Methodology of training members of river units on a ship simulator

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Abstract:

Introduction/aim: This paper aims to present the methodology for creating educational content/scenarios on a ship simulator (bridge simulator) that will serve officers of river units in developing the ability to react when performing regular and military tactical tasks on the ships of the River Flotilla. Also, training on the simulator aims to train officers of river units using modern information technologies.

Methods: The paper uses simulation methods, experimental methods, case studies, and operational research.

Results: Specific educational content/scenarios were created, also specific methodology was developed and the principles were clearly defined according to which content/scenarios are created on the ship simulator.

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Conclusion: By using the ship simulator, in different teaching scenarios, cadets of river units as well as members of river units are trained and acquire the ability to react adequately in real situations in the shortest possible time.

Keywords: ship simulator (bridge simulator), training methodology, river units, emergency response, ship maneuvering.

Introduction

Simulation is one of the most realistic methods in training ship personnel (crew). While training during ship navigation provides a realistic situation of the environment and movement of the ship, there are also several disadvantages such as costs, required time, and difficulty to ensure different situations and specific hydrometeorological conditions during navigation. This can be overcome by using a ship simulator as a training platform since it is cheaper, provides opportunities for rapid scenario changes, and can provide situations with different levels of risk without the risk of damage to a real ship (European Commission, 2018). Simulations as a substitute for reality are very useful. Namely, experimental methods, to which simulations belong, are evaluated as the most realistic. The use of simulators for the acquisition of navigational skills has been present for several decades. The use of the simulator made it possible to see specific and complex navigational conditions in a new way. Namely, the simulators enable the training of various maneuvers and navigation in very specific hydrometeorological conditions. Simulators are very successfully used in the education of future officers of river units, members of the River Flotilla, as well as all other watchkeeping officers. Also, the simulator can be used for training experienced navigation officers who do not have experience with certain ship types which exist as mathematical ship models in the ship simulator.

The research was conducted on the *Wärtsilä Navigation Simulator NTPRO 5000* (Figure 1) which includes:

- two instructor workplaces with a control and supervision station,
- ship control station,
- radar station – Automatic Radar Plotting Aid (ARPA),
- station with electronic charts – Electronic Chart Display and Information System (ECDIS),
- station for ship satellite and radio communication – Global Maritime Distress and Safety System (GMDSS), and
- panels and monitors for visualization.

Figure 1 – NTPRO 5000 Wärtsilä Navigation Simulator

The instructor station on the *NTPRO 5000 simulator* is intended for:

- creation and refinement of training scenarios,
- starting and conducting exercises on the simulator, and
- exercise debriefing.

Simulators also enable the analysis of the ship's maneuvering characteristics by performing various maneuvers such as the ship's stopping distance, turning circle, zig-zag maneuver, etc. By comparing the results of the mentioned maneuvers obtained in real environmental conditions with those obtained on the simulator, it is possible to evaluate the quality of the ship simulator itself. Although practical experience on certain types of ships is of great importance, prior training on a ship simulator can make it easier to get to know their maneuvering characteristics. Also, in this way, the expected ship maneuverability can be tested on the simulator, i.e., in real environmental conditions.

Creation of training scenarios

To create training scenarios, it is necessary to define a clear aim (goal), and the starting point of the exercise. Since the goals are the improvement of special skills in subjects related to ship maneuvering and navigation, it is necessary to respect international Maritime and River

conventions and regulations (International Maritime Organization, 2010, 2014; Službeni glasnik Republike Srbije, 111/2020) which represent the normative basis for the development of training. In particular, it is necessary to respect the regulations that define training based on simulations and apply the required standards, primarily to improve the safety and security of navigation. The International Convention on Standards for Training, Certification and Watchkeeping of Seafarers (International Convention on Standards of Training, Certification and Watchkeeping for Seafarers - STCW) adopted in 1978 with the amendments from Manila in 2010, defines the requirements and standards of seafarers' training (Šoškić et al, 2011).

By using ship simulators, during simulations of extraordinary and specific navigation conditions, participants gain the ability to predict and evaluate critical moments and situations when performing tasks. Thus, the risk of possible accidents is reduced and it helps the members of river units to anticipate and correctly respond to emergencies that may arise in navigation, i.e., to acquire knowledge so that they can perform tasks independently (Radojević, 2013). Training is the process that new cadets of river units go through when they are onboard to learn how to carry out their ordinary tasks, and above all to understand how the ship functions to perform a specific task. In essence, training has a goal that cadets are educated and trained to perform proper actions and procedures onboard and to perform tasks independently. Today, simulations are an inevitable part of almost every learning or training process, and they are especially important in ship management training as well as in basic aircraft management training (Vlačić et al, 2022).

Some of specific situations onboard that can be simulated are search and rescue (Radojević & Kresojević, 2020; Kresojevic & Ristic Vakanjac, 2023), navigation in difficult conditions, navigation in ice and the passage through a lock, but also many others.

The principles of good practice on a ship simulator are:

- risk reduction;
- efficient bridge team management;
- building teamwork in achieving goals;
- an inexhaustible source of the possibility of repeating actions in the created situations; and
- a tool that enables qualitative and quantitative analysis of the created scenarios.

The ship simulator enables teamwork and communication on the bridge as well as building leadership and commanding skills. The following resources are available on the ship simulator to provide the highest possible quality training to the members of river units:

- electronic navigation equipment;
- maps and publications, including electronic resources;
- panels and monitors that simulate the hydrometeorological environment;
- ECDIS;
- GMDSS; and
- ARPA radar.

The ship simulator makes it possible to observe the work of a person in training and if necessary the instructor can run the same scenario and practice all phases of the decision-making process onboard.

The ship simulator is used in river and sea navigation to solve problems of maneuvering, primarily in conditions of restricted waterways, navigation in a limited water area, conditions of shallow water, occurrence of icebergs, overtaking and passing other ships, etc. (Ari et al, 2013).

Considering that the members of river units realized their tasks in navigation on inland waterways, teaching scenarios were created so that they precisely simulate specific situations of navigation on inland waterways. Namely, navigation through inland waterways, canals, or straits is very complex and requires experience and alertness, primarily due to limited water areas, ie., narrow and shallow waterways. The methodology training on the ship simulator (Diagram 1) begins with defining the aims of the training through the creation of a scenario that represents the way and path from the idea to the realization of the exercise itself and later analysis (Sharma et al, 2018). In this research, the defined parameters of environmental conditions, river speed, wind speed and direction, and visibility were used as the parameters of the greatest importance when performing the maneuver of passing through the lock. After defining the ship model, the parameters of the environment, the design and definition of the tasks that trainees should fulfill, as well as the definition of the parameters that are monitored to make the work itself measurable, i.e., to define the success of the exercise itself, are approached. The above data is entered into the software of the ship simulator which creates the training scenarios. In this way, the instructor creates the most faithful navigation simulation.

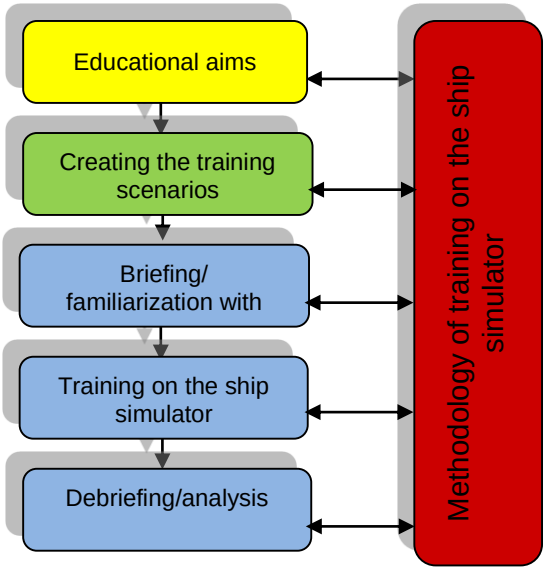

Diagram 1 – Methodology of training on the ship simulator

In the briefing, the instructor presents the simulation to the entire group of trainees. The briefing is "commonly focused on practical information regarding the upcoming scenario and the learning objectives". (Sellberg, 2018).

The instructor also points out the need to know the meteorological and hydrological factors that affect river navigation in order to create the most realistic simulation possible. The instructor, from the instructor's station, constantly monitors the exercise, monitors the reactions of the trainees during the training and records the parts of the exercise interesting for re-examination and analysis (Figure 2).

Figure 2 – Members of the River Units working on the ship bridge simulator

The instructor can stop or pause the exercise, if necessary. This allows the instructor to observe and analyze the characteristic phases of the exercise with the trainees and determine positive actions as well as possible mistakes they made. At the end of the exercise, the analysis starts. In the analysis, the instructor discusses individual procedures on the bridge with the trainees. In this way, critical thinking and reasoning are developed and correct procedures on the ship bridge are learned.

Solving specific navigational tasks

One of specific tasks in navigation on inland waterways is overcoming unevenness, which is achieved by ship locks (Bugarski et. al, 2020). Such a scenario of a passage through a lock is shown in Figure 3.

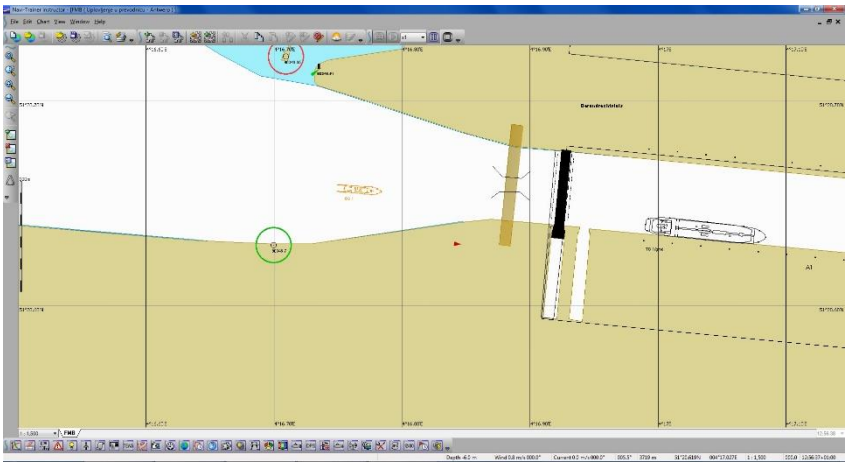

Figure 3 – Instructor's station – ship passing through the lock

The lock itself has its parameters of height and speed transition. In the presented simulation, the lock near Antwerp was used. The mathematical model of the ship used is a patrol ship, which in terms of dimensions is most similar to the ships in the River Flotilla. Ship locks are important elements of waterway systems. To improve the efficiency of transport on inland waterways, it is important to ensure that ships pass through locks without having to spend unnecessary time waiting at lock entrances, which is especially important on frequent waterways (Figure 4). The use of the simulator is particularly effective when practicing entering a lock, where hydrometeorological conditions (wind, visibility, river current) are simulated. The lock specificity requires navigation officers to be very well trained regarding the choice of maneuvers when entering the lock,

mooring the ship, going through the lock, changing the water level and choosing maneuvers when leaving the lock, i.e., exiting it.

The technical characteristics of the lock (length and width of the lock, capacity in terms of the number of ships in the lock depending on their characteristics) determine the actions of navigation officers during the maneuver of entering, going through the lock and leaving it.

By simulating these conditions, cadets and members of river units get an almost realistic picture of the conditions prevailing in the lock and the actions during maneuvering.

All ship maneuvers in locks are complex and complicated tasks for all ships of the River Flotilla, so training in the lock itself without prior preparation would pose a certain risk to crews and ships. Also, in the lock itself, due to the dynamics of activities and the specifics of passage conditions, members of river units are not able to see all the necessary parameters as they can do it on the ship simulator.

At a time when waterways are being digitized and becoming "smart", it is important to work on the availability of information that could contribute to the optimization of the operation of locks and the passage of ships through locks. Certain authors suggest the use of fuzzy logic and smart signalization for better traffic organization in the lock area (Bugarski et. al, 2020).

In this way, trainees understand the importance of efficiency in addition to the safety and security of navigation.

Figure 4 – Visualization of a ship waiting to enter the lock

From the point of view of navigation and execution of a task, ie., in the cases when an entire riverine unit (fleet/flotilla) needs to pass through the lock because there is no alternative waterway, it is necessary for a trainee to calculate the time for that operation. In such situations, the lock throughput is calculated and expressed by the number of vessels that can pass through the lock in a certain period. The throughput capacity of a lock depends, first of all, on the size of the chamber, the duration of the lifting, the method (one-way or two-way lock), the degree of occupancy of the chamber, and the like.

The daily throughput, expressed in the number of ships that pass through the lock, is equal to the ratio of the daily throughput and the time of one lifting (one-way or two-way), which is calculated according to formula (1). So, for example, the daily throughput during one-way transiting the lock of the Danube-Tisa-Danube hydro system (dimensions L=85m, W=12m, T=3m) amounts to 34 ships (if one ship is accommodated in the lock), and it is calculated according to the form:

$$N_1 = \frac{24 \times 60}{T_{pr}} = \frac{1440}{41{,}5} \approx 34 \qquad (1)$$

where: T_{pr} – one-way lifting time.

Large locks, such as the Djerdap lock, which have much larger dimensions (L=310m, W=34m, T=4.5m) and a passage time of 90 minutes, have a much higher throughput.

Throughput power for two-way lifting is calculated according to the same principle as the throughput power for one-way lifting (Rosić, 2010). We can use operational research for the problem of lifting a riverine unit and placing several ships in the lock chamber. In this way, it contributes to the optimization of the process and the efficiency of the task execution.

Comparative analysis of the use of the ship simulator and the training in real conditions on board

After the completion of the training of cadets and the training of members of river units, a comparative analysis of the training on the ship simulator and the training in real environmental conditions on the ship was carried out; among others, the following conclusions were reached:

- The simulator provides opportunities to carry out training under more difficult hydrological and meteorological conditions, which later, especially for navigation officers, gives better results when working onboard.

- The use of simulators for the analysis of certain events (reconstruction) - real situations - accidents, exercises, and similar is particularly important. The simulator enables a detailed analysis of a large number of parameters that cannot be observed in a real situation and subsequently analyzed. Also, this feature of the simulator can be used when planning exercises or real, especially specific military tactical tasks, where, by using the simulator, certain problems can be predicted and overcome, which otherwise could not be timely detected and preemptively warned against. This characteristic of the simulator represents a great step forward in preparing for the implementation of tasks, where a certain number of difficulties can be prevented by preventive organizational measures, which favors the preparation of trainees for the implementation of tasks. The use of simulators with previously performed reconnaissance of the area where the task will be carried out is particularly noteworthy. This feature is basic, and usable for a larger range of tasks, and depending on the character of the specific task, it depends on the effectiveness - the usability of the simulator. In this domain, in addition to better preparation and possible supplementary training for a specific task, it also has a psychological effect, because better-prepared personnel are more confident in themselves and in their technique, and will perform tasks better.
- On the inland waterways of the Republic of Serbia, numerous navigationally difficult areas require great caution because there are dangerous obstacles that threaten safe navigation and therefore the simulator can significantly contribute to preventing accidents and incidents in such areas.

Such assessments were also the subject of analysis in European Union projects or research within academic and scientific institutions. The results reached are similar, and among other things, the conclusions are:

- that training onboard and on the simulator needs to be understood as complementary.
- that it is certain that the degree of realism is always somewhat lacking in the simulator. On the other hand, the training possibilities and the degree of freedom regarding the content of the simulator training are much greater (European Commission, 2018).
- that the last meter during the berthing operation, i.e., as the ship approaches the dock, the behavior of the ship in the simulator becomes less realistic. This also applies to approaching any coastal structure or other ship (Zghyer & Ostnes, 2019).

All researchers agree that the simulator puts the candidates in real situations on the river, enabling navigation in various navigation areas with the same or similar hydrometeorological conditions, without spending material and technical resources, enabling a greater frequency than would be the practice without a ship simulator, while also shortening the time necessary to prepare the exercise.

The training can be carried out on various subsystems (radar, electronic charts, etc.) that are on the ships in particular, which is important for river units cadets because for them the simulator would represent the first contact with those subsystems so that, after boarding the River Flotilla ships, the time required to familiarize with, train on and master these subsystems would be significantly reduced. The simulator is used throughout the education, so that cadets, by gradually mastering the skills necessary for ship management and navigation, reach the maximum level of training that will enable them to use the simulator as an integrated system (Nikolić, 2016).

As the simulator enables navigation with various types of ships, officers who prepare for naval missions have the opportunity to gain insight into the maneuverability of the ships on which they would perform tasks during the mission.

Since practice is important in the training of members of river units, working on the simulator will significantly increase the level of skills and practical knowledge necessary to perform various jobs on the ships of the River Flotilla (Nikolić, 2016).

Conclusion

With the development of modern technologies, the current education system encounters inevitable changes to which the Military Academy, as a higher education institution, continuously adapts. To this end, the NT PRO 5000 ship simulator was introduced into the system of education and training of cadets in preparing for river unit officers as well as of river unit officers' undergoing training. The introduction of the simulator significantly improves the education and training system, which results in better training of river unit cadets for initial duties, in improved levels of training of officers at training courses, as well as in better preparedness of officers for participation in naval missions (multinational operations).

The ship simulator is a system that realistically represents the ship bridge. Training based on simulations contributes to the development of the safety and security of navigation. The goals of the research are the creation of education content/scenarios on the simulator as well as

operational research that is applied to specific situations such as navigation on inland waterways and the ship passing through locks.

