Hrvatska akademija znanosti i umjetnosti –
Razred za Tehničke znanosti

Croatian Academy of Sciences and Art –
Department of Technical Sciences

Tehnički fakultet Sveučilišta u Rijeci
Faculty of Engineering, University of Rijeka

Pomorski fakultet Sveučilišta u Rijeci
Faculty of Maritime Studies, University of Rijeka

Fakultet za pomorstvo i promet Sveučilišta u Ljubljani
Faculty of Maritime Studies and Transport
University of Ljubljana

Udruga za proučavanje i razvoj pomorstva
Association for Research and Development
of Maritime Industries

X. MEĐUNARODNO SAVJETOVANJE O MORSKOJ TEHNOLOGIJI

in memoriam akademiku
Zlatku Winkleru
16. – 17. studenog 2023.
na Tehničkom fakultetu Sveučilišta u Rijeci

10th INTERNATIONAL CONFERENCE ON MARINE TECHNOLOGY

in memoriam of the academician
Zlatko Winkler
November 16 and 17, 2023
at the Faculty of Engineering
University of Rijeka

Knjiga sažetaka

Book of Abstracts

Knjiga sažetaka
X. MEĐUNARODNO SAVJETOVANJE O MORSKOJ TEHNOLOGIJI in memoriam akademiku Zlatku Winkleru (WINKLER 2023)
16. – 17. studenog 2023. godine, Tehnički fakultet Sveučilišta u Rijeci, Rijeka, Hrvatska

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Rijeka, siječanj 2024.
Rijeka, January 2024

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Ova knjiga sažetaka odnosi se na sve recenzirane sažetke radova (članke i postere) koji su prezentirani na Savjetovanju. Plenarna predavanja, priopćenja i diskusija su održani na engleskom jeziku, dok je ceremonija otvaranja održana paralelno na hrvatskom i engleskom jeziku.
Sažetci svih radova, uključujući naslov i ključne riječi su prikazani prvo na engleskom a zatim na hrvatskom jeziku, osim onih radova koji su pristigli isključivo na engleskom jeziku.

This book of abstracts applies to all reviewed abstracts (papers and posters) presented at the Conference. Plenary lectures, presentations and discussions were held in English, while the opening ceremony was held in parallel in Croatian and English.
Abstracts of all papers/posters, including titles and keywords, are presented first in English and then in Croatian, except for those papers/posters received exclusively in English.

ODRŽANI SKUPOVI O MORSKOJ TEHNOLOGIJI
***/** PAST VENUES OF CONFERENCE*

- **24. 11. 1979. Zagreb:** Prvo savjetovanje o morskoj tehnologiji u sklopu III. Konferencije SITH za tehnološki razvoj SR Hrvatske. Suorganizator : Tehnički fakultet Sveučilišta u Rijeci
- **11. 12. 1980. Rijeka:** Kolokvij o morskoj tehnologiji. Problematika jedne od aktivnosti koju razvija Zavod za brodogradnju i inženjerstvo morske tehnologije. Organizator: Tehnički fakultet Sveučilišta u Rijeci
- **16.–18. 11. 1983. Opatija:** Mogućnosti razvoja morske tehnologije u području Jadranskog mora. Organizatori: SITH i Sveučilište u Rijeci, Tehnički fakultet Rijeka.
- **14.–15. 04. 1987. Zagreb:** Savjetovanje – Problemi čvrstoće konstrukcije objekata morske tehnologije. Organizator: Jugoslavenska akademija znanosti i umjetnosti, Zagreb
- **29. 09. 1994. Opatija:** Međunarodni okrugli stol : Priobalje i podmorje Jadrana, realna šansa za hrvatski turizam. Organizator: Sveučilište u Rijeci, Tehnički fakultet, Pomorski fakultet i Brodarski institut u Zagrebu.
- **01.–04. 03. 1995. Opatija:** Međunarodna konferencija. Priobalje i podmorje Jadrana realna šansa za hrvatski turizam. Organizator: Sveučilište u Rijeci, Tehnički Fakultet i Pomorski fakultet u Rijeci.
- **28.-29. 11. 2005. Rijeka:** I. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Organizator: Znanstveno vijeće za pomorstvo-Sekcija za morsku tehnologiju i Tehnički fakultet Sveučilišta u Rijeci.
- **26.-27. 11. 2007. Rijeka:** II. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Organizator: Znanstveno vijeće za pomorstvo-Sekcija za morsku tehnologiju i Tehnički fakultet Sveučilišta u Rijeci
- **30.11. i 1. 12. 2009. Rijeka:** III. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Organizator: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Sekcija za morsku tehnologiju i Tehnički fakultet Sveučilišta u Rijeci.
- **25.-26. 11. 2011. Rijeka:** IV. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Organizator: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Sekcija za morsku tehnologiju i Tehnički fakultet Sveučilišta u Rijeci.
- **22.-23. 11. 2013. Rijeka:** V. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Organizator: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Sekcija za morsku tehnologiju i Tehnički fakultet Sveučilišta u Rijeci.
- **20. 11. 2015. Rijeka:** VI. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Pokrovitelj: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Razred za tehničke znanosti; Organizator: Tehnički fakultet Sveučilišta u Rijeci.
- **17. 11. 2017. Rijeka:** VII. Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Pokrovitelj: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Razred za tehničke znanosti; Organizator: Tehnički fakultet Sveučilišta u Rijeci, suorganizatori: Pomorski fakultet Sveučilišta u Rijeci i Udruga za proučavanje i razvoj pomorstva.
- **15.-16. 11. 2019. Rijeka:** VIII. Međunarodno Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Pokrovitelj: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Razred za

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- **11.-12. 11. 2021. Rijeka:** IX. Međunarodno Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Pokrovitelj: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Razred za tehničke znanosti; Organizator: Tehnički fakultet Sveučilišta u Rijeci, suorganizatori: Pomorski fakultet Sveučilišta u Rijeci, Fakultet za pomorstvo i promet Sveučilišta u Ljubljani i Udruga za proučavanje i razvoj pomorstva
- **16.-17. 11. 2023. Rijeka:** X. Međunarodno Savjetovanje o morskoj tehnologiji in memoriam akademiku Zlatku Winkleru. Pokrovitelj: Znanstveno vijeće za pomorstvo Hrvatske akademije znanosti i umjetnosti – Razred za tehničke znanosti; Organizator: Tehnički fakultet Sveučilišta u Rijeci, suorganizatori: Pomorski fakultet Sveučilišta u Rijeci, Fakultet za pomorstvo i promet Sveučilišta u Ljubljani i Udruga za proučavanje i razvoj pomorstva

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Cilj i sadržaj Savjetovanja je dati pregled i ukazati na znanstvena istraživanja, rezultate i primjenu u području morske tehnologije u Hrvatskoj i šire, kao i na značaj za gospodarstvo i poticaj razvoja ove djelatnosti, te informirati naše gospodarstvo, znanstvenu i stručnu javnost o značajkama gospodarstvene djelatnosti morske tehnologije. Dodatno, dati poticaj za uspostavljanje primjerenog stupnja koordinacije i kooperacije u gospodarstvenim djelatnostima vezanim uz more i morsku tehnologiju, posebno s aspekta nužne izvozne ekspanzije, te konačno dati elemente za sudjelovanje u međunarodnom transferu tehnologije na temelju vlastitih tehnoloških znanja.

***The* aim and content** of the Conference is to give an overview and point out scientific research, results and application in the field of marine technology in Croatia and wider and the importance for the economy and stimulate the development of this activity, and to inform our economy, scientific and professional public. In addition, provide an incentive to establish an appropriate level of coordination and cooperation in economic activities related to the sea and marine technology, especially in terms of necessary export expansion, and finally provide elements for participation in international technology transfer based on own technological knowledge.
The following topics from scientific fields, in research and application are envisaged:

- Marine environmental protection
- Intelligent Underwater Systems and Technologies, Autonomous Vessels
- Biotechnology, Fisheries and Aquaculture, Marine Biology
- Maritime Transport, Economy
- Shipbuilding Technology and Shipyards
- Marine Structures and Engineering, Small and Pleasure Crafts
- Construction and Design in Shipbuilding and Mechanical Engineering
- Mining, Oil and Geological research, Material and Chemical Engineering
- Marine Automation and Control, Marine Electronics
- Renewable energy sources in the field of marine technology
- Desalination of sea water in conjunction with renewable energy sources
- Legislation, rules, standardization
- Computer applications in the design, manufacture and operation of marine technology facilities

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Program Savjetovanja
Conference Program

1. dan – četvrtak 16. studeni 2023.
1st day – Thursday, November 16, 2023

08:00–09:00 **Prijave sudionika** / ***Participants Registration***
Recepcija savjetovanja/ *Conference desk*

09:00–09:30 **Ceremonija otvaranja** / ***Opening ceremony***
Predavaonica P1 / *Room P1*

Pozdravni govori / *Welcome speach*
Albert Zamarin, Full Profesor, D.Sc., Head of the Marine Technology Section of the Scientific Council for the Maritime Science of the Croatian Academy of Sciences and Arts, President of the Organizing Committee
Ivo Senjanović, Academician, Croatian Academy of Sciences and Arts
Peter Vidmar, Assoc. Prof. D.Sc. – Dean – Faculty of Maritime Studies and Transport, University of Ljubljana, Co-organizer
Ana Perić Hadžić, Prof. D.Sc. Madam Dean – Faculty of Maritime Studies, University of Rijeka, Co-organizer
Siniša Vilke, Assoc. Prof. D.Sc. editor-in-chief of the *Journal of Maritime and Transportation Sciences*, Co-organizer
Senka Mačešić, Full Professor, D.Sc. – Vice-rector for Digitalization and Development- University of Rijeka
Lado Kranjčević, Full Professor, D.Sc. – Dean – Faculty of Engineering University of Rijeka

09:30–11:30 Plenarna sekcija / Plenary *Session 1*
Predavaonica P1 / *Room P1*
Predsjedavajući / *Chairman: Albert Zamarin*

1.1 **Aleksandar Vuković / Lürsen Design Center Kvarner, Croatia**
LEAN SHIP DESIGN: CUSTOMER FOCUS, OPTIMIZED EFFICIENCY AND MAXIMIZED VALUE

1.2 **Deni Vlašić / Navis Consult, KONGSBERG Company / Croatia**
DESIGN OF CATAMARAN FOR PUBLIC INSTITUTION 'REZERVAT LOKRUM'

1.3 **Paolo Paliaga / Fakultet pririodnih znanosti Sveuciliste Pula, Croatia**
IMPACT OF INVASIVE CTENOPHORA IN THE NORTHERN ADRIATIC AND MEASURES FOR THEIR SUPPRESSION

11:30–12:00 **Stanka za kavu** / ***Coffee Break***

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Program Savjetovanja
Conference Program

12:00–13:30 Izlaganja 2 / *Session 2*

Marine Biology, Marine Environmental Protection
Predavaonica P1 / *Room P1*
Predsjedavajući/ *Chairman: Tomislav Mrakovčić*

2.1 Dulčić Jakov
CHANGES IN THE BIODIVERSITY OF ICHTHYOFAUNA OF THE MEDITERRANEAN/ADRIATIC SEA – ARE THERE ANY REASONS FOR CONCERN?

2.2 Runko Luttenberger Lidija, Ančić Ivica
COASTAL ENVIRONMENT ALTERATIONS AND SENSORY LANDSCAPE

2.3 Paliaga Paolo, Burić Emil, Blecich Paolo, Matulja Tin, Milotti Giaconda, Iveša Neven, Buršić Moira, Djakovac Tamara, Najdek Dragić Mirjana, Mičić Milena, Budiša Andrea
IMPACT OF INVASIVE CTENOPHORA IN THE NORTHERN ADