenario development
- Scenarios were developed to use in full-mission simulators

The initial part of the course covers the introduction of the main principals of automation systems and continues with the weaknesses and limitations of them. The second part is based on generic scenarios which facilitate the understanding of the operation of automated systems. The project also makes a place for users to improve their own scenarios to support special requirements. Further information is available on the SURPASS website (www.surpass.pro) .

5. CONSIDERATIONS

In the light of the above mentioned facts the following considerations which ensure the safe management of ships are found. These considerations are open to discussion and need further studies.

Firstly we need to improve scenarios in the light of the existing accident investigation reports related to automation failure, then we should select the most applicable ones for training purposes. Based on these selected scenarios we should study risk assessments. Working on the risk assessments we can improve our risk management plans which will help us to create our standing checklists before accident happens and "to do" list in case of an incident (Klimczak, 2007).

Secondly we must decide on the aim, objectives and learning outcomes for our training which will help us to decide on the content of the programme based on the scenarios. This programme should also cover the introductory subjects' related basic working principals, capabilities, weaknesses and limitations of the selected automation system. The main part of the training should be constructed on a real time scenario and case studies.

These kind of realistic trainings should be included in the education and training programmes of maritime education institutions for both cadet officers (midshipman) and crews. Such an application will strengthen the existing maritime vocational education and training systems and achieve more realistic in-school training.

The electro-technique courses in the operational and management level Marine Engineering programmes (IMO Model Course 7.04 and 7.02) provide basic information to the cadets to understand main feature of the automation systems and it is strongly recommended that this course should be added also to Navigation Engineering programmes (IMO Model Course 7.03 and 7.01) to have a similar background. The managerial level officer courses are based on ship management related problems and in particular in case of emergency situations. And it is fairly important inclusion of automation related courses in these programmes. The academic programme of the most naval academies is in line with the STCW requirements to provide their midshipman also seafaring officers' qualifications and this issue should also be considered for them.

The STCW introduced two new job specifications in the engineering department which are ETO (Electro Technical Officer) and ETR (Electro Technical Rating) both are closely related to the automation systems on board. Following these improvements it is evident that ships will have special training programmes and drills on automation failures. This training will also cover other officers and ratings who are the end users of these systems.

The close cooperation between user side and industry will be very helpful for producers to solve ergonomic problems at the design and production phases of ship-borne automated systems. Additionally short courses for crews on newly introduced automated systems by producer, before or during mounting phase will provide better understanding of the system features by users. It will also help the producers to realize problems at the user side and to improve solutions to them.

5. CONCLUSION

Unfortunately the shipping industry still suffers from accidents related to automation failures. This situation enforces us to take necessary measures and actions to reduce such accidents which may

create serious even fatal results. The better education on these systems is one of the solutions which may be applied in the short term. But we should also consider additional measures and actions.

It is approved that there is a need to improve new techniques, methods and procedures to overcome accidents related to automation failure. All these studies should be reflected to the officers and crew education and training programmes. Considering the working conditions of seafarers, different types of delivery methods for education in particular distance learning should be considered. The SURPASS project will be a good example for future activities from which we will benefit greatly.

The cooperation between users and producers of automated systems will create synergy and platform for transfer of knowledge and innovations. This will also eliminate man-machine interface problems and feedback from end- users provides valuable information for the system designers.

Because of the nature of operations at sea, not only merchant fleets but also navies experience the same problems. Most of the systems developed for merchant and war ships are very similar and they are usually produced by the same companies. This facilitates cooperation between both sides as well as producers. To sum up, we should look for new cooperation opportunities in the new world order.

REFERENCES:

a. MCA, (2007) MIN 261(M) Research Project, November 2007, London

b. MAIB Report 24/2007, (2007), Joint MAIB and SHK investigation on Prospero,

December 2007. Prospero London

c. Gregory D and Sahanhan P., (2010), Human Element. A guide to human behaviour in the shipping industry, UK MCA, London

d. IMO MSC/Circ/1014, Guidance on fatigue mitigation and management, IMO Publication, London

e. SURPASS Project, (2012), Short Course Programme in Automated Systems in Shipping www.surpass.pro

e. Ziarati, R., (2010). The SURPASS Project Turkish Maritime Journal, January 2010, Istanbul

f. IMO MSC/Circ.1091, Issues to be considered when introducing new technology on board ship, IMO Publication, London

g. Ziarati R and Ziarati R., (2010) Short Course Programme in Automated Systems in Shipping , International Conference on Human Performance at Sea HPAS 2010 (16th-18th June 2010), Glasgow, Scotland, UK,

h. Rowley, J, (2006), MCA Report RP454: Development and Guidance for the mitigation of human error in automated ship-borne maritime systems, QinetiQ

i. Ziarati R., (2006). 'Safety At Sea – Applying Pareto Analysis', Proceedings of World Maritime Technology Conference (WMTC 06), Queen Elizabeth Conference Centre, London IMLA 19 – 28th September – 1st October 2011 – Opatija/Rijeka, Croatia

j. Ziarati R., (2011), Developing Scenarios for Automation, Proceedings- IMLA 19 Conference (28th September – 1st October 2011) – Opatija/Rijeka, Croatia

k. UKOLN (UK Office for Library Networking), (2013), Technical Advisory Service Manual: Section 1-Human Resources Programme (file:///C:/Users/edemirel/Desktop/ICHQ/nof-digitise%20Programme%20Manual%20%20Human%20Resources.htm)
l. Klimczak K. M., (2007) Risk Management Theory: A comprehensive empirical assessment, Working Paper, Leon Kozminski Academy of Entrepreneurship and Management (http://mpra.ub.uni-muenchen.de/4241/)
m. IMO STCW, (2010), Standards Training , Certification and Watchkeeping, IMO Publication, London
n. MSC 90/16/126, (2012), Technical Assistance Sub-Programme In Maritime Safety and Security, Periodical report on model course, IMO Publication, London

Curriculum Vitae

Asst. Prof. Dr. Captain Ergun Demirel BSc, MSc (Int.Rel), PhD (Maritime Management-Policy), FImarEST, CMarTECH

Dr. Demirel graduated from the Naval Academy in 1971 and joined the Turkish Navy. Upon completion of the Naval War College in 1980 he commanded destroyers, served in the Coast Guard Headquarters as Assistant Chief of Staff Operations and Surface Training Centre as Chief of Education.

He commanded the Turkish Fleet Logistic Division and Midshipmen Regiment of the Naval Academy and he served as Academic Dean of the Naval War College.

After retirement in 2001, he became a Board Member of OMSAN Logistics Turkey, which is one of the biggest logistics companies in Turkey. He gave Maritime Strategy lectures in Istanbul University and the Naval War College.

He joined TUDEV in 2003. Capt Demirel served as the Programme Leader for Navigation Engineering, TUDEV Institute of Maritime Studies.

He is a member of the Maritime Faculty at Piri Reis University as well as being the Director of the Maritime Higher Vocational School.

He has written a number of international papers in the area of Maritime Education and Training.