SURPASS Project Begins
Review of Accidents with Special References to Vessels with Automated Systems

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TUDEV's new research and development project to make automated vessels safer has been approved by the Turkish National Agency and the European Union. The project was jointly developed by Professor Ziarati and Mrs Sadan Kapanoglu. The project is named Short Course Programmes for Automated Systems in Shipping (SURPASS).

The Reason for the Project

The international standards for merchant navy education and training (MET) currently in place were introduced in 1995 (IMO STCW-95). Since 1995, there has been rapid revolution in design of ships and the equipment used in the navigation and propulsion systems on board these ships and yet there has been no serious attempt to revise the STCW and/or the International model courses such as IMO 7.03, 7.04, 7.01 and 7.02. One very important development has been the introduction of automation in operating a ship. The modern ships particularly container and fuel carrying vessels are becoming increasingly automated. The automation has brought with it two problems, one concerning the inadequacy of existing seafarers' education and training viz., that if any aspects of automation fails the crew often are not trained to use alternative systems and hence respond to it effectively (IMO MSC 82, 2006; Ziarati, 2006). The second problem has arisen from the review of the arguments from recent IMO Maritime Safety Committee (reports MSC 82/15/2 and MSC 82/15/3, 2006) namely that the human operators rarely understand all the characteristics of automatic systems and these systems' weaknesses and limitations which have now been found to be the main causes of accidents.

The main aim is to transfer the innovation already developed in the design, delivery and assessment of short courses in order to fill the gap created as the result of emergence and application of the automated systems.

The partnership is composed of partners who have the necessary knowledge either on related aspects of automation or those who have developed software and/or hardware which are needed for the proposed short training programme in automation.
The main tangible outcomes are a new course in automation with 8 modules, each concerning a particular level of depth in knowledge, skills and understating, for a given level of seniority and concerning a given job function and adaptation of an e-learning platform with assessment facilities. Since the intention is to adapt e-learning and e-assessment both in the training and learning methods, viz., self-learning and self-assessment tools, the project products will target a wider audience including active seafarers working on board engineering departments of automated vessels.

The main intangible outcome is that the course would provide an opportunity for many rating and officers with no or little knowledge of automation to acquire the necessary expertise and seek employment on board vessels with automated systems. The knowledge needed for example by Engineers on board a vessel has to match the complexity of the automated system and other related equipment they operate. To ensure this will be the case the course is designed to be a bolt-on programme and capable of being up-dated.
Impact is expected to include widespread use of the course in partner and other EU countries.

INTRODUCTION

To fully understand the problems with automation it became necessary to review and study the accident reports by major authorities and to refer to major projects which one way or another have been instigated to make seas a safer place for transportation of good and people. Accidents are recorded and reported by various authorities such as Marine Investigation Module (MINMod), USA, Marine Accident Investigation Board (MAIB), UK, Transportation Safety Board (TSB), Canada and Australian Transportation Safety Board (ATSB), Australia as well as many other international, European and national organisations such as IMO[2], OECD[1], Lloyd's Register[3].

What is alarming is that sea transportation is growing and with this growth the number of accidents continues to occur at undesirable levels with unfortunate consequences, which vary from loss of lives, substantial damage to marine environment and loss of cargo. This is despite having modern technologies, well equipped and seaworthy ships with qualified crew particularly as far as automated vessels are concerned. Careful study of the accident reports reveals that 80 to 85% of all accidents are either directly initiated by human error or are associated with human error by means of inappropriate human responding to threat situations (SPIRIT, 2007). This is in line with the findings of a recent paper (Ziarati, 2006) that 80% of accidents at sea are caused by human error. The latter paper notes that mistakes are usually made not because of deficient or inadequate regulations, but because the regulations and standards, that do exist, are often ignored. The IMO (Ziarati, 2006) clearly indicates the causes of many of the accidents at sea are due to deficiencies in education and training of seafarers or disregard for current standards and regulations. The study presented in this paper also surprisingly supports the findings of two reports submitted by MCA to IMO MSC82 (reports MSC 82/15/2 and MSC 82/15/3, 2006) elucidating that automation has brought with it a new problem and specific types of accidents which need to be fully understood if these accidents are to be avoided.