Navigation scenarios on the ship simulator are created based on defined and calculated environmental conditions, as well as specific types of ships and locks. Instructors, in this way, create the most faithful navigation simulation. In solving the tasks of optimizing the passage of vessels, ie., operational research is applied to navigation through locks. Seafarers and shipowners around the world use simulators and operational research to solve specific problems in navigation. In addition, simulations provide a platform for professional seafarers, shipowners, and engineers to work together in virtual "real world" conditions to solve specific navigational tasks. This synergy creates the potential for significant savings in the costs of building ships and facilities, their exploitation, and increases the efficiency of safety and security of navigation. The lessons learned using these methods are extremely important in the education of nautical personnel and represent a contribution to the introduction of modern training methods. Training on the ship simulator at the Military Academy provides excellent results, which, in addition to better preparation and possible additional training for a specific task, also has a psychological effect, because better-prepared personnel are more confident in themselves and in their technique, and will better realize assigned tasks.

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Metodología de formación de integrantes de unidades fluviales en un simulador de barco

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CAMPO: informática (educación), ingeniería mecánica
TIPO DE ARTÍCULO: artículo de revisión

Resumen:

Introducción/objetivo: Este artículo tiene como objetivo presentar la metodología para la creación de contenidos/escenarios educativos en un simulador de barco (simulador de puente) que sirva a los oficiales de unidades fluviales en el desarrollo de la capacidad de reacción al realizar tareas tácticas regulares y militares en los barcos de la Flotilla fluvial. Además, el entrenamiento en el simulador tiene como objetivo capacitar a los oficiales de las pequeñas unidades fluviales utilizando las tecnologías modernas de la información.

Métodos: El artículo utiliza métodos de simulación, métodos experimentales, estudios de casos e investigación operativa.

Resultados: Se crearon contenidos/escenarios educativos específicos, también se desarrolló una metodología específica y se definieron claramente los principios según los cuales se crean contenidos/escenarios en el simulador de barco.

Conclusión: Mediante el uso del simulador de barco, en diferentes escenarios de enseñanza, tanto cadetes de unidades fluviales como miembros de unidades fluviales se entrenan y adquieren la capacidad de reaccionar adecuadamente en situaciones reales en el menor tiempo posible.

Palabras claves: simulador de barco (simulador de puente), metodología de entrenamiento, unidades fluviales, respuesta a emergencias, maniobras de barcos.

Методология обучения военнослужащих речной флотилии на судовом симуляторе

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РУБРИКА ГРНТИ: 28.17.31 Моделирование процессов управления,
30.15.35 Теория механизмов и машин,
27.47.00 Математическая кибернетика
ВИД СТАТЬИ: обзорная статья

Резюме:

Введение/цель: Цель данной статьи заключается в представлении методологии создания образовательного контента/сценариев на судовом симуляторе (bridge simulator), который поможет военнослужащим речного флота развить способность быстрого реагирования при выполнении штатных, а также боевых и тактических задач на судах Речной флотилии. При подготовке военнослужащих речного флота на судовом симуляторе используются современные информационные технологии.

Методы: В статье используются методы моделирования, экспериментальные методы, исследование случая и операционные исследования.

Результаты: Были разработаны конкретные образовательные контенты/сценарии, а также конкретная методология при четко определенных принципах, в соответствии с которыми контенты/сценарии создаются на судовом симуляторе.

Выводы: Используя судовой симулятор в различных учебных сценариях, курсанты, а также военнослужащие речной флотилии проходят учения и развивают навыки быстрого реагирования в реальных ситуациях.

Ключевые слова: судовой симулятор, методология обучения, речная флотилия, реагирование на чрезвычайные ситуации, маневрирование судном.

Методика обуке припадника рода речних јединица на бродском симулатору

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ОБЛАСТ: рачунарске науке, машинство
КАТЕГОРИЈА (ТИП) ЧЛАНКА: прегледни рад

Сажетак:

Увод/циљ: Циљ овог рада је да се прикаже методика креирања наставних садржаја/сцена на бродском симулатору који ће служити официрима рода речних јединица у развијању способности реаговања приликом извршавања редовних и борбених задатака на бродовима Речне флотиле. Такође, циљ обуке на симулатору је едукација официра рода речних јединица применом савремених информационих технологија.

Методе: У раду се користи метода симулације, метода експеримента, студије случаја и операциона истраживања.

Резултати: Креиране су специфичне наставне сцене/садржаји, при чему је развијена и методика креирања, и јасно су дефинисани принципи по којима се дизајнирају садржаји/сцене на бродском симулатору.

Закључак: Употребом бродског симулатора, у различитим наставним сценама, кадети рода речних јединица, као и припадници овог рода, обучавају се и стичу способности да у стварној ситуацији реагују адекватно за што краће време.

Кључне речи: бродски симулатор, методика обуке, речне јединице, реаговање у критичним ситуацијама, маневрисање бродом.

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