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PROBLEMI KORIŠTENJA SIMULATORA U EDUKACIJI UPRAVLJANJA I MANEVRIRANJA BRODOM

PROBLEMS DURING SIMULATOR TRAINING IN SHIP HANDLING EDUCATION

SAŽETAK

Najveći broj istraženih utjecaja ljudskog faktora na nezgode u pomorskom prometu vezani su uz ponašanje individualnog člana posade broda i njegov subjektivni pristup rješavanju problema. Poradi toga uspješnost upravljanja brodom uvelike ovisi o vještini, znanju i iskustvu zapovjednika i časnika u straži. Specijalizirani navigacijski simulatori vrlo su korisna sredstva za edukaciju upravljanja i manevriranja brodom. Upotrebom takvih simulatora znatno se može poboljšati edukacija zapovjednika, časnika palube i peljara. Tijekom provođenja edukacije studenata i iskusnog nautičkog osoblja na navigacijskim simulatorima javljaju se određeni problemi koje je potrebno analizirati. Najvažnija nastavna zadaća je kreirati što je moguće više realnu situaciju (scenarij).

Ključne riječi: *navigacijski simulator, rukovanje brodom (manevriranje), edukacija*

SUMMARY

Most of the studied effects of human factor on casualties in maritime transport are related to individual ship crew members' subjective approach to solving the problem. That is why a success in ship management greatly depends on skills, knowledge and experience of the master and the officer of the watch. Specialized navigational simulators are very useful aids in the ship handling education. Using these simulators much can be done on the plane of education of shipmasters, deck officers and certainly of pilots. During the education of students and experienced nautical personnel, some problems have arisen which needed to be analysed. The most important teaching task is creating a situation as real as possible.

Key words: *navigational simulator, ship handling, education*

1. UVOD

Suvremeni pomorski promet kombinacija je stručnih i složenih radnji objedinjenih i definiranih raznim međunarodnim i nacionalnim propisima i standardima. Kao posljedica navedenog, današnji brodovi, promatrajući tehnološki, predstavljaju vrlo napredne sustavne jedinice s visokim stupnjem pouzdanosti svih implementiranih podsustava. Međutim, suvremena tehnologija upravljanja brodom u specifičnom radnom okruženju uzrokuje promjene u ponašanju zapovjednika i časnika u straži [3]. Zbog toga se u istraživanjima, ljudska pogreška pojavljuje kao jedan od glavnih uzročnika svih pomorskih nezgoda (75 – 96 %) [16]. Značajan preduvjet za podizanje razine sigurnosti plovidbe broda je kvalificirana i dobro obučena posada. Brodski sustavi u osnovi ovise o čovjeku, koji njima upravlja u određenom trenutku.

Poznavanje manevarskih karakteristika broda temelji se na odgovarajućem teorijskom znanju i predstavlja preduvjet za sigurno upravljanje i manevriranje brodom. Slabo ili nedovoljno teorijsko znanje može rezultirati neprimjerenim postupcima u upravljanju i manevriranju zapovjednika i časnika broda. Takvi postupci mogu uzrokovati oštećenja na vlastitom brodu, ostalim brodovima u blizini, teretu, a mogu ugroziti i ljudske živote na moru te prouzročiti onečišćenje. U ekstremnim slučajevima, takvi postupci mogu dovesti do gubitka brodova i tereta te fatalnih gubitaka brodske posade i putnika.

Imajući na umu ljudske pogreške u statistici pomorskih nezgoda jasna je važnost rukovanja brodom, a osobito edukacija rukovanja brodom [7]. Posebnu pozornost valja poduzeti tijekom upravljanja velikim brodovima i brodovima neuobičajenih manevarskih karakteristika koji zahtijevaju dodatno znanje i veću sposobnost predviđanja tijekom manevriranja.

Najvažnija i vrlo korisna pomagala u edukaciji upravljanja i manevriranja brodom su specijalizirani simulatori, ali tijekom edukacije studenata i iskusnog nautičkog osoblja javljaju se određeni problemi koje je potrebno analizirati. Cilj ovoga rada je istaknuti neke od tih problema.

