



Training the Trainees and Trainers in COLREGs

Reza Ziarati, BSc (Eng), PhD (Eng), Cert Ed, CMechE, CElecE, CMarEng, CEng, FIMechE, FIET, FIMarEST¹

Capt. Djani Mohovic, PhD²

Capt. Nicolai Velikov, PhD³

Tomaz Gregoric, MSc⁴

Capt. Himadri Lahiry¹

Capt. Robert Mohovic, PhD²

Capt. Renato Ivce, PhD²

Igor Rudan, PhD²

Ana Peric Hadzic, PhD²

Silja Teege⁵

1. Centre for Factories of the Future, Berekely House, Kenilworth, CV8 1EB, United Kingdom, reza.ziarati@c4ff.co.uk
2. Nikola Vaptsarov Naval Academy, 73, Vasil Drumev Str, 9026 Varna, Bulgaria, n.velikov@nvna.eu
3. University of Rijeka, Faculty of Maritime Studies, Studentska 2, 51000 Rijeka, Croatia, dmohovic@pfri.hr
4. Spinaker d.o.o., Sončna pot 8, SI-6320 Portorož, Slovenija; tomaz.gregoric@spinaker.si
5. Managing Director Sea Teach S.L. Port Petit 324 07660 Cala D'or Mallorca/ Spain, www.sea-teach.com

ABSTRACT:

The term "navigation" implies actions undertaken to enable a vessel to sail safely from the port of departure to the port of arrival in a defined period of time. The navigation of the vessel is exposed to many dangers and accidents which can occur and may have far reaching consequences on people, society, property and marine environment. By analysing maritime accidents in the past, it is known that human error and wrong interpretation of the Rules are the most frequent reasons for vessels collisions. Recognising that issue, the European Union approved the project "Avoiding Collisions at Sea" (ACTs) funded by the EU's Leonardo da Vinci programme. The purpose of this project was to identify skill gaps in the knowledge and teaching of COLREGs (International Regulations for Preventing Collisions at Sea 1972 - Rules) for maritime professionals. The research results obtained have clearly showed skill gaps in the understanding of some parts of COLREGs due to wrong interpretation and application of the Rules. The only way to change this in the future is to improve learning methods, understanding and proper application of COLREGs inter alia using these research results. The results of ACTs project are presented in Part 2 of this paper. Furthermore, it was noted that application of rules in multi-ship collision situations and when more than one rule applies in a collision created a new challenge for the research team. To this end, a second proposal, Avoiding Collisions at Sea Plus (ACTs Plus) was prepared and submitted to the European Commission (Erasmus +) for support. The project was approved in 2015 and led to new findings which are included in this paper. The results of ACTs Plus are presented in Part 3 of this paper. Part 1 of the paper gives the background to both projects ACTs and ACTs Plus.

Key words: COLREGs misunderstandings, skill gaps, training needs, improving teaching methodology.

1 INTRODUCTION

The Centre for Factories of the Future (C4FF) initiated several European Union funded projects on avoiding collisions at sea (ACTs). Details of these projects are given in Ziarati et al (2017) and Mohovic et al (2018), two of the main partners in the consortium. From the research evidence, the most frequent reason for collision between vessels shows that 85% of all accidents are either directly initiated by human error or are associated with human error by means of inappropriate human response. Analysis note 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 MSC clearly indicates that the causes of many of the accidents at sea are due to deficiencies in maritime education and training of seafarers or disregard for current standards and regulations. MAIB (Marine Accidents Investigation Branch) safety study analyses accidents from 1994 to 2003, where 55% of all accidents were collisions. Study also notes that 19% of the vessels involved in collision were completely unaware of the other vessel until collision, 24% of them were aware too late and 57% of them were aware of the other vessel. Safety report conducted by the EMSA (European Maritime Safety Agency) analysed accidents from 2007 to 2010. The



report shows that total number of all accidents including collisions is falling, however if number of collisions is compared with other types of accidents it can be seen that collisions constitute 40% of all accidents.

By using a questionnaire, the authors have studied the knowledge and understanding of COLREGs by nautical students and maritime professionals and non-professionals. The questionnaire has been designed in such a way so as to test the understanding of the Rules in order to see what parts of the Rules are misunderstood. The questionnaire, in a paper form and on-line, has been distributed within the EU and all over the world. In that way, all the various methods of learning the Rules in different countries have been included into the research.

Regardless of the learning methods, the results of the questionnaire have confirmed skill gaps by nautical students and experienced maritime professionals and non-professionals from all over the world. After identifying skill gaps, based on the research results, a proper learning methodology can be developed.

The ACTS Plus project results clearly identified additional areas for consideration. Full set of scenarios are presented in the project website, www.advanced.ecolregs.com.

Part 1 - General Consideration

The IMO defines collisions as casualty caused by ships striking or being struck by another ship, regardless of whether the ships are underway, anchored or moored. This type of casualty event does not include ships striking underwater wrecks. The collision can be with other ship or with multiple ships or ship not underway.

The International Regulations for Preventing Collisions at Sea 1972 (COLREGs) are a set of rules to be followed by navigation officers to avoid collisions at sea. It is one of the most important International Conventions that all seagoing Officers must possess full knowledge of, as well as having the skills needed to apply them correctly. However, case law, as stated in the MARS and MAIB reports, indicates that many of the basic principles of the rules are improperly understood and applied such as it being common practice to use VHF Radio in collision avoidance procedures; although such radio communications are not part of the COLREGs (MAIB, 2004). Recent studies undertaken by Ziarati et al (2011, 2017) showed that almost 50% of seafarers disregard/ignore the COLREGs at sea when they are taking action. This case law is further supported by several reports such as (IMO, 2005) that 80% of accidents at sea are caused by human error and Ziarati (2006), Ziarati et al (2017) 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 MSC (Ziarati, 2006; Ziarati et al 2017) clearly indicates that the causes of many of the accidents at sea are due to deficiencies in maritime education and training of seafarers or disregard for current standards and regulations.

