Novel Approach For Assessing The Results Of Radar - ARPA Simulator Training

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ABSTRACT
The ultimate purpose of this study is to develop one novel approach for assessing and analysing the results of the Radar and ARPA simulator training as it is improved by each maritime university and institute in the world. There are many different kinds of Maritime Education and Training (MET) simulator in the maritime training universities/institutes all over the worlds. These MET simulators are going to be one of a major training facility in maritime universities/institutes. These MET simulators include Radar-ARPA, GMDSS, Ship handling, Cargo handling and Engine room simulator and so on.

The Standard Training Certificate and Watch keeping (STCW 95) have additional standards for Radar and ARPA simulators as simulating the operational capabilities. The instructor should not only consider the capabilities of simulator facility but also take into account the ability to assess the results of training for MET. Then we had some experiments for assessing the results of Radar and ARPA simulator training. There were four scenarios. The first scenario has one own ship and one target ship. These ships get sufficient distances in head-on situation. There are one own ship and two target ships on the second scenario. The first target ship comes from the port side and the other came from starboard side in three ways stand off situation. The third scenario has one own ship and three target ships. All target ships are crossing in a row ahead of own ship. The last scenario has a total of seven vessels, one of them is own vessel, and the other six are target vessels. In these experiments, three different groups of student were chosen for experimental subjects to analyse the results. The first group of students was second year students who had had no lessons on this Radar and ARPA simulator training. The second group was third year students who had had the lessons on the Radar and ARPA simulator training. The third group fourth year students who had finished the long term on board training and they understand how to use operate the Radar and ARPA equipment. Each group consists of ten students.

Consequently authors analyzed the results of these experiments, compared these experimental results of different academic year students and show the efficiency and effectiveness with the training and lesson about Radar and ARPA. Finally authors propose one novel approach for assessing the results of Radar and ARPA simulator training based on these experimental results and some recommendations for future MET training.

1. Introduction

Radar and Automatic Radar Plotting Aids (ARPA) simulator training are compulsory training for maritime universities and institutes. STCW 95 has standards for Radar and ARPA Simulation:

"Radar simulation equipment shall be capable of simulating the operational capabilities of navigational equipment which meets all applicable performance standards adopted by the Organization and incorporate facilities to:

1. Operate in the stabilized relative motion mode and sea and ground stabilized true motion modes,
2. Model weather, tidal streams, current, shadow sectors, spurious echoes and other propagation effects, and generate coastlines, navigational buoys and search and rescue transponders; and
3. Create a real time operating environmental incorporating at least two own-ship stations with ability to change own ship's course and speed, and include parameters for at least 20 targets ships and appropriate communication facilities.

ARPA simulator equipments shall be capable of simulating the operational capabilities of ARPAs which meet all applicable performance standards adopted by the Organization, and shall incorporate the facilities for:

1. manual and automatic target acquisition,
2. past track information,
3. use of exclusion areas,
4. vector/graphic time-scale and data display, and
5. trial manoeuvres" (STCW, 1995).

Authors decided to development for the Radar and ARPA simulator training. Authors prepared two steps for experiments. In the first step they prepared three different scenarios, which were open sea and have one to six targets. In second step, authors divided ten students each class except first year students. Each selected student passed all scenarios. After all experiments, they analyzed results of the experiment.

2. Experimental Facility

2.1 Radar and ARPA Simulator in I.T.U. Maritime Faculty

The Radar and ARPA Simulator in ITUMF is shown in Fig. 1, which includes 2 own ship's bridges equipped with different navigational instruments. This simulator is predominantly used as radar booths, but is each equipped with a visual display system. Each of visual views, which has 60 degree's horizontal field, is generated with a highly efficient virtual image generation system (Sindel Vision 6000). The acoustic effect that are the sounded from outside vehicles or from the vessel's own engine is generated with a corresponding acoustic generator.