1. INTRODUCTION

Modern maritime transport is a combination of expert and complex operations united and defined by various international and national regulations and standards. As a result, the ships of today are, technologically speaking, very advanced system units with a high degree of reliability of all the implemented systems. However, this modern technology of ship managing through a specific work environment modifies the behaviour of the master and the officer on watch [3]. Therefore, in some researches, a human error emerges as one of the main factors (75 – 96 % of all maritime casualties) [16]. A significant prerequisite for raising the level of ship safety is a qualified and well trained crew. Ship systems are basically subject to man, who manages them in a given moment.

The knowledge of the ship manoeuvring characteristics is based upon the relevant theoretical knowledge and is a prerequisite for safe ship handling. Poor or insufficient theoretical knowledge may, however, result in a bad performance of a particular ship handling operation by the master or navigating officer. This can cause damage to the own ship and other nearby ships, to cargo and can, likewise, imperil life at sea. In the extreme cases, it may also give rise to the loss of ships or cargo and to fatal losses to the ship's crew and passengers.

Bearing in mind human error statistics in maritime casualties, the importance of ship's handling and especially of ship handling education is evident [7]. A special attention should be paid to during handling large ships and ships with unusually manoeuvring characteristics which require additional knowledge and a higher predicting capability of their behaviour during the ships' handling.

The first and very useful aids in the ship's handling education are specialized simulators, but during the education of students and experienced nautical personnel some problems have arisen and where an analysis is needed. The aim of this paper is to highlight some of these problems.

2. TEORIJSKO ZNANJE – OSNOVA ZA KORIŠTENJE SIMULATORA U EDUKACIJI

Poznavanje manevarskih svojstava broda jedan je od temeljnih čimbenika sigurnosti broda tijekom manevriranja kao i u plovidbi. Važnost ove činjenice posebno je naglasila Međunarodna pomorska organizacija (IMO) usvajanjem Rezolucije A.601(15) *Provision and Display of Manoeuvring Information on Board Ships* [9]. Prema ovoj Rezoluciji na brodu moraju biti vidljivo prikazana manevarska svojstva broda kako bi se tim podacima mogli koristiti zapovjednici, časnici palube i peljari. U dodatku ove Rezolucije prezentiran je i način prikaza informacija o manevarskim svojstvima broda, sadržajno sastavljen od tri dijela:

- Peljarska karta (*Pilot Card*) – ispunjava je zapovjednik broda, a služi peljaru u svrhu pružanja osnovnih informacija o manevarskim svojstvima broda
- Poster u kormilarnici (*Wheelhouse poster*) – mora biti trajno postavljen na zapovjedničkom mostu, sadrži posebne i detaljne informacije o manevarskim svojstvima broda
- Manevarski priručnik (*Manoeuvring booklet*) – obvezno dostupan na brodu, mora sadržavati opsežne detalje o manevarskim osobinama broda te ostale važne podatke.

Ovako prikazani podaci o manevarskim svojstvima broda zasigurno predstavljaju povećanje stupnja sigurnosti pri manevriranju brodovima jer svim uključenim osobama u postupke manevriranje pružaju informacije na vrlo pristupačan način. Izrazito je važno i to da je ovaj način prikaza osnovnih manevarskih obilježja brodova unificiran te je bitno smanjen problem razumijevanja značenja pojedinih elemenata bez obzira na porijeklo posade broda kao i zemljopisno područje manevriranja, što također bitno doprinosi općoj sigurnosti broda.

Osim prethodno spomenute Rezolucije, u svrhu povećanja razine sigurnosti tijekom manevriranja brodovima, osnovna manevarska svojstva brodova i parametri tih svojstava predmet su međunarodne unifikacije koju je Međunarodna pomorska organizacija (IMO) učinila usvajanjem Rezolucije MSC 137(76) *Standards for Ship Manoeuvrability* [10].

2. THEORETICAL KNOWLEDGE – BASIS FOR SIMULATOR TRAINING

Knowing the manoeuvring characteristics of ships is one of the basic factors of the ship safety during the ship manoeuvring and navigation. A particular emphasis of this fact was stressed by the *International Maritime Organization (IMO)* with the adoption of the resolution *A.601(15) Provision and Display of Manoeuvring Information on Board Ships* [9]. According to this resolution the manoeuvring characteristics on board the ship must be shown in graphic detail so that the shipmasters, deck officers and pilots can use the data. The addendum to this resolution presents the method of displaying manoeuvring information regarding the ship's manoeuvrability and is made up of three parts, reading as follow:

- The *Pilot card* which is filled in by the shipmaster and serves to give the pilot, upon his arrival on board the ship, basic information on the manoeuvring characteristics of the ship;
- The *Wheelhouse poster* which must be placed permanently on the navigating bridge and must contain specific and detailed information describing the manoeuvring characteristics of the ship;
- The *Manoeuvring booklet* must be accessible and must contain comprehensive details on the ship's manoeuvring characteristics and other important data.

The data on manoeuvring characteristics displayed in this way certainly expand the degree of safety during the ship manoeuvring, since they render information to all persons included in the manoeuvring procedures in a very approachable way. Another point of great importance is that this manner of displaying the basic manoeuvring features of ships is unified and it essentially reduces the problems of understanding the meanings of particular elements regardless of the origin of the crew on board the ship or of the part of the world in which the manoeuvring takes place. This substantially contributes to the general safety of the ship during manoeuvring.

For the purpose of raising the degree of safety during ship manoeuvrings, in addition to the previously mentioned resolution, the basic ma-

Manevarska svojstva broda predmet su izučavanja konstruktora brodova koji nastoje dobiti što bolja osnovna manevarska svojstva broda kako bi se olakšalo manevriranje brodom te postigla pritom što veća sigurnost. Međutim, osim poznavanja osnovnih manevarskih svojstava broda potrebno je poznavati i ostale čimbenike koji utječu na sigurno manevriranje brodom kao što su djelovanje vjetera i morske struje i ostalih vanjskih čimbenika. Većina ovih utjecaja mogu se točno spoznati samo na određenom brodu uz praktično iskustvo. Međutim, poznavanje nastanka ovih utjecaja kao i prethodno uvježbavanje manevriranja na specijaliziranim simulatorima može umnogome pomoći u upoznavanju manevarskih karakteristika pojedine vrste brodova u raznim uvjetima plovidbe.

Stoga, kako bi se zapovjednici i časnici palube što bolje pripremili za uspješno manevriranje brodom u uvjetima eksploatacije, Međunarodna pomorska organizacija je kroz Konvenciju STCW 78 s izmjenama i dopunama [11] ovome segmentu edukacije zapovjednika i časnika palube posvetila posebnu pažnju. U dijelu A Konvencije unutar poglavlja A-II koji donosi programe naobrazbe za temeljna zvanja zapovjednika i časnika palube posebno je opsežan program vezan za manevriranje brodom. Osim u obveznom dijelu A Konvencije u dijelu B također je predviđen dio koji se odnosi na područje manevriranja brodom. U tom dijelu predviđa se posebna izobrazba pod nazivom "Izobrazba za zapovjednika i I. časnika na velikim brodovima i brodovima s neuobičajenim manevarskim svojstvima". Ovdje treba pridodati i posebnu izobrazbu "Simulatori broda i skupni rad na zapovjedničkom mostu" – u kojoj je sadržano planiranje putovanja s posebnim naglaskom planiranja u peljarskim vodama, skupni rad na zapovjedničkom mostu između časnika, zapovjednika, peljara, kormilara, odnos zapovjednik-peljar, te poznavanje manevarskih karakteristika brodova. Upravo su navigacijski simulatori najvažnije sredstvo u provođenju ove vrste edukacije.

Iz prije navedenog je vidljiva važnost koju Međunarodna pomorska organizacija posvećuje ovom teorijskom i praktičnom pitanju, a sve u svrhu postizanja što većeg stupnja sigurnosti kako u plovidbi tako i tijekom manevriranja. Na ovaj način povećava se opći stupanj sigurnosti na moru te se preventivno djeluje i smanjuje rizik onečišćenja morskog okoliša koji bi mogao nastati u nezgodama izazvanim pogrešnim manevriranjem.

noeuving characteristics of ships and the parameters of these characteristics are the subject of international unification that the *International Maritime Organization (IMO)* has effected with the adoption of the resolution *MSC 137(76) Standards for Ships Manoeuvrability* [10].

The manoeuvring characteristics of ships are a subject of the study by ship designers who endeavour to attain the best possible manoeuvring characteristics that will facilitate the ship's manoeuvrability and, at the same time, enhance its safety. However, besides being knowledgeable about the ship's basic manoeuvring characteristics, it is also necessary to be familiar with all the other factors that have an effect on safe manoeuvring, such as the effect of the wind, the sea current and other external factors. Most of these effects can only be accurately acknowledged on a definite ship coupled with practical experience. The knowledge of the source of these effects and of the previous manoeuvring exercising on specialized simulators can be of great help in getting to know the manoeuvring characteristics of particular types of ships under different navigating conditions.