Collisions remain a major source of accidents at sea resulting in serious injuries and loss of life and property. The European Maritime Safety Agencies 2014 Maritime Accident Review found that between 2011-2013 in the category of 'accidents with a ship' Collisions were the second leading cause of accidents resulting in serious injuries (20% of accidents) and 15% of accidents deemed as a 'serious occurrence' were caused by collisions.

It is accepted within the global community that there will be no changes to the COLREGs regulations in the short-medium future, indeed the International Maritime Lecturers Association made its position supporting the IMO regulations clear in its IMLA Newsletter Volume 1 June 2014). where it stated that the "IMO, has provided a clear text for COLREGs" and that as for "COLREG specific" accidents these can be attributed to "the unsatisfactory results of maritime training" or "seafarers not being able to use COLREG properly at sea". Therefore with both the regulator (IMO) and professional lecturers association (MLA) supporting the current regulations it falls to the Maritime Education Providers to develop innovative approaches to better understand COLREGS themselves, and new methodologies to teach COLREGs to cadets.

Seeing the severity of this issue the initial research has been carried out by the partners to identify training needs, for COLREGs (www.marifuture.org/Reports/Development-Papers/ADP_11_2015_MARIFUTURE.pdf) and subsequent research (www.ecolregs.com) has shown the seriousness of the problem. The EU target of zero collision at sea can only be achieved by introducing a new means of avoiding collisions at sea viz., not only that rules are explain so that they are easy to understand and interpret but also hazards are evaluated with a view to avoid accidents happening. This new approach



requires application of Predictive Analytics in application of COLREGs. All projects on collision regulations at sea have been on the basis that all vessels obey the internationally approved COLREGs. The new project considers vessels which may break or disregard the rules, which is one of the main reasons for collisions at sea.

Apparent Normalisation of Deviation from COLREGs

Keeping a safe navigation watch onboard a modern merchant vessel demands a high level of competency in many skills. The cognitive demands on individuals and teams have altered commensurately with the increasing complexity and change within the deck officer's role (Barnett, 1994). Paradoxically, increasing technology that focuses on safety and improved situational awareness, using satellite positioning systems and ECDIS, along with other high-automation tools such as collision avoidance radar, does not necessarily make for safer operating environments – especially with regards to collision avoidance.

The International Regulations for Preventing Collision at Sea (the COLREGs) are quite clear concerning actions to be taken by the stand-on vessel. Slowing down to allow more time to assess the situation is allowed by Rule 8(e), but Rule 8(a) does not give a vessel which is initially required to keep her course and speed the right to take action at an early stage. Rule 17(a)(ii) only permits such a vessel to manoeuvre when it becomes apparent that the give way vessel is not taking appropriate action (Cockcroft and Lameijer, 2011). Alterations of course may be considered the best solution, provided that they are 'readily apparent to the other ship observing visually' and alterations of less than 10° are unlikely to be accepted as satisfying this requirement (Cockcroft and Lameijer, 2011).

Mr Justice Sheen (1993) considers that:

"the errors of navigation which I regard as most serious are those errors which are made by an officer who has time to think. At such time there is no excuse for failure to comply with the Collision Regulations".

(Sheen, 1993, in Cockcroft and Lameijer, 2011, p.37)

It may be asserted that six miles is too early, with the exception of reducing speed, even if there is an immediate response to telegraph orders. A large vessel moving at high speed cannot be expected to rapidly slow down through it carrying considerable momentum (Cockcroft and Lameijer, 2011).

In a trial conducted at Solent University Bridge Simulator section, to check the participants' understanding of the IRPCS, a short examination using multiple-choice questioning as the means of assessment was employed. All officers scored 100% in those questions related to the actions of the stand-on and give-way vessels, as well as those rules relating to crossing, head-on and overtaking situations.

Despite this, all of the participants, including those that turned to port, thereby contravening Rule 17, believed that their initial action was appropriate for the developing situation, providing a strong indication that satisfying, in terms of action to avoid collision and to achieve passing at a 'safe' distance, was the underlying aim of all participants, irrespective of the requirements of the COLREGs.

The extent to which the actions taken were contrary to the requirements of the COLREGs may also be seen to endorse Perrow's (1999) assertion that the error inducing character of the maritime industry lies in the social organisation of the personnel on board ships, in which the behaviour of staff, masters and crews usually flow along the course of least resistance which is, in turn, determined by their human capacities; their expertise, the expectations, management style and culture of the company; and [their interpretation of [the] requirements of the law (Gregory and Shanahan, 2010). This confluence of factors leads to a dilemma that sharp-end operators are supposed to be 'efficient rather than thorough, except where the outcome shows that they should have been thorough, rather than efficient' (Schröder-Hinrichs, *et al.*, 2012, p.161).

Recent MAIB investigations indicate that technology is having a positive impact on navigation practices, including a reduction in OOW workload. However, there is a danger of the OOW operating under an illusion of control, while his or her overall situation awareness (SA) has, in fact, been reduced (Wheal, 2012).



Although ECDIS may be a useful SA tool, if the person using it is not fully conversant with its capabilities, limitations and menu systems, then it is counter-productive. The grounding of the cruise ship the Royal Majesty in 1995 is an example of trusting electronic devices blindly. It is offered that technical skills in cross-checking ECDIS positions, through the use of complementary position monitoring techniques, must be verbalised to the team, clearly stating the navigation status of the team. The same must be applied to the use of ARPA Radar and AIS, crosschecking and then verbalising CPAs and Time To CPA's (TTCPA) to the whole team, thereby sharing a mental model of the prevailing situation.

However, in the Simulator exercises, this often took the form of one team member standing back and allowing his/her dominant colleague to take the lead. In an industry where differing national cultures are thrown together, there is potential for 'tiger' personalities, utilising heuristics as a primary decision making tool, to dominate decision-making at the expense of safety/standard procedures. Combined with an apparent desire to satisfice, it is suggested that the normalising of deviation through misvention may be a significant factor

It would appear that, despite standardisation of training and certification, ships' officers are prone to normalising deviation. Certainly, the assertion from one interviewee that turning to port is easier, suggests that bridge staff seek to satisfice and 'misvent', rather than seeking a compliant solution and would suggest that experienced seafarers in possession of the appropriate certificates of competence routinely fail to apply the COLREGS uniformly, casting doubt over the efficacy of STCW (Sampson *et al.*, 2011) prior to the 2010 amendments.

In summary, it would appear that although all Deck Officers learn and are examined as being competent in their understanding of the COLREGS, there is the risk that deviation from the Rules becomes normalised behaviour – possibly due to economical factors or a 'new' culture brought about by a dominant authority. The example of classroom situations where a number of occasions are exercised when Rule 17 (Not Alter to Port for a vessel on own Port Side) is practiced and tested, it would appear that when the seafarer enters the 'real world' either at sea itself or in a simulator, there is a tendency to 'normalise' altering to port to get around the stern of a crossing vessel on the Port side. This is not only dangerous, but totally contradicts the intention of the Rule. Why this happens apparently so regularly could be the subject of further research.

References:

- Barnett, M. L., (1994), *The Effectiveness and Practical Application of Simulators as Tools for Training and Examining Seafarers*. Southampton, Southampton Institute.
- Cockcroft, A. N., and Lameijer, J. N. F., (2011), *A Guide to the Collision Avoidance Rules*, Bodmin, MPG Books Ltd.
- Gregory, D., and Shanahan, P., (2010), *The Human element – a guide to human behaviour in the shipping industry*, The Stationery Office.
- Perrow, C., (1999), *Normal Accidents – Living with High-Risk Technologies*, Princeton, Princeton University Press.
- Sampson H., Gekara, V., and Bllor, M., (2011), *Water-tight or sinking? A consideration of the standards of the contemporary assessment practices underpinning seafarer licence examinations and their implications for employers*. Maritime Policy and Management: The Flagship Journal of International Shipping and Port Research 38:1.
- Schroeder-Hinrichs, J., Hollnagel, E., and Baldauf, M., (2012), *From Titanic to Costa Concordia – a century of lessons not learned*. Retrieved from Springer.com website:
http://download.springer.com/static/pdf/396/art%253A10.1007%252Fs13437-012-0032-3.pdf?auth66=1352725930_2a38e17cbce4f3c30e7d9c44e7b110f3&ext=.pdf
- Wheal, D., (2012), *The question facing us is not how much work can the human do safely, but how little?* In Atkinson, H., (Ed), (2012), *Digital Hydrography on the Maritime Web: Embracing the challenges and opportunities*, Plymouth, International Federation of Hydrographic Societies.

PART 2 - ACTS PROJECT

2. IDENTIFICATION OF THE TRAINING NEEDS –



The questions have been designed to determine which rules are difficult to understand and which rules are most often broken in practice. Such questions are more difficult than the questions which simply check the knowledge. In a technical sense, the questionnaire has been prepared according to the instructions of the professors from the Faculty of the Humanities and Social Sciences in Rijeka who are experts in dealing with teaching and assessment methods. Preparing questions for testing the Rules for understanding has been a very difficult task. Only 4 questions from the total of 372 from the MCA COLREGs test have been taken. In accordance with the suggestions given by colleagues from the Faculty of the Humanities and Social Sciences in Rijeka, some graphical scenarios have been prepared and used in the questionnaire. This type of questions has been the right choice as there have been many positive comments. Some comments have referred to the language used in the questionnaire as being an archaic one, but this has been agreed between Partners to use words and phrases as much as possible from COLREGs (IMO).

The aim has been to examine the understanding of certain Rules, where in the scenarios only two vessels have been used. In practice, however, multi-encounters scenarios are very often used, but they have not been used in the ACT project questionnaire. Once the final version of the questionnaire in the English language has been prepared, partners from Croatia, Slovenia, Turkey and Spain have translated the questionnaire into their proper languages. The Slovenian Partner has been in charge of a non-professional questionnaire. The questionnaire has been made up of four groups of questions:

- General questions for identifying the target group of respondents (12 questions).
- Questions that have had an answer in COLREGs (34 questions).
- Questions for testing the opinion and actions of seafarers (12 questions).
- Optional questions for teachers and lecturers at maritime colleges (4 questions).

This type of questions has been intentionally left to students in order to check if the professors have explained them some situations and what they will do when appointed as junior officers.

General questions aimed at enabling the analysis and extraction of desired characteristic groups of participants in order to obtain quality conclusions and comparisons among groups. Group of questions that have an answer in COLREGs are the most important group of the questions for determining which Rules are hard to understand. On these groups of questions some remarks were received because multiple-choice answers have been offered.

3. DATA COLLECTION

The questionnaire was distributed from January to the end of March 2014 through Lime survey and in a printed form. The results from the printed form have been inserted in the Lime survey. The questionnaire has been distributed to all maritime schools and colleges, seafarers on board merchant ships, teachers and lecturers at maritime institutions, VTS operators, employees of the port authorities, pilots as well as to masters of fishing boats and yachts.

The Partners have contacted crew managers who have sent questionnaires to all vessels and to seafarers ashore as well. They have also asked some seafarers to fulfil the questionnaire in their offices. High school and faculty students have fulfilled the questionnaire in their classrooms. The questionnaire has been announced and the candidates have been allowed to use books when filling in the questionnaire. The time for filling in the questionnaire has not been limited. In that way, managed to test the understanding of the Rules, because they have been allowed to use all possible literature with no time limit. The respondents have taken 30-40 minutes to complete the questionnaire. By using such type of testing, stress have been avoided which is usually present on board a vessel. By the end of March 2014, the questionnaire was fulfilled by 1280 participants (professional seafarers, maritime high school and faculty students) and 285 holders of licenses for various types of ships/boats (pleasure craft and small fishing vessels). By January 2015, the questionnaire was fulfilled by 1498 seafarers and 288 non-professionals.

Most of the participants were maritime faculty students, ships officers and masters. Ages of participants were from 19 to more than 63 years and the most of them were from Croatia, Turkey, Spain and UK. In average, participants have over 5 years of sea going experience and most of them navigate on liquid cargo vessels, containers and bulk carriers. Also 9% of participants were involved in collision and most of those collisions occurred in coastal waters and harbour areas and visibility was over 6 miles. Only 34% of all participants attended some additional COLREG training course as well.

4. ANALYSIS OF THE QUESTIONNAIRE RESULTS



The questionnaire results analysis for the understanding of the Rules has shown that maritime education and training lecturers have had the best results, followed by seafarers with sea experience who have on the average 15% better results than participants with no sea experience. Percentage of correct answers by participant, with and without sea experience, and by maritime education and training lecturers are shown in 1. However, in questions regarding Rule 10 (TSS), participants with no sea experience have more correct answers and in questions regarding Rule 17 (Action by Stand-on Vessel) and Rule 18 (Responsibilities between Vessels) the results obtained from all participants are similar. Moreover, the results obtained from high school and maritime faculty participants have shown no difference in understanding the Rules. Questions for testing the opinion of seafarers, like a minimum CPA, parallel course overtaking, and distance to start avoiding collision have received different answers because there are no correct answers in the Rules, but a difference between participants with and without sea experience has been noticed.

5. OUTCOME OF THE RESEARCH EVIDENCE

This paper proposes a complete set of solutions based on research evidence of ACT project and ACT+ project. In ACT project, an e-learning model was outlined for an encounter between two vessels and actions taken as per each collision regulation. In ACT+ project, for e-learning of COLREGS, the examples show how the model has been developed to include the simulation of the behaviour of more than two ships, at the entrance to harbours, in narrow channels and in high seas so that the rules can be interpreted precisely, and can be understood in the same way by everyone avoiding ambiguity.

The COLREGS rules and regulations include 5 parts and 38 rules. Among these rules and regulations, this paper mainly focuses on the Part B of the Steering and Sailing rules. According to the COLREGS, the collision situation among two ships can be divided into head-on, crossing and overtaking to the route angle. And the own ship should needs to give way to all the ships that appear on its starboard side, and it is not a stand on ship until all ships are on the port side

In multiple ships scenarios, it is important to determine the relationships and the hierarchy of the Rules that can be applied for collision avoidance. Rules that have priority over the other have to be clearly determined so that officers are able to apply them without having any difficulty.

While explaining the rules, manoeuvring characteristics of the vessel are also included in order to make correct decisions on-taking appropriate actions to avoid collision. Attempts have been made in ongoing ACT+ e-learning COLREG course, to add as many as possible scenarios encountered in real life to improve the Rules learning methodologies for students and seafarers in a situation of multiple ships scenarios.

Under the general requirements of the International Regulations for Preventing Collisions at Sea (COLREGS), the decision-making for anti-collision is analysed for both give-way and stand-on ships situations, including the emergency actions taken by ships. The stand-on ship is the ship which should get through this area as soon as possible by keeping its speed and course. Meanwhile, the give-way ship should change its speed and course in order to clear this area for the convenience of stand-on ship's pass way. There are three kinds of the ship meeting scenarios, which are the head-on, overtaking and crossing. In the study of ship collision problems, it is an important issue to ensure that the shortest distance of the collision does not occur or the nearest distance that two ships can pass each other safely,

CPA is the most simple and effective means to predict the target ships' position and to estimate collision risk. In this paper, CPA is calculated every time to make sure that the path planning decision is safe and the ships have large enough area to move, no matter whether ships change their speeds and courses. That means that during the ships take anti-collision actions where the CPA should keep larger than set minimal value.

In case of collision avoidance of give-way ships, it is important to determine whether own ship is stand-on ship or give-way ship, and then make the decision to make changes on range and the speed of the give-way ship and the stand-on ship if necessary.

A multi-ship collision avoidance decision-making and path planning formulation is studied in a distributed way. This paper proposes a complete set of solutions for multi-ship collision avoidance in intelligent navigation, by using a top-to-bottom organization to structure the system. The system is designed with two layers: the collision avoidance decision-making and the path planning. Under the general requirements of the International Regulations for Preventing Collisions at Sea



(COLREGs), the performance of distributed path planning decision-making for anti-collision is analysed for both give-way and stand-on ships situations, including the emergency actions taken by the stand-on ship in case of the give-way ship's fault of collision avoidance measures.

6. GRAPHICAL ANALYSIS OF THE QUESTIONNAIRE RESULTS

The questionnaire results analysis for the understanding of the Rules has shown that maritime education and training lecturers have had the best results, followed by seafarers with sea experience who have on the average 15% better results than participants with no sea experience. The results obtained are shown in Figure 1.

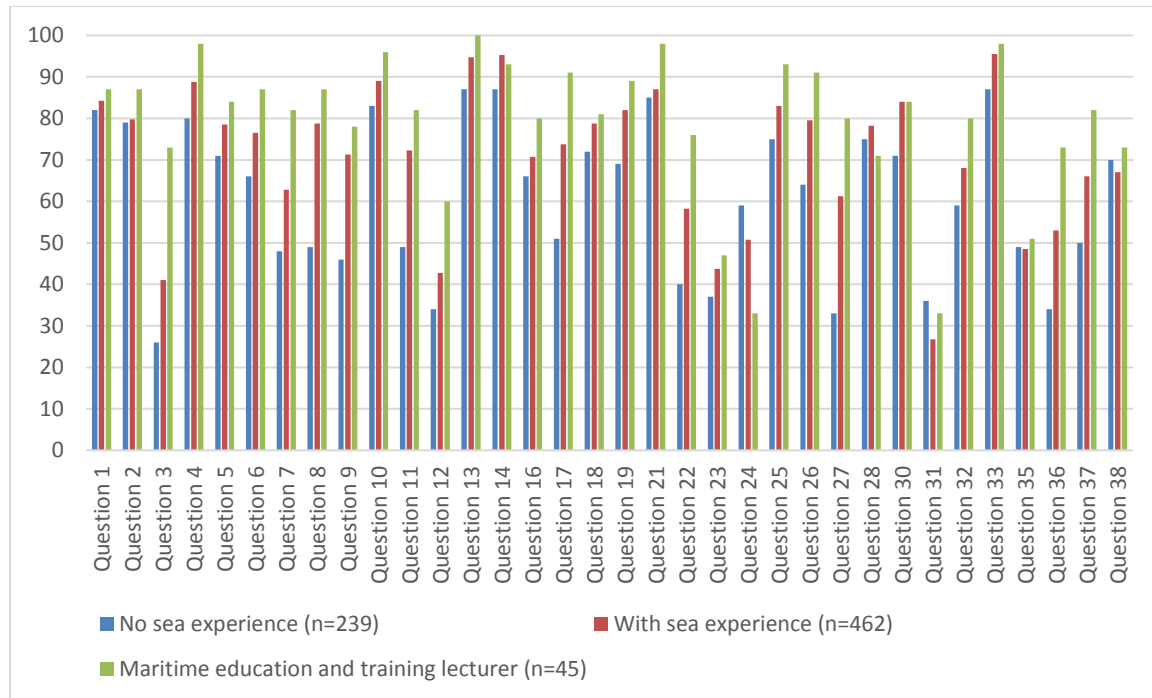


Figure 1: Percentage of correct answers by participant without and with sea experience and by maritime education and training lecturers

However, in questions regarding Rule 10 (TSS), participants with no sea experience have more correct answers and in questions regarding Rule 17 (Action by Stand-on Vessel) and Rule 18 (Responsibilities between Vessels) the results obtained from all participants are similar. Moreover, the results obtained from high school and maritime faculty participants have shown no difference in understanding the Rules.

Questions for testing the opinion of seafarers, like a minimum CPA, parallel course overtaking, and distance for start avoiding collision have received different answers because there are no correct answers in the Rules, but a difference between participants with and without sea experience has been noticed as is shown in Figure 2.

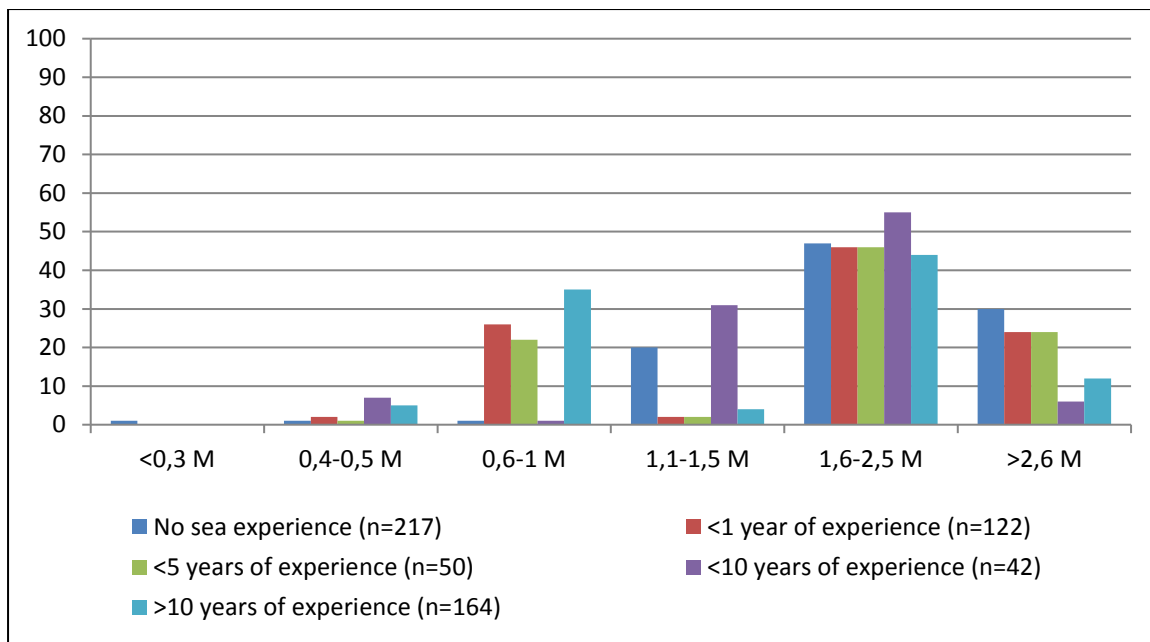


Figure 2: Percentage of answers for a minimum CPA opinion testing by different respondent groups

Rules which are hard to understand according to all participants are Rule 6 (Safe Speed), Rule 8 (Action to Avoid Collision), Rule 9 (Narrow Channel), Rule 10 (Traffic Separation Scheme), Rule 13 (Overtaking), Rule 18 (Responsibilities between Vessels) and Rule 19 (Conduct of the Vessels in Restricted Visibility). The results are showed in Figure 3.