Each of the bridges includes following components:

- 2 consoles with Radar and ARPA unit (two Sperry, and two generic display)
- steering-stand console
- chart table with navigational instruments such as Loran, Omega, GPS, DGPS, Echo sounder
- Visual Generator with LCD Projectors

Fig. 1 Bridge of the ARPA-Radar Simulator in ITUMF

2.2 Experimental scenarios

This experiment has four different and typical scenarios. The first scenario is a **"head on situation"**, second one is a **"three-way stand off"**, third one is a **"multiple crossing situations"** and fourth scenario is a "**continuous crossing situation".**

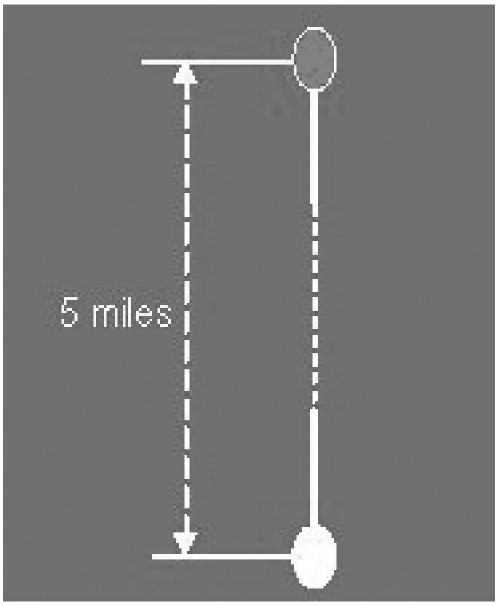

Fig. 2 Head on situation (Scenario 1)

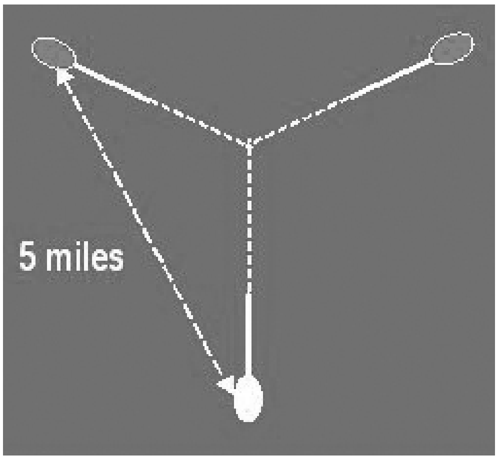

Fig. 3 Three-way stands off (Scenario 2)

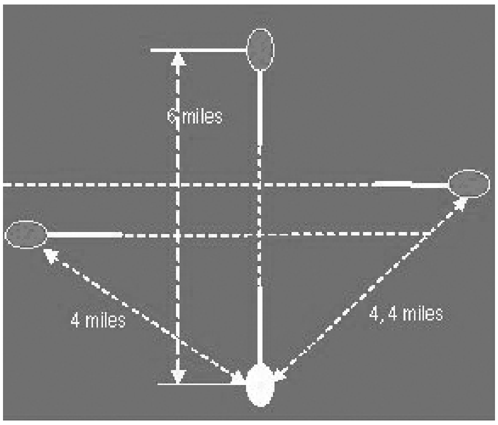

Fig. 4 Multiple crossing situations (Scenario 3)

Fig. 2 shows the first scenario that has only two vessels. One vessel is an own vessel, and the other vessel is a target vessel. The own vessel's course is 000˚, the target's one is 180˚, and so two vessels have opposite course but same speed. The experimental subjects (students) can select various actions (manoeuvring by using-ordering course and/or speed) to avoid a collision with target vessel.

Fig. 3 shows the second scenario that has three vessels. One is own vessel, the others are target vessels. One target vessel has takes a course on 245˚ and speed in 18.0 knots, the course of another target vessel is 115˚ and speed is 18.0 knots. Own ship's course is set default value on 000˚.

Fig. 4 shows the third scenario (Scenario 3) has four vessels all together, one is own

Fig. 5 Continuous crossing situations (Scenario 4)

vessel, and another three vessels are target vessels. Own vessel's course is 000˚, the first target vessel's course is 270˚, the second vessel's course is 180˚ and the last target vessel's course is 090˚; all target ships' speed are 18.0 knots. Fourth scenario (Scenario 4) has total seven vessels, one of them is own vessel, and the other six are target vessels, as displayed by Fig.5. Own ship's course is 000˚, target ships' course on 270˚ and speed in18 knots. The distance among internal of all target ships are 3 miles.

2.3 Subjective Risk of Collision (SRC) Level

During the experiment, the all experiment subjects (students) must answer the SRC values every one-minute. It is defined that a navigator cognises Subjectively the Risk of Collision (Umatani, 2001). It was used to make a quantitative assessment of the risk of collision at 5 levels. Level 1 is the first level which a navigator never feels an existence of the risk of collision. Level 2 is the second level which a navigator rarely feels an existence of the risk of collision. Level 3 is the third level which a navigator usually feels an existence of the risk of collision. Level 4 is the fourth level which a navigator strongly feels an existence of the risk of collision. Level 5 is the maximum level which a navigator extremely feels an existence of the risk of collision. Fig. 6 shows S.R.C. Sheet that is used in this study to analyse as follows.

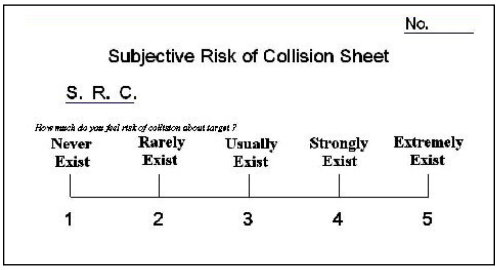

Fig. 6 Subjective Risk of Collision – SRC

2.4 Heart Rate Monitor-HRM

The Heart Rate Monitor is equipment that consists of a watch, a heart belt and software, can measure heartbeats. This model of the heart rate monitor made by POLAR Co. Ltd. is called S 810 shows as Fig.7. Professional and amateurs athletes have been relying on the information provided by the heart rate monitor as follows,

- A heart rate monitor is like a rev counter, giving a precise measurement of exercise intensity,
- Training at ideal pace is made possible with a heart rate monitor,
- Direct measurement of heart rate during exercise is the most accurate way to gauge performance,
- Progress can be monitored and measured, increasing motivation,
- It introduces objective observation,
- It is a tool for regulating frequency and intensity of workouts.

Fig. 7 Heart Rate Monitor – HRM

3. Results and Discussions

Authors' main aim is to find the effective Radar and ARPA simulator training method and is to develop the assessing method for Maritime Simulator Training. In the first step of this study, one method and one experimental result to quantify the maritime training results with using simulator are shown clearly. At the end of the first step of this study, three results are as follows,

(1) It is necessary to combine the subjective assessment and the objective one, and so all trainees should use above two results to assess the training.

(2) Before the training, all trainees must make good use of all nautical instruments.

(3) There are three indexes of goodness to assess the subjective results of training,

but it is difficult that two indexes of goodness for collecting and cognizing information are verified in the middle of training, because these two indexes of goodness depend on the level of proficiency about ARPA and Radar. Accordingly these two indexes of goodness should be assessed before this training.

(4) The S.R.C. helps a trainee to assess goodness for judgment and decision-making.

In the first step of study authors used scenario 1, 2 and 4 with student except first class year, but second step they used scenario 1, 2 and 3 with different students except first class year. Authors used new equipment, that is a Heart Rate Monitor, with subjective risk of collision (SRC) at the second step, and have four interesting and significant results as follows:

(1) After analysing, the heart rate and subjective risk of collision (SRC) have no correlations other.

(2) The SRC value has non-linear relation with four parameters [the distance from own vessel to targets, relative bearing, closest point of approach (CPA) and time of closest point of approach (TCPA)], but heart rate has shown no correlation with four parameters, according to relation between the risk of collision and four parameters; distance from own vessel to targets, CPA and TCPA obtained a strong correlation between each other.

(3) The physiological factors are physiological factors, physical factors, pathological factors and pharmaceutical factors. The psychological factors are psychological and psycho-social factors. The SRC is one psychological index, but heart rate is a physical factor. The combination of the subjective risk of collision and the heart rate is one of the human factors.

(4) The authors found the characteristics of the non-linearity between the SRC and four parameters. This relation, which has resulted from the regression analysis which is Microsoft excel program, used by authors, could be used in a special case and if it was implemented to general case, but it had a significant results. For future studies, authors believe that the knowledge about internal and/or external human factors can be used heart rate monitor by a specific model.

Scenario 1, 2 and 3 are used in the third step of study. In this step authors used statistical software (SPSS 11.5) for analyzing data by regression analysis. The most effective and variable explanation on the SRC was DISTANCE as the first element where students were concerned about assessing the risk of collision. CPA was less important for students to avoid the collision. The similar relation was between CPA and DISTANCE. Lecturers/operators for Radar and ARPA simulator training should prepare specific scenarios for only using ARPA information such as CPA and TCPA for improving the using Radar and ARPA functions.

Authors finished three steps their study. Authors analyzed results of steps by using six criteria. These criteria are Knowledge, Methodology, Human Factor, Facility Factor, Environmental Factor and Management Factor. These criteria are divided into two parts. One part is Knowledge and Methodology as internal factors; other part is human, facility, environmental and management factor as external factors. Authors compared results using six criteria shown as table 1.

	KNOWLEDGE	METHODOLOGY	HUMAN FACTORS	FACILITY FACTOR	ENVIRONMENTAL FACTOR	MANAGEMENT FACTOR
1.STEP	X			X		
2.STEP		X	X		X	
3.STEP	X			X	X	X

Table.1 Results of three steps of study

Authors developed environmental approach model for enhancing scenarios by results of these studies shown as Fig 8. First step is *Aim* at the model; instructor must decide to aim for scenario and to put objectives for this aim. Second step is *Facility*; every MET have Radar and ARPA simulator that's why instructor must care for facility of simulator such as what kind of facilities which are day or night and fog, rain and heavy wave, can be used in scenarios. Environmental factor affects facility and it is relevant to aim of scenario. Third step of the model is *Methodology*. Institutes designate the general methodology of training in their policy and also they should use the guidelines of STCW Convention for making this methodology. On the other hand instructor may affect methodology while putting it into practice. Instructor who is the person makes to implement the scenarios by using these internal factors. Student is mainly important item due to they implement scenarios which is prepared for them. The success level of students in scenarios is affected by knowledge and human factor. Student's knowledge is depending by class. Human factor effect is varying by students. Some students can be nervous; some of them can be ease in the scenarios. Finally when all above items are combined in harmonization, the best scenario can be obtained for purpose of the training.

Authors prepared a *Questionnaire*, which used the Environmental Approach Model, displayed in table 2. It helps instructors for evaluating their best scenarios.

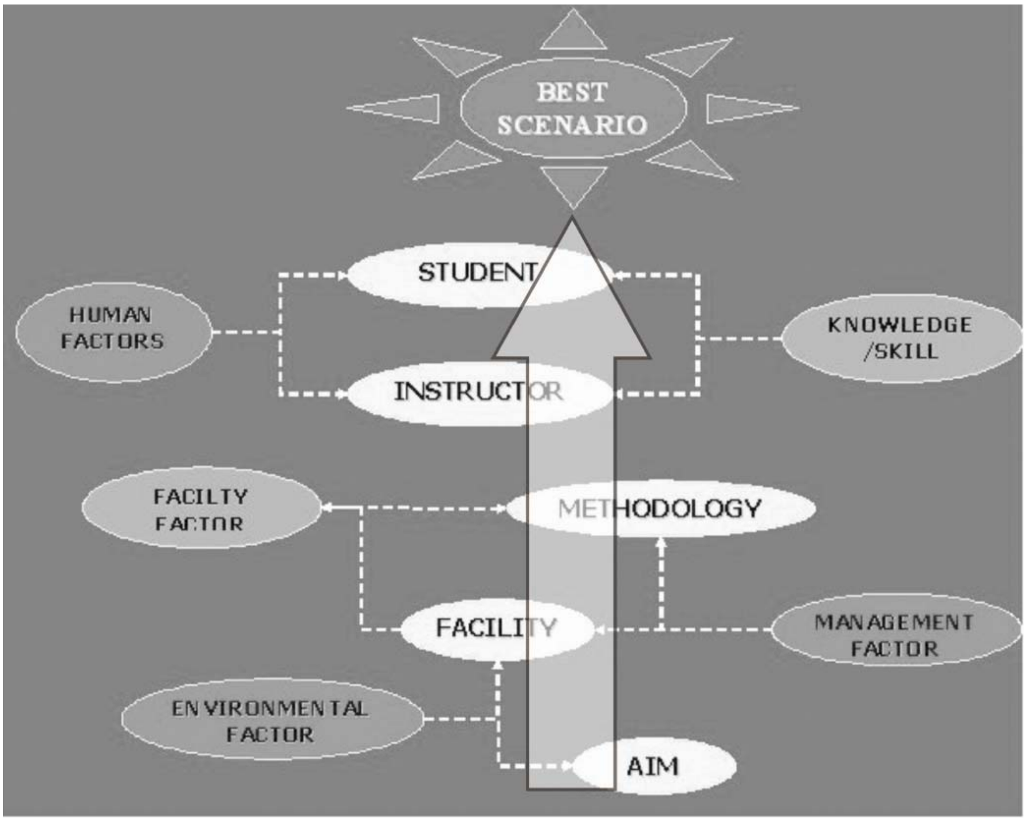

Fig. 8 Environmental Approach Model for the best scenario

NO	*ITEM*	-2 Strongly Disagree	-1 Disagree	0 Neutral	1 Agree	2 Strongly Agree
1	The scenario's time is enough	☐	☐	☐	☐	☐
2	I think scenario was difficult for me					
3	I understand my role of the bridge team					
4	I could use navigation equipment during scenario					
5	I lost target ships because of night (If scenario is night)					
6	I lost our ship manoeuvrability after fog (If scenario has fog)					
7	I lost our ship manoeuvrability after rain (If scenario has rain)					
8	I think scenario was easy for me					
9	I could plot to target ships on the ARPA-Radar screen					
10	Bridge was crowded					
11	I think we get aim of the scenario explained briefing section					
12	I think the traffic situation in scenario is too complex					
13	Communication in the bridge team is good					
14	Everybody knows their task in the bridge team					
15	I think no need to be a team					
16	I deeply treat what my task in the scenario					
17	Briefing explanation is enough to understand scenario objectives					
18	De-briefing material in an interesting way					
19	The objectives of scenario are more subjective					
20	The objectives of scenario are more objective					
21	Lecturer should interfere to scenario					
22	Before briefing section some texts should be given about scenario					
23	My knowledge of the subject has increased after scenario					
24	I think we never get a real situation like as this scenario					
25	I clearly understood the assessment requirements for main aim of the scenario					
26	The assessment method were effective					
27	The relationship between this scenario and other scenarios in the lesson is well understood					
28	I think this scenario should be repeated one more time					

Table 2. Frame of the Questionnaire

4. Conclusion

The final purpose of this study's authors was to develop one novel approach for assessing and analysing the results of Radar and ARPA training as it is improved by maritime universities and institutes around the world. The main aim of the study is to create a new model for Radar-ARPA training. The authors came to the following conclusions:

1 To propose the novel Environmental Approach Model for the best scenario.

2 To prepare the Frame of the Questionnaire for assessing students and developing scenarios by using the novel Environmental Approach Model.

3 To propose how to consider the scenario before for making and after for evaluating by using above the Questionnaire.

Acknowledgements

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BIOGRAPHY

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Tanzer is research assistant at the Deck Department of the Istanbul Technical University Maritime Faculty since 1997. He was previously officer, chief officer and captain of the different type of vessel between 1990 and 1997. He is responsible lecturer of the Radar-ARPA and Ship Handling Simulator. He lectures some advanced STCW Courses (Bridge Resource Management, Ship-Company and Port Facility Security Officer and VTS Training). He started PhD in 2001 and research subject is “Marine Pollution and Reception Facility”.

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Nobuyoshi Kouguchi received the B.Sc. degree from Maritime University of Kobe in 1978 and Ph.D. in telecommunication engineering from Osaka University in 1998. Between 1991 and 2003, he was an associate professor at Maritime University of Kobe, and science 2003, he has been an associate professor at Maritime Science Faculty of Kobe University. His research interests are the evaluation for Maritime Education and Training, the signal processing for RADAR and GPS signal (especially Arrayed GPS Buoy Wave Observation System and Wavelet Transform of RADAR signal) and navigator’s cognitive and decision-making process.

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Masao Furusho is a long term expert of JICA (Japan International Cooperative Agency) Project on improving maritime research activities. He graduated from the Department of Nautical Science, Kobe University of Mercantile Marine in 1978. He holds the First Grade Maritime Officer (Navigation) in 1986, Doctor of Psychology from Chukyo University in 2000. He is a specialist on Traffic Psychology at Sea, on Maritime Safety Management, and on Visual Perception at sea. His research interests are lookout, visual performance and human factors in maritime traffic system. His main educational contents and teaching subjects are ship safety management and good seamanship in maritime traffic system, safety and maintenance of ships.