For the purpose of preparing shipmasters and deck officers for a successful manoeuvring of the ship under actual conditions, the *International Maritime Organization* has, through *Convention STCW 78 as amended* [11], rendered special attentions to this segment of education of shipmasters and deck officers. In part *A* of the *Convention*, namely, in chapter *A-II* that deals with the training programmes for the basic professions of shipmaster and deck officer, a particularly extensive program is linked to the ship manoeuvring. This program includes the basic elements of manoeuvring as well as manoeuvring and handling a ship in all conditions. In addition to the obligatory section *A*, the *Convention* in part *B* also foresees a section that refers to the domain of manoeuvring the ship. The said section foresees a special training under the title *The Training Course for Master and Chief Officer of Large Ships and Ships with Unusual Manoeuvring Characteristics*. It is necessary to add hereto a special training under the *Ship Simulator and Bridge Teamwork*, which is, likewise, partially linked to the manoeuvrability characteristics of various types of ships and also to the passage planning, especially in pilotage water, working on the navigational

3. NAVIGACIJSKI SIMULATORI U EDUKACIJI MANEVRIRANJA BRODOM

Korištenje simulatora za stjecanje vještina u pomorstvu nije novost [1]. Primjena elektroničkih računala omogućila je pojavu novih znanstvenih disciplina čime su specifični i gotovo nerješivi problemi sagledani na novi način. Izrada matematičkog modela broda i korištenje računala omogućava detaljan grafički prikaz broda i njegovog kretanja koji se lako može usporediti s kretanjem broda u stvarnosti. Osnovni zahtjev svakog modela je opisati sustav dovoljno detaljno tako da su karakteristike modela kompatibilne s karakteristikama cijelog sustava.

U edukaciji na području manevriranja brodom, na današnjem stupnju razvoja, od neprocjenjive je važnosti korištenje sofisticiranih simulatora na kojima se mogu vrlo zorno upoznati manevarske karakteristike različitih vrsta brodova kao i njihovo ponašanje u plovidbi i manevriranju pri različitim vanjskim uvjetima kao i različitim stanjima nakrcanosti broda. Simulatori omogućavaju analizu manevarskih karakteristika broda izvođenjem raznih manevara kao što su zalet broda, krug okreta, cik-cak manevar, spiralni manevar, manevar izvlačenja, kao i evaluaciju podataka navedenih na Peljarskoj karti, Posteru u kormilarnici i Manevarskom priručniku. Usporedbom rezultata navedenih manevara dobivenih u stvarnosti i na simulatoru moguće je vrednovati kvalitetu samog simulatora. Iako je praktično iskustvo na pojedinim vrstama brodova također vrlo važno, prethodnim uvježbavanjem na simulatorima olakšana je interpretacija i upoznavanje manevarskih karakteristika konkretnog broda u eksploataciji, a od velike je koristi i u predviđanju očekivanih ponašanja broda u stvarnosti.

Simulatori se vrlo uspješno mogu koristiti u edukaciji studenata koji se pripremaju za zanimanje časnika palube, a kasnije i zapovjednike, ali i za edukaciju već iskusnih pomoraca koji nisu imali iskustva na pojedinim vrstama i veličinama brodova kao i za uvježbavanje peljara.

bridge as a team, master-pilot relationship, etc. The most important means in this education are sophisticated ship's handling simulators.

From our account so far, the many courses that the *International Maritime Organization* has taken to achieve safety, as great as possible, both during navigation and manoeuvring, are apparent. Thereby, an increase in the general degree of safety at sea is achieved and it has a preventive effect and decreases the risks of polluting the maritime environment that might occur in accidents caused by faulty manoeuvring.

3. NAVIGATIONAL SIMULATORS IN THE SHIP HANDLING EDUCATION

Simulation in seamanship is not a novelty [1]. The application of the electronic computer has made the appearance of new scientific disciplines possible, whereas specific and almost unsolvable problems have been envisaged in a new way. The creation of a mathematical model of a ship and the use of the electronic computer has enabled graphically detailed demonstrations of the ship and her movements that can easily be verified in practice. The basic demand of each model is that the system is described in full details and that the model characteristics are compatible to the characteristics of the entire system.

In the ship manoeuvrability education and at the current level of development, the use of sophisticated simulators on which one can get to know much better and through a real situation the manoeuvring characteristics of different types of ships and their behaviour during navigation and in manoeuvring under different atmospheric conditions and different loading, is today of utmost importance. Simulators enable the analysis of the manoeuvring characteristics by means of the execution of various manoeuvres such as *head reach*, *turning circle*, *zig-zag manoeuvre*, *spiral manoeuvre*, *pull out manoeuvre*, etc., and by the evaluation of the data from the *Pilot card*, *Wheelhouse poster* and *Manoeuvring booklet*. By analysing the results of this trial, it is possible to evaluate the performance of the ship's handling simulator too. Although the practical experience on board various types of ships is also of great importance, the previous exercises on simulators facilitate the interpretation of and the

4. PROBLEMI PRI UPOTREBI NAVIGACIJSKIH SIMULATORA U EDUKACIJI MANEVRIRANJA BRODOM

Nastavnici Zavoda za nautičke znanosti na Pomorskom fakultetu u Rijeci koriste navigacijske simulatore u izobrazbi studenata kao i iskusnih pomoraca dugi niz godina. Značajno je napomenuti da su korisnici simulatora dolazili iz različitih zemalja, s različitim predznanjem. Navedeni kandidati posjedovali su različito navigacijsko iskustvo, od studenata bez navigacijskog iskustva, do časnika, zapovjednika i peljara s različitim stupnjem navigacijskog iskustva. Tijekom višegodišnjeg istraživanja provedeno je niz ciljanih intervjua s korisnicima simulatora. U obradi i analizi dobivenih rezultata istraživanja strukturalno su podijeljene interesne skupine korisnika simulatora u korelaciji s ishodima učenja te očekivanim kompetencijama.

U naobrazbi studenata, uvježbavanje na simulatorima predstavlja prvi doticaj s manevriranjem brodovima što je za njih od neprocjenjivog značaja. Međutim, osim ovog aspekta na simulatorima se vrlo zorno i dojmljivo mogu prikazati pa i objasniti pojedini teorijski pojmovi koje je neophodno poznavati i razumjeti. U radu sa studentima na simulatorima javlja se problem kojeg treba svakako uzeti u obzir, a odnosi se na to da pojedini studenti rad na simulatoru shvaćaju kao videoigru. Zbog toga je dužnost nastavnika učiniti okruženje na vježbi što realnije te objasniti ozbiljnost i odgovornost časnika tijekom manevriranja na stvarnom brodu.

Vrlo je interesantno iskustvo nastavnika i u izobrazbi iskusnih zapovjednika i časnika palube, pa i peljara. Na ovoj ustanovi se već čitav niz godina provodi dopunska izobrazba pomoraca na simulatorima unutar tečajeva kao što su ARPA – *Automatic Radar Plotting Aids, operational & management level*, RO – *Radar Observer*, Simulatori broda i skupni rad na zapovjedničkom mostu – *Ship Simulator and Bridge Teamwork*, Izobrazba za zapovjednika i I. časnika na velikim brodovima i brodovima s neuobičajenim manevrarskim svojstvima – *The Training Course for Master and Chief Officer of Large Ships and Ships with Unusual Manoeuvring Characteristics*, Rad na elektroničkim kartama – ECDIS – *Electronic Chart Display and Information System Training*, itd.

familiarization with the manoeuvring characteristics of a concrete ship in exploitation and this is a major advantage for anticipating the expected behaviour of a ship in reality.

Simulators can be used quite successfully on a plan of training students who are preparing themselves for the vocation of a deck officer, and, subsequently, of a shipmaster, but likewise for the training of the already experienced mariners with a lack of experience on a certain type or size of ship, as well as for the training of pilots.

4. PROBLEMS IN THE USE OF A NAVIGATION SIMULATOR IN THE SHIP HANDLING EDUCATION

Teachers who teach the science of navigation (nautical subjects) at the *Rijeka* have been using simulators in training students and experienced nautical personnel for a number of years. It is important to note that the simulator users have come from different countries with different levels of knowledge. Some of the candidates have been students who have never been on board a ship, but there have also been officers, masters and pilots with various degrees of experience. During many years of the research carried out, a series of target interviews have been conducted with the simulator users. These interviews have helped us to establish different interest groups of simulator users according to the learning outcomes and expected competencies.

In the education of students, the practicing on simulators is their first contact with the ship manoeuvring and it represents an experience of inestimable value to them. But, in addition to this aspect, simulators can impressively and in graphic detail explain certain theoretical concepts, the knowledge and understanding of which is indispensable. However, working with students on simulators gives rise to a problem that must, by all means, be overcome. Namely, some students experience their work on simulators as if playing a video game. It is therefore the teacher's duty to create an atmosphere as realistic as possible and to elucidate to the students the earnestness and responsibility involved in manoeuvring a real ship in real life.

The teachers also have a very interesting practical acquaintance in the training of experi-

Skupnom analizom nastavnika koji izvode ove tečajeve uočeno je da iskusni časnici, pa i zapovjednici ponekad poduzimaju pogrešne radnje te imaju pogrešne procjene kad na vježbama manevriraju brodovima veličina i karakteristika na kojima nisu imali prethodnog iskustva. Posebno se javljaju pogreške u nepravovremenom poduzimanju radnji pri manevriranju velikim brodovima što rezultira sudarima, nasukanjima ili udarima o obalu. Vrlo je interesantno istaknuti da ova grupa polaznika ozbiljnije pristupa radu na simulatorima. Osim toga, iako se radi o kandidatima i profesiji koja je u znatnoj mjeri tradicionalna, polaznici u pravilu podupiru ovakav način dodatne izobrazbe te je smatraju potrebnom.

Prilikom provođenja vježbi, u potpunoj konfiguraciji zapovjedničkog mosta, nastavnici zamjećuju da studenti, ali i iskusniji časnici i zapovjednici pri obavljanju navigacijske straže previše pozornosti posvećuju ECDIS sustavu, u odnosu na radar te vizualno osmatranje. Takvo ponašanje može prouzročiti značajnu opasnost, jer se na zaslonu ECDIS sustava ne prikazuje pozicija i podaci plovila (bez AIS-a) koji nisu prihvaćeni radarskim sustavom. Slična se pogreška može pojaviti u stvarnoj situaciji na zapovjedničkom mostu prilikom plovidbe brodova opremljenih ECDIS-om u slučaju slabe vidljivosti ili tijekom noćne plovidbe.

Analizom provedenih intervjuva, s korisnicima simulatora s navigacijskim iskustvom, utvrđeno je da su korisnici ocijenili model kretanja broda i utjecaj vanjskih sila na kretanje broda simulatora vrlo vjerodostojnim. Nadalje, utvrđeno je da se kod korisnika simulatora nije uspjele postići isto psihofizičko ponašanja koje se javlja pri upravljanju brodom u stvarnosti. Temeljem ovakvih rezultata proizišlih iz istraživanja autori zaključuju da se ponašanje korisnika simulatora tijekom izvođenja vježbi ne razlikuje od ponašanja prilikom upravljanja brodom u stvarnosti. Poradi toga dolazi do različitih odluka korisnika simulatora tijekom vježbe na simulatoru ili iste situacije u stvarnosti (plovidba većom brzinom pri prilazu obali nego u stvarnosti, mimoilaženje s drugim brodovima na manjim udaljenostima nego u stvarnosti, započinjanje manevra izbjegavanja brodova na manjim udaljenostima nego u stvarnosti itd.).

U cilju točnije procjene i vrednovanja ponašanja ljudi na navigacijskim simulatorima potrebno je u daljnjim istraživanjima utvrditi utjecaj rada na simulatoru na same korisnike te

enced shipmasters and deck officers, and even pilots. This Faculty has for many years been conducting a remedial education of the ship crew on simulators within the framework of the following training courses: *Automatic Radar Plotting Aids (ARPA – operational & management level)*, *Radar Observer (RO)*, *Ship Simulator and Bridge Teamwork*, *Training Course for Masters and Chief Officers of Large Ships with Unusual Manoeuvring Characteristics*, *Bridge Team Management*, *ECDIS – Electronic Chart Display and Information System Training*, etc.

From a group analysis made by teachers who have been teaching at these courses, it became evident that experienced officers and masters too sometimes undertake wrong steps and make faulty estimations when practicing manoeuvres on board ships of the size and characteristics that they had no previous real experience with. Mistakes have been made particularly because of the overdue undertaking of actions when manoeuvring with large ships and thus causing collisions, running ashore or crashing against the wharf. It is very interesting to note that this group of participants has a much more serious approach to working on simulators. Besides, even though this is a group of men and a profession of a rather traditional hue, they usually strongly support this method of remedial education and consider it necessary.

During the exercises in a full mission bridge configuration, the teachers have noted, that the students and the experienced shipboard crew members have given too much attention to the electronic chart display rather than to the radar and visual display. This is a very important mistake which may cause serious danger because the electronic chart display does not show the ship's position and her data (ships without AIS) if not acquired on the radar. A similar mistake may occur in a real situation on the navigational bridge on board ships equipped with *ECDIS* in case of poor visibility or in night navigation.

When analysing interviews made with the simulator users who have had a previous seafaring experience, it was determined that they had considered the model of the ship movements and the influence of external forces to be authentic. However, it was determined that the psychological effect, that handling a ship in reality brings about, could not be achieved in the simulator. Based on these results, the authors can conclude that the behaviour of seafa-

utvrditi percepciju korisnika simulatora s naglaskom na osjećaj odgovornosti, uzbuđenja, treme, straha, stresa i ostalih psihofizičkih stanja.

5. ZAKLJUČAK

Koristeći sofisticirane simulatore moguće je mnogo učiniti na planu edukacije zapovjednika i časnika palube, kao i peljara. Međutim, nastavnici moraju u svakom trenutku biti svjesni ograničenja simulatora i problema prikazanih u ovome radu. Nadalje, moguće je navigacijske simulatore koristiti i u raznim istraživanjima kao što su primjerice analize pomorskih nezgoda sudara ili nasukanja, planiranja prilaznih plovnih putova, postava lučkih obala te u analizi drugih sigurnosnih obilježja.

Danas se grade brodovi velikih dimenzija čime se prilikom plovidbe stvaraju velike sile inercije što uz same dimenzije ima značajan utjecaj na manevriranje velikih brodova. Takvi se brodovi stoga ne mogu brzo zaustaviti niti mogu promijeniti smjer kretanja u kratkom vremenu što zahtijeva značajniju mogućnost predviđanja kretanja, prilikom upravljanja takvom vrstom brodova. Časnici palube, da bi sigurno upravljali brodom od luke polazišta do krajnjeg odredišta, moraju biti dobro upoznati s manevarskim karakteristikama samog broda. Upravo stoga navigacijski simulatori imaju nezamjenjivu ulogu u izobrazbi pomoraca.

Analizom provedenih istraživanja ustanovljena su određena ograničenja kod upotrebe navigacijskih simulatora. Zbog toga je potrebno daljnjim istraživanjima utvrditi utjecaj rada na simulatoru na same korisnike te utvrditi percepciju korisnika simulatora s naglaskom na osjećaj odgovornosti, uzbuđenja, treme, straha, stresa i ostalih psihofizičkih stanja.

Users in the simulator differs from the behaviour normally encountered in handling a ship in reality. As a result, the actions performed by the simulator users during simulator exercises differ from the actions they would undertake in reality (e.g, approaching the shore at a higher speed than one would use in reality, passing and avoiding other vessels in closer proximity than one would do in reality, etc.).

In order to determine and evaluate more precisely the behaviour of the navigational simulator users, it is necessary to conduct further researches into how working on the simulator affects the user's perception, sense of responsibility, excitement, fear, stress, etc.

5. CONCLUSION

By using sophisticated simulators, much can be done on the plan of the education of students, shipmasters, deck officers and, certainly, of pilots too. But the teaching staff should always bear in mind the limitation of the simulators and the problems analysed before. Furthermore, it is possible to use such simulators for various high professional and research works such as: analysing some cases of collision or groundings, planning the approach to channels, fairways and harbours or terminals layout and some safety parameters as well.

Today, we can follow the building of ships of huge dimensions. A deep draft and a large inertia have an essential effect on the manoeuvring procedure of such giant vessels. Therefore, such ships cannot come to a quick stop nor can they make a turn in a relatively brief span of time. For operating such vessels, a greater possibility of anticipation is required. In order to navigate safely a vessel from the port of departure to the port of destination, the deck officers must be well acquainted with the manoeuvring characteristics of their vessels. For this purpose the sophisticated ship's handling simulators are essential teaching aids.

In order to determine and evaluate more precisely the behaviour of the navigational simulator users, it is necessary to conduct further researches into how working on the simulator affects the user's perception, sense of responsibility, excitement, fear, stress, etc.

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