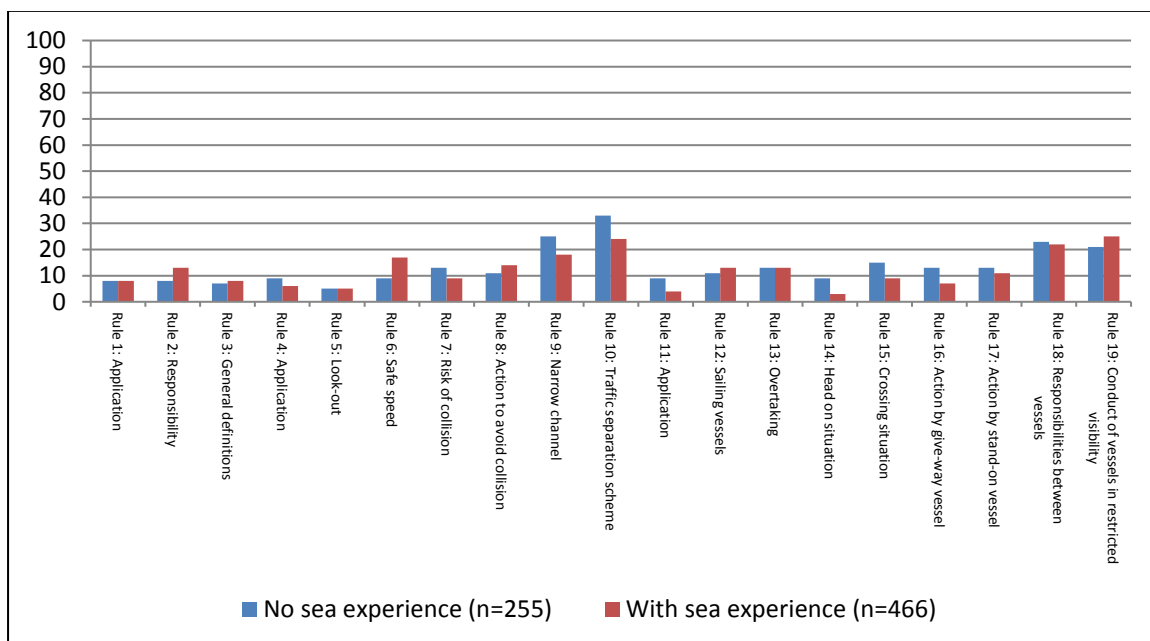


Figure 3: Rules which are most difficult to understand for participants without and with sea experience

Questions about using VHF in collision avoidance have shown that participants with sea experience less than 10 years use more VHF in collision avoidance than participants over 10 years of sea experience. Moreover, only 40 % of the participants with sea experience use more VHF communication after AIS equipment become mandatory, and 70% believe that VHF contact can be useful for preventing collisions at sea.

Questions for maritime education and training lecturers have shown that over 63% of students have problems in interpreting the Rules.

According to maritime education and training lecturers, Rules which are most difficult for students to understand are Rule 19 (Conduct of the Vessels in Restricted Visibility), Rule 18 (Responsibilities between Vessels), Rule 10 (Traffic Separation



Scheme), Rule 6 (Safe Speed) and Rule 7 (Risk of Collision), and those answers are very similar to the answers given by other participants. The results are shown in Figure 4.

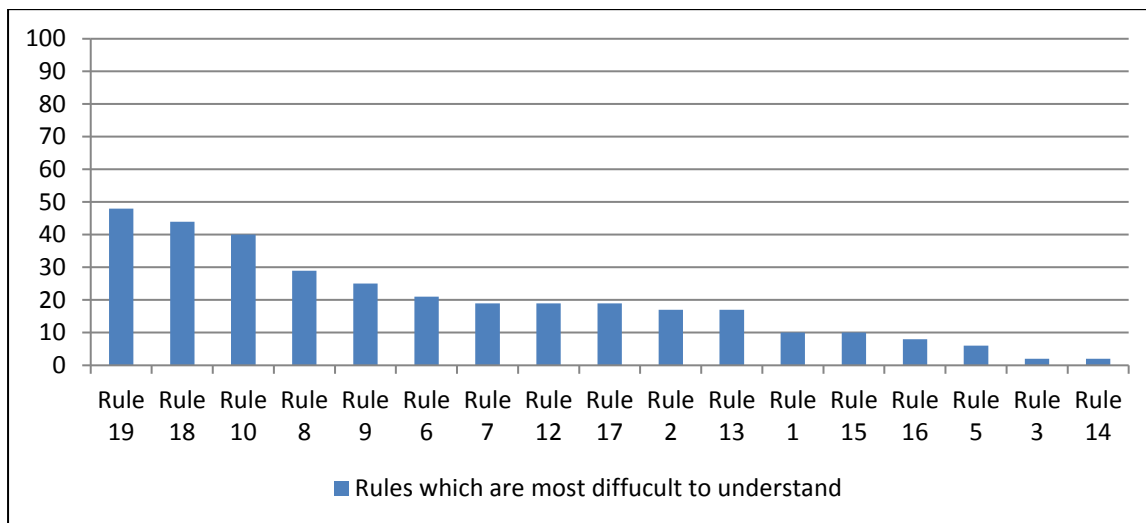


Figure 4: Rules which are most difficult for students to understand – answered by lecturers



7. VALIDATION OF THE QUESTIONNAIRE RESULTS

In order to validate the results of the questionnaire, workshops have been organized in all of the partners' countries and the research results obtained have been presented. The workshops aimed at presenting the results of the research, at validating the obtained results through discussions, at conducting discussion on the methods of learning the Rules and at determining the best way to use the results of the project for long-life learning.

In all partners' countries, workshops have been attended by 102 participants: teachers and professors at maritime colleges and faculties, seafarers, representatives of government authorities and maritime companies, pilots and members of various professional associations related to maritime shipping.

It has been concluded, on the workshops, that the results obtained have been in accordance with the workshop participants' opinions and that there has been a strong need for the implementation of new methods of learning and teaching of COLREGs.

The questionnaire results and the conclusions from workshop discussions have clearly confirmed that there are significant differences in the understanding and application of the Rules.

8. FINDINGS OF THE RESEARCH

Taking into account all the facts stated above, the following conclusions can be drawn:

1. Need for the change or review of the COLREGs. The rules would have to have some minor changes or updates in accordance with evolving technology, and some drastic changes that are unlikely to expect. And what is more important is that the existing rules have to be interpreted precisely, so that they can be understood in the same way by everyone.
2. Necessity to determine the relationships and the hierarchy of the Rules. Rules that have priority over the other ones have to be clearly determined and navigation officers should be able to apply them without having any difficulty. A flow chart showing the priority of the rules is suggested. This would also lead to developing a sequence for learning/teaching the rules.
3. Establishing common understanding of the Rules – COLREGs guidelines. Establishing a common understanding of an individual rule through some kind of Guidelines is needed and standardizing the education, training and assessment of COLREGs through the COLREGs Model Course. COLREGs model course should be an integral part of the STCW. It is interesting that professional seafarers think that Rules and literature for learning Rules should be clarified, and non-professionals are satisfied with the learning materials. This has to be born in mind when preparing the COLREGs Model Course.
4. Need for a further clarifications of some Rules. At each workshop, it was pointed out that certain rules should be clarified. In some rules, certain definition should be added in order to clarify the rules. While explaining the rules, manoeuvring characteristics of the vessel should be included in order to make correct decisions on taking appropriate actions to avoid collision.
5. Establishing a brief COLREGs course and develop a COLREGs e-course. The COLREGs course should be easy to use by simple means of the information technology, rather than by expensive simulators.
6. Considering the results of the ACTs questionnaire and the analysis of the actual collisions, the conclusion is that the Rules are not easy to understand or apply in certain cases.
7. In order to improve the Rules learning methodologies for students and seafarers it is suggested as follows:
 - To use the case study scenarios to cover each individual rule
 - To include as many as possible scenarios as real life may pose within COLREGs training case studies
 - Radar view together with the bridge view should be included in the case studies



- Use of Court decisions for the interpretation of case studies
 - Use of as much as possible visual images to make teaching COLREGs more effective
 - Training methodologies: use of images, simulators, CADs and visuals
 - Use of former accidents scenarios in an animated form
 - Using of 3D dynamic animations, day and night, when cases and examples are used to support rules explanations
 - Use of multi-ship situation scenario
 - Use of materials such as animated scenarios of the Rules so that cadets can see the Rules in action and role play as vessels, to see the results of their decisions
 - Scenarios must always be based on impartial reports e.g. MAIB reports or similar ones to ensure impartiality in the decision and report findings used for the scenarios
 - Use of e-learning solution, software, mobile app to let students run short COLREGs
8. Need for official translation of COLREGs. Official translation of COLREGs in multiple languages could be made, but even more important are the explanations of the Rules.
 9. COLREGs test should be prepared in the mother tongue language and in English as well.

9. CONCLUSION

The questionnaire results and conclusions of workshops discussions have clearly indicated problems in the understanding and application of COLREGs by nautical students and maritime professionals and non-professionals. As the research has been conducted in the EU and worldwide, the obtained results are relevant because different learning methods have been included into the survey and all those methods have shown same deficiencies. This gives clear results that it is necessary to improve the learning methods of COLREGs in the future.

The project clearly showed that there are fundamental interpretation of the rules in multi-ship collision environment and when more than one rule applied in any situation. The ongoing work on the project includes the development of a set of new scenarios for multi-ship collision environments and multi-rule situations with a view to improve the learning method in these cases. It is possible to achieve a reduction of collisions at sea by a better understanding of the aforementioned complex situations by professional and non-professional seafarers, and it is believed that this new teaching methodology of the multi-rules and in situation when there are more than one ship involved would contribute to making the seas safer. Part 2 of this paper primarily concentrates on more complex cases that were considered in the ACTs project.

REFERENCES

- [1] Mohavic, D., et al. (2018), Avoiding Collisions at Sea – From Multi-Ship To Ship-To-Ship Encounter, IMLA 2018, Manila, Philippine - http://www.marifuture.org/Publications/Papers/ACTS_Plus_IMLA25_Paper.pdf
- [2] Ziarati R., et al. (2017) Avoiding Collisions at Sea – Pareto Analysis, IAMU Conference, Bulgaria http://www.marifuture.org/Publications/Papers/Avoiding_Collisions_At_Sea.pdf
- [3] Acar, U., Ziarati, R., Ziarati, M. (2008). Collisions and groundings – major causes of accidents at sea. Marifuture papers: 48 - 51. http://www.marifuture.org/Publications/Papers/Collisions_and_groundings_major_causes_of_accidents_at_sea.pdf (last accessed, November 2014).
- [4] Acar, U., Ziarati, R., Ziarati, M. (2012). An investigation into COLREGs and their application at sea. Marifuture papers: 40-47.



- [5] European maritime safety agency. (2010). Maritime accident review. <http://emsa.europa.eu/publications/technical-reports-studies-and-plans/item/1219-maritime-accident-review-2010.html> (last accessed, September 2014)
- [6] Macrae, C. Human factors at sea: common patterns of error in groundings and collisions. *Maritime Policy & Management: The flagship journal of international shipping and port research*: 33.
- [7] Marine Accident Investigation Branch. (2004) Bridge watch keeping safety study. http://www.maib.gov.uk/cms_resources.cfm?file=/ Bridge_watchkeeping_safety_study.pdf (last accessed, November 2014).
- [8] European maritime safety agency. (2010) Maritime accident review. <http://emsa.europa.eu/publications/technical-reports-studies-and-plans/item/1219-maritime-accident-review-2010.html> (last accessed, October 2014)
- [9] IMO Publications (2003). *COLREG – Convention on the International Regulations for Preventing Collisions at Sea 1972*, Consolidated Edition 2003, London.
- [10] Maritime professionals' on-line survey: <http://limesurvey.c4ff.co.uk/index.php?r=survey/index/sid/613743/lang/en> (last accessed, January 2015).

Part 3 – ACTS Plus

It is clear to everyone that explaining the application of collision avoidance rules between two ships at sea is not enough. This is because in practice, more than two ships are often encountered in the same area and then collision avoidance becomes much more complex.

Therefore, ACTS Plus focuses on situations where more than two ships are encountered in the same area, or when obligations between encountered ships require the determination of the hierarchy among the applicable Rules.

In such encounters, there is a need to explain the relationships and hierarchy of the rules in order to determine suitable courses of action to avoid collision. Furthermore, in explaining the application of the Rules, it is very useful to use scenarios that occur (or may occur) in practice when more than two ships are encountered or, when multi-ships are encountered that have different constraints or when ships are encountered in specific areas such as Narrow channels or Traffic Separation Schemes.

The goal is to prepare Complex Multi-rule and Multi-ship Scenarios in an easy and user-friendly manner and clearly explain which Rules the mariners should apply.

As an appropriate way to facilitate the application of COLREGs in multi-ship encounters is “Divida et Impera” approach, the ACTS Plus Project utilises this approach. The “Divida et Impera” approach is based on splitting the multi-ship encounters into several ship-on-ship encounters taking into consideration if the situation is occurring on high seas, in narrow channels, in Traffic Separation Schemes, or in coastal waters. It also takes into account encounters between ships with different responsibilities, or when ships are navigating in or near areas of restricted visibility.

It is not unusual to discover several contrary obligations of a single ship identified in the ship-on-ship encounters. The analyses of these obligations are often needed in interpreting and finding the most appropriate collision avoiding actions for the Give-way vessel(s).

To make the use of ACTS Plus Project easier, a Complex COLREGs Teacher Training Programme has been prepared. This Teacher Training Programme is written in a manual form so that it can also be of benefit for the trainees as well as the trainers. It contains all the necessary information required by the teachers/instructors of Advanced COLREGs Course. Guidance to instructors/trainers, on application of all scenarios, is given online. A copy of the Programme can be found in the project website (www.advanced.ecolregs.com).



1. Aims of the ACTS Plus Project

The ACTS Plus Project concerns is designed to enable Deck Officers and Masters to take responsibility for the safe movement of the vessel, improving their skills on the application of Regulations for Preventing Collisions at Sea (COLREGs) when encounters multi-ship scenarios.

Furthermore, the project is intended for all COLREGs Teacher to teach application of the COLREGs their students and trainees in a better and more successfully way.

This Project has been established to develop the current personal and professional skills needed for navigators to safely handle the ship in condensed waters. This unit highlights the importance of seeking feedback from repeatedly conducted practices from various multi-ship applications to improve performance by continuously reviewing their learning needs.

ACTS Plus w Project will also enable learners to evaluate the effectiveness and impact of their learning against the achievement of their role and a mission as a navigator and chosen career path as a Merchant Navy Deck Officer.

This Project relies heavily on the assumption that the learners already have gained the knowledge of COLREGs and have had experience and familiarity with the non-advance unit covered by previous ACTs (Avoiding Collision at Sea) course (www.ecolregs.com). The unit content emphasises on the appropriate understanding of collision regulations and their interpretation and analysis of complex multi ship scenarios at Sea.

The ACTS Plus Teacher Training Programme provides guidelines how to show Complex Multi-rule and Multi-ship Scenarios in an easy and user-friendly manner with a clear interpretation to promote better understanding of the Rules. The Programme gives in details the explanation as how to use Advanced COLREGs Course which demonstrates various situations involving more than two vessels in the three main types of situations: Crossing situation, Overtaking situation and Head-on situation which can take place on the High Seas, in Narrow Channels, in Traffic Separation Schemes and in Coastal Waters. A total of 18 scenarios were thus developed. Teacher Training Programme explains in details just one scenario, *Overtaking and crossing situation on the high seas*, which can be equally applied to all other scenarios. This example clearly explains the "Divida et Impera" approach used on the multi-ship encounter scenario. The greatest challenge was not to determine huge number of scenarios, but the way in which the Rules should be applied and which collision avoidance actions can be taken so that the actions that were taken fully complied with the COLREGs. Normally the number of scenarios in practice can far exceed the 18 that the Advanced COLREGs Course platform contains, but using the principle of solving complex collision avoidance situation as shown in the 18 developed scenarios, any other complex situation of encountered ships can also be solved.

For the assessment purposes, use of COLREGs Assessment platform is explained and the programme is expected to be presented to an internationally recognised accrediting institution for recognition.

Objective of ACTS Plus

Elements of the ACTS Plus and its Teacher Training Programme provide the detailed knowledge to support the training outcomes related to the Navigation and collision avoidance, and assist command decision-making in a complex situation.

Conclusions

CONCLUSIONS

It is clear that there are real concerns as respondents with no seafaring experience did better than expected. It is pertinent to note that results of survey were based on a sample of some 1500 people but even so the outcome is not encouraging. A new survey may have to be initiated to verify the outcome of the ACTs survey which could shed more light on the level of



understanding and application of COLREGs. The introductory part of the paper has identified serious issues with COLREGs. Use of VHF has also been a case for concern. If COLREGs are understood better and interpreted correctly the probable effect will be the more confident navigational duties that officers can perform. It reduces the use and dependency on VHF.

The MET programmes are the parts of the broken segment if the COLREGs today are not as effective as it should be. There is no room for seafarers in charge of vessel to be 80% correct, what should be required are 100% confidence and no less. A set of standards for officers and higher ranks across Europe may be helpful to justify the understanding of seafarers so that COLREGs can operate in an environment of mutual comprehension, understanding and coordination. The Project ACTs Plus online course with some 18 scenarios many of which were developed in ship simulators and videoed would help all seafarers to interpret COLREGs and apply them correctly when there is possibility of a collision. The COLREGs need to be updated to meet the improved technology demands. The more automated systems may well be included where needed. The national authorities may take the COLREGs more seriously and issue similar guidance (MCA, 2002) to their seafarer network to spread the word of COLREGs and discourage the use of VHF at sea. This paper was primarily written to warn against treating all rules equally. This is because as shown by the Pareto Analysis some of the Rules, particularly for instance Rule 19, are more challenging and hence further work is recommended. Also it is of paramount importance to consider scenarios where more than one rule applies.

ACKNOWLEDGEMENT: The authors would like to thank all partners for their contribution to this paper.

REFERENCES

- Belcher, P., 2002. A sociological interpretation of the COLREGs. *The Journal of Navigation*. 55(213-214). pp.3.
- IMO, 2010. Maritime Knowledge Centre. Current awareness centre. November. p.7
- IMO, 1999. Officer in charge of the navigational watch (Model Course 7.03).1999 Edition.
- MAIB, 2004. Bridge Watchkeeping Safety Study: a case study of maritime accidents. Maritime Accident Investigation Branch.
- MARS, 2005. Use of VHF in Collision Avoidance 1. [Online] Available at: <www.nautinst.org/MARS>. Report no: 200518 [Accessed on 12 April 2011]
- Parker, C., 2010. Fairplay. *The psychology of marine engineering*.370 (11), pp.26
- Stitt, A.P.A., 2002. The COLREGS – Time for a rewrite?. *Journal of navigation*. 419-430. pp.2.
- Ziarati, R., 2006. "Safety at Sea – Applying Pareto Analysis" Proceedings of World Maritime Technology Conference (WMTC 06), Queen Elizabeth Conference Centre.
- Ziarati, R., Lahiry, H., Mohovic, D., Baric, M., Velikov, N., Teege, T., Akdemir, B., 2017. Avoiding collisions At Sea – Pareto Analysis, MariFuture, January 2017.