The work reviewed as part of this investigation considered the outcomes of several European Union (EU) education and training initiatives (see bibliography). These include several Leonardo pilot projects, SOS, 1997, TRAIN 4Cs (2007), E-GMDSS (2006), HIICOSS I (1997); SAS (1998); NORAY(1999); ORION (2001); CIVILPRONAVY (2001); FISHTRAIN (2001); SECURETAS MARE (2002); HIICOSS II (2002); NETOSKAR (2003). The results of a number of research and development programmes such as METHAR (2002) and METNET (2002) were also taken into consideration exploiting as well as the information contained in (SPIRIT, 2007). The work being conducted under the EU funded Leonardo Project Safety On Sea (SOS, 2007) reported in Ziarati (2006), which identified several causes of the accidents and deficiencies in the education and training standards is summarised in the following diagram:

Causes:		
	A Use of navigation equipment	28%
	B Communication	24%
	C Equipment failure including engines	16%
	D Confusion due to standards and regulations	12%
	E Inadequacy of standards/applications by third parties	8%
	F Unknown	12%

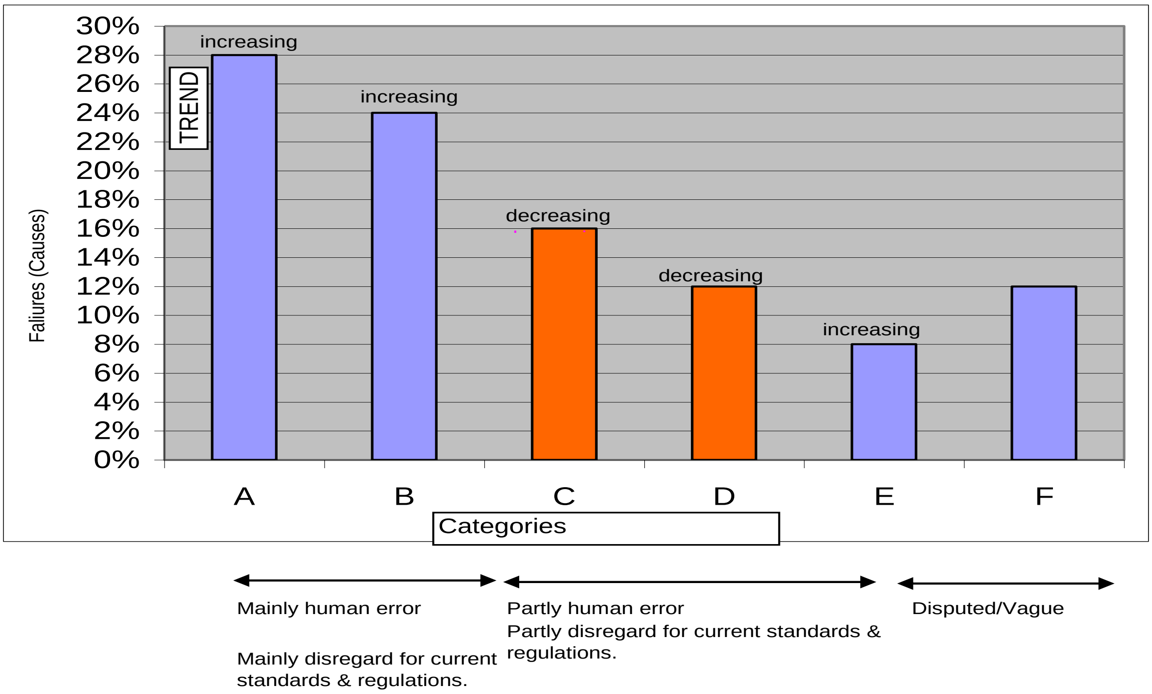


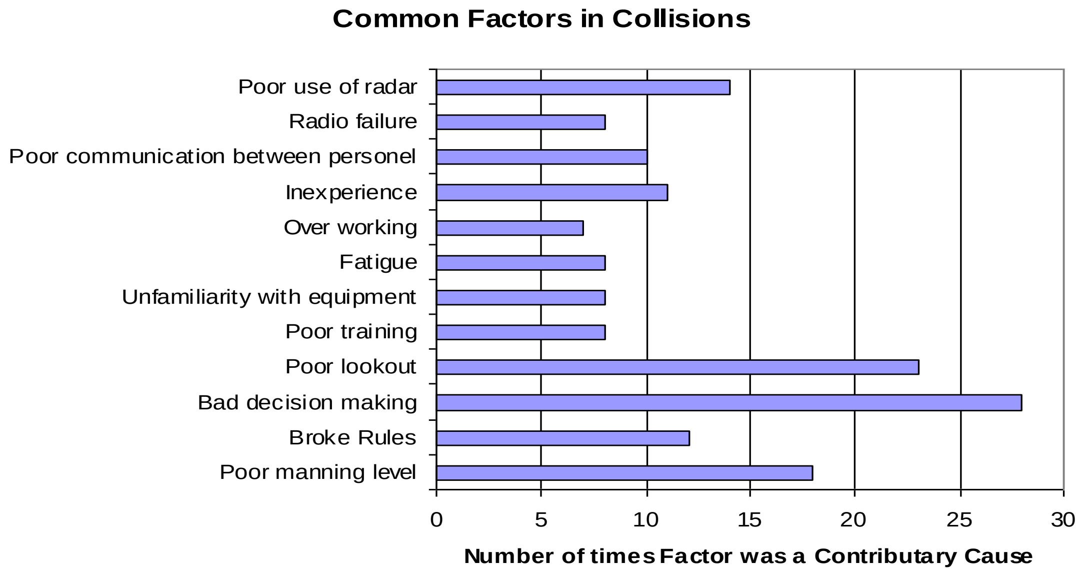
Fig 1 Pareto Chart identifying main sources of accidents (Source: Ziarati, 2006)

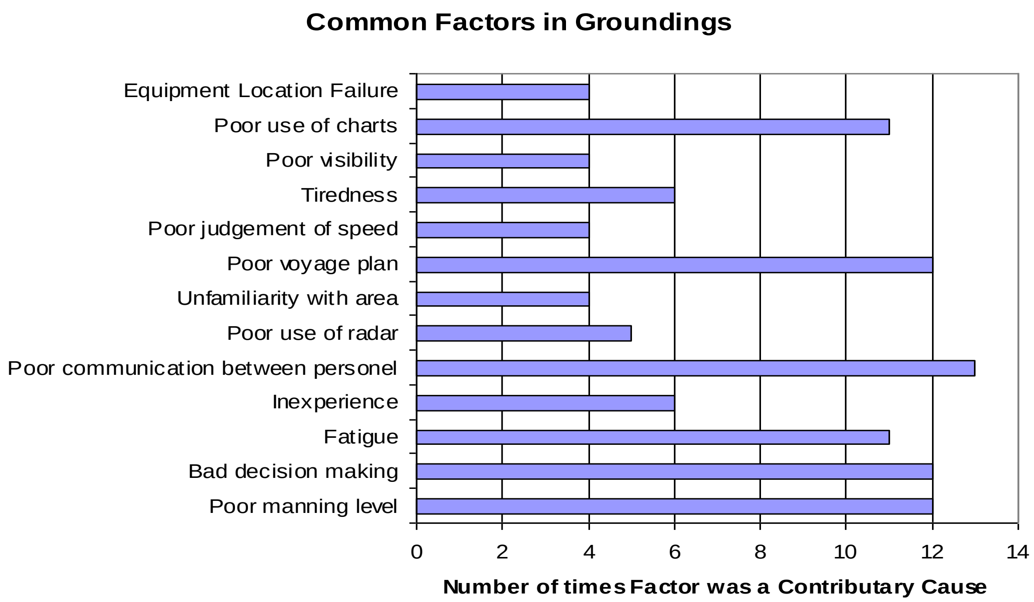
It is pertinent to point out that to counter the problems with language competency a new Leonardo project (MarTEL, 2007) was prepared by a team consisting of some 7 European countries. A second Leonardo project known as SURPASS (2007) was instigated to overcome the problems with automation failure. The team for the latter project consist of 8 European countries. A third project (SPIRIT) composed of major organisations in Europe was formulated to primarily assist the crew in emergency situations. The latter project is expected to identify improvement areas for system and component manufacturers including simulator producers with a view to improve the capability of simulators. This project is expected to bring vessel system manufactures closer to simulator makers and there in turn closer to training providers. This is expected to ensure training institutions are not lagging behind the simulator and system manufacturers. More information about these innovative projects is given in the following paragraphs.

Research Method

The first task was to revisit the findings of the earlier work summarised in the above diagram and try to pin point the main causes of accidents. The second task was to review the existing accident reports and find the main reported causes of accidents particularly for collisions and grounding. The third and final tasks was to offer solutions that could reduce accidents primarily due to automation of bridge (INS/IBS – Integrated Navigation/Bridge System) and/or Engine room (IErRM – Integrated Engine room Resource Management). INS/IBS together with IErRM is now referred to as AMRM (Automated Marine Resource Management).

The reviews led to visits to several centres and many productive discussions with partners in associated EU funded projects to verify the results shown in the following 2 diagrams.





Figs 2 and 3 – Common Factors in Collisions and Grounding (Source: Project SPIRIT, 2007)

The above diagrams clearly substantiate the earlier findings that problems with and use of navigation equipment and poor communication are major causes for concern. The latter as reported earlier was a main area of concern reported in the Human Element Group of IMO (MSC, 2006). What is new is, as shown in the above diagrams, that bad decision making is the most dominant cause of accidents. There are also issues concerning the crew such as fatigue, tiredness, manning level and so forth that requires careful consideration.

The key question in this programme of research was how could those concerned with education and training and/or well being of seafarers respond to these identified causes and complement and supplement the existing arrangements with a view to reduce the number and severity of the reported accidents in the future?

To respond to the above question let us first investigate how training takes place in progressive maritime education and training institutions. It was found that without exception, and despite the fact that the use of simulators is not mandatory under the existing regulations (STCW 95), all centres visited use sophisticated

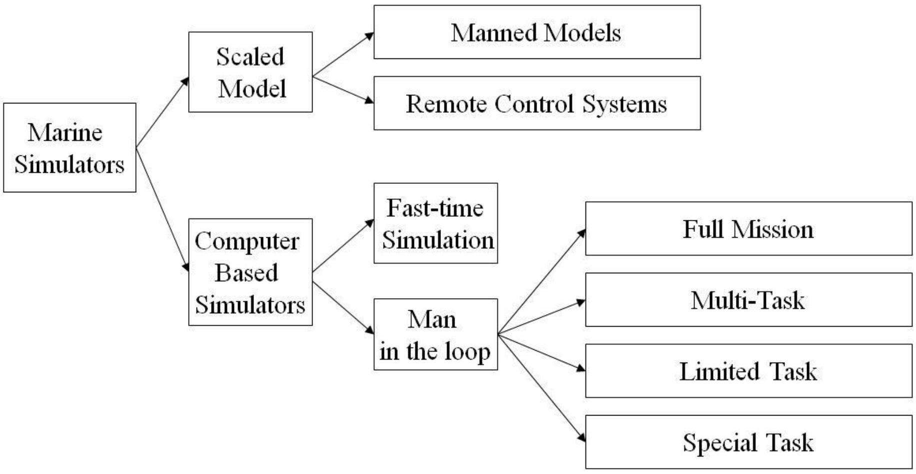


Fig. 4 Type of Marine Simulators (Source Spirit Proposal. Dr Osman Turan).

bridge and/or engine simulators with various degree of complexity. Some such as TUDEV, in their training and education programmes include BRM and Ship Handling courses in addition to IMO mandatory ancillary courses. They also expect all their officer cadets to take the additional courses required by MCA. Simulators can be subdivided as depicted below:

The most popular simulators use computer-based simulators with the 'man-in-loop' for a range of applications as shown in Fig. 4.

A typical arrangement for training of seafarers using simulators often commences with the selection of an appropriate scenario followed by trainees using the simulator under the supervision of an instructor. The trainees' progress is monitored by training staff and the process is concluded by a briefing session which could include informal or formal assessment or a feedback and/or debriefing activities. Most of the scenarios involved developing and assessing skills in navigating a vessel with little or no attention to human element issues other than offering training in the correct use of navigation equipment and/or rules and conventions. In some cases observed, fault analysis play a major part: the instructors encouraging the trainees to identify and then rectify faults of various complexities. The research (SURPASS, 2007) has shown that the trainers themselves are often unable to overcome the problems created or questions raised when considering scenarios dealing with failure in aspects of automated systems. The training instructors were noted not be familiar with weaknesses and limitations of such systems. Furthermore, problems with poor communication are often overlooked and no distinction is made between mistakes and/or slips. The latter issue is an important one because mistakes are rule- or knowledge- based whereas slips are lapses due to tiredness, forgetfulness, etc.

In the training scenarios and briefings intentions, human actions and subsequent consequences are often analysed, again with different degree of sophistication and in some cases feedback and feed forward provided an opportunity for arguing the actions by the crew. However, issues related to human failure only encompassed those relating to navigation matters. To support the activities in making seas safer, directly in connection with the four main problems, four proposals were formulated and three were presented to the European Union for consideration. The following paragraphs give brief details of these projects.

Project SURPASS - The main aim of this project is to fill the gap created as the result of emergence and application of the automated systems in the education and training of seafarers by provision of a training course enabling them to have a full understanding of automated systems, and these systems' weaknesses and limitations. To achieve this aim it is necessary to identify the training needs and develop or adapt methods and methodologies both for content development as well as for the delivery of the modules within the course. This aim will only be achieved if a well-planned literature review of, on the one hand, the automated system and components, and on the other hand, the accidents and incidents, such as that by Savannah Express (2005) or the very recent sinking of Glorious (2007) in the Bosphorous, are carefully and meticulously carried out. The former accident was due to engine failure and the latter due to navigation (steering, rudder) failure. Emergencies at sea are rare. However, when they do appear they could cause loss of life and material damage, therefore seafarers not only have to learn how to operate automated systems but should regularly be refreshed in order to ensure the safety of the crew, passengers and/or cargo. Due to this rare but at times severe outcomes, seafarers will need to remember also how to react to dangerous and emergency situations and able to react and handle the situation (SPIRIT, 2007). The second aim is to make courses being developed under this initiative also available to industry to ensure companies in the sector**,** particularly ship operators and ship builders, are aware of the support these systems require and operational features as well as their management. This aim is expected to make the companies more competitive and reduce loss of life and personal injuries as well as substantially reduce the cost of accidents and incidents. The SURPASS courses can also be used by ship crews who are working on board these vessels and pilots at ports, as an up-dating programme of personnel or self development. Furthermore, many employees and individuals would be able to enhance their skills and competence and hence become more employable. The skills and competence again could help individuals to become more mobile and seek better paid jobs or work in other flag states. The project intends to facilitate the training of trainers. The third aim is to adapt e-learning and e-assessment systems and use Internet as a means of communication within the target groups as well as for training material delivery and its assessment. There will be two types of assessment. One as part of the learning strategy so that self-assessment and trainee-centre-learning and inquiry methods could be used to enhance learning; and the second is assessment which is designed to measure performance evaluation and for progression purposes.

A new project in support of SURPASS has been initiated at TUDEV. The new project known as the **Clean Diesel II** is based on the successful EU funded Clean Diesel project. The project comprises an Engine management system called Main Diesel Program which provides real-time simulation of a diesel propulsion unit in parallel with an actual Engine Finger-print software (Heat Release and Rate of Injection Programs). The Engine simulation is regularly compared with Engine actual finger-print and if there are any deviations these are noted and correction is made using a Poke Yoke system developed by Ziarati (2003). If correction is not possible, for instance, on board an automated vessel then the software provides a switching mechanism wherever feasible from automated to manual operation. The SURPASS project provides courses for both automated and manual operation of both engine propulsion and the ship's bridge.

CONCLUSION

The findings of the reviews of the accidents reveal that 80 to 85% of all accidents are either directly initiated by human error or are associated with human error by means of inappropriate human responding to threat situations. Most of scenarios provided by the simulator makers and training providers were noted to be primarily on non-human element issues. When addressing the overall safety and efficiency in bridge and engine operations, it is very important to focus on the performance of total bridge, engine or combined system. This requires careful consideration of all factors which influence performance and reliability of both the human operator and the equipment as part of a total system. The current practice with engine simulators does not involve automation failure cases such as those experienced with Savannah Express (2005). It is hoped that in light of recent findings STCW code and requirements as well as IMO model courses are revised and up-dated.

There are basically three types of failures: Design, Equipment and Human. Four detailed projects as described above, involving some twenty partners from some 15 different European countries, were developed to eliminate the main causes of accidents and incidents. Further details of these exiting projects are available at www.maredu.co.uk.

Author's Biography - Professor R. Ziarati is presently the Principal of TUDEV Institute of Maritime Studies, a position he has held since September 2003. He has held several senior positions in academia and industry and developed, as part of a funded project, a novel variable geometry turbocharged diesel engine and was the designer of a marine engine management system. He has supported the establishment of several education and research centres in the UK and overseas. Dr. M. Ziarati is currently the Director of the Marine Education (MarEdu) a partnership between TUDEV and Centre for Factories of the Future. For more information about C4Ff see www.c4ff.co.uk.

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