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Applying the augmented reality concept in maritime engineering personnel training

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Abstract. The article contributes to a common challenge for linking the academic training with the practical skills of maritime personnel in the current highly dynamic maritime environment. The article presents the concept of augmented reality, wider used in the field of information technologies, applied on the training and exercise of qualified engineering maritime personnel by combining real life data (technical indicators of different aggregates from the ship power system, location and development of fire, flood water, etc.) with computer generated data from the simulation complexes. The elaborated innovative shipboard training procedure of combining the work with the Ship Power Plant simulator, fire accident in the engine room, forecasting and alignment / reconciliation of the scenarios for the development of the fire and counter-action on a real fire field has no analogue.

The question "How to make the ship crew management more effective and efficient" is in the very centre of the debates on the role of the human element in shipping. The most popular answer is to make this small group, the crew, behave as a team. The ship is a complex technical facility which is a „*man-machine system* ", generally determined as an „*aggregate of operators and technical means used in labour activity* " [1]. The correct implementation of the systemic approach requires consideration of the environment for functioning of that system. Assuming that the environment is not purely physical and expanding the approach, we shall inevitably reach the model representing the system as an inter-related aggregate of: Technology; Individual; Group; Organizational environment; Society and culture; Practice; Physical environment.

This multi-component model is known as the „*Septigon Model*".[2] That model is useful because „it captures most of the human factors elements that form part of the maritime system. [3]

In addition, the components of the system can be re-defined in three groups:

- Human factor related components;
- Technology;
- Physical environment.

The optimization of the functioning of those three groups of components is essential for the safety training. The Human factor related components and Technology shall be definitely subjected to optimization.

Technologies marked an exclusively quick progress. Their function' reliability had reached high values but nevertheless the human factor related aspects remain a key focus in optimising the crew management. Presently, figures show high share of human errors as a reason for about ¾ of the accidents at sea. In response to that trend, several concepts emerged which are closely directed to

optimization of the human factor related components. Classically, these concepts are related with organizational behavior, leadership, human errors.

This paper elaborates a new conceptual assumption which aims to contribute to the current maritime crew training combining human factor with upgraded technical opportunities and resources.

Augmented reality, part of informatics, can be applied on the training and of qualified seafarers by combining real world data (technical indicators of different aggregates from the ship power system, location and development fire, flood water, etc.) with computer generated data from the simulation complexes.

Virtual reality training (using Engine Room Simulator ERS) and real world elements such as firefighting on board a ship are an extremely important element in the practical execution of the tasks of a real firepower. When working in this system of enriched reality (derived from the idea of added reality), the following subsystems are defined:

- Interactive / real time work (ERS exercises related to controlling and building specific skills and habits in emergency situations) [4];
- Work related to forecasting and matching between the real and the virtual, choosing the best approach in the situation. Already known data from the simulator (sensor readings, sensors, etc.) are used and the possible scenarios for the development of the created environment are observed by working on a fire safety training simulator;
- Working in a real environment of the Fire Zone, eliminating the consequences of the emerging crisis situation, using the best solution from the previous activity.

An exercise for seafarers was developed in a virtual frigate warship in the ERS TehSim5000 simulation complex. [5] The participants are divided into different teams or teams: for firefighting, engine room team, and technical team. The exercise was developed on the basis of the ability of the marine engineers' training complex and the ANZAC vessel model on the simulator, prioritization and finding the best option and method for fire extinguishing in a fire safety simulator and on the real fire field. Various firefighting models have been developed in the ship power system, similar to those used by military frigates.

An important part of the three dimensional training (the three subsystems) is that there is a constant interaction between them and the ability to receive feedback in real live actions. Higher personal safety, efficiency and security are some of the benefits of implementing the developed training concept and reduce the cost of shipowners by creating a lower incidents risk on the workplace.

The exercise emphasizes the individual work and the individual experience of each participant in different working environment, aims at good results related to knowledge, habits and skills acquired during the training and working on a ship.

The concept of preparing and implementing this type of exercise consists of the following stages:

- General theoretical training;
- Elaborating and developing the scenarios for action;
- Training and setting situation - fire in the engine room;
- Applying and sending existing real-time incident data of a fire simulator for action and evaluation;
- Projecting and responding to the real environment on the fire field using the most suitable methods and means of fire handling;
- Feedback, evaluation of actions and implementation of outcomes.

1. General theoretical training

The implementation of new and more sophisticated main and auxiliary machinery management systems requires the development and implementation of special automated training

systems. These modern tools have led to time and resource savings, and a significant increase in learning efficiency.[6] Most of the fires in the engine compartment are caused by a cracked pipe coupled with a hot surface. In order to detect and eliminate the problem, it is necessary to respond professional and quickly. Engine room problems affect not only the crew on spot, but also the safety of the entire ship.

2. Elaborating and developing the scenarios for action.

The simulator sets out scenarios of real firefighting situations faced by engineering staff in a machine room of a certain frigate ship. An important part of the scenario is that the Simulator Ship Power System should be clearly and accurately transmitted to predict and reconcile the scenarios for the development of the fire and the fire elimination on the real firefighting field.

Example of sample action scenario:

- smoke detected on first deck located in the engine room area - ERS alarm system triggered.
- Firefighting team number 1 command: Prepare to fire fight in a machine room. Limitations: Prepare for Class B extinguishing, including petroleum products.
- Firefighting team number 1 responds: The preparation is started in compliance with the specified restrictions.
- IMMEDIATE STOP OF VENTILATION.
- PROVIDING SELF-POWER SUPPLY OF THE VESSEL:

Stop Generator 1 and 2, START the Emergency Generator .

- Firefighting team number 1: Perform Intelligence in the engine room, strictly sticking to the imposed restrictions and safety measures.
- The central management post. Firefighting team number 1 enters the smoky area.

3. Training and setting situation - fire in the engine room.

The simulators are used for acquiring habits and skills, and real fields to gain real experience. They are exact copies of some part of the ship's equipment. The training systems are complete replicas of real-world ship equipment and help to form complex skills and habits at the stage of a single training and working in a team. The firefighting field reproduces various operational effects and is used in conjunction with simulators and simulator systems to find the best method and means of responding to the situation - a fire in a machine room.

3.1. Applying and sending existing real-time incident data of a fire simulator for action and evaluation.

Steps for action and assessing the fire - fire alarm in the safety training simulator:

- Defining and locating the fire.
- Evaluating available capabilities - presence of a firefighting team and various extinguishing options (water, foam, carbon dioxide, etc.).[7,8]
- Formulating the restrictions and criteria for decision making.
- Identifying alternatives.
- Evaluating the alternatives.
- Selection of alternatives and transmission of data to the Real Fire Field.

3.2. Projecting and responding to the real environment on the fire field using the most suitable methods and means of fire handling.

The way the fire on board the ship is organized will greatly affect its effectiveness. The review of the organization should give some inputs into the best way for involving the crew in a concrete emergency situation and the exact fire extinguishing agent. In order for the organization to function properly, it is important to make physical experiments on burning materials by applying the possible fire eliminating methods.[9]

4. Feedback, evaluation of actions and implementation of outcomes.

The aim of the developed exercise is to apply the outcomes from the Real Fire Field for triggering the fire extinguishing system with the respective fire extinguishing agent for achieving the best results.

The outcomes are used for elaborating of a procedure and realization of real-time ship study, involving the presented three-dimensional action (three subsystems): working with the Simulator Ship Power System, fire situation in the engine room, forecasting and unification / reconciliation of the scenarios for the fire development and real extinguishing fire on a Fire Field.

The elaborated innovative shipboard training approach has no analogue in today's training and will be presented for approval by the respective maritime training authorities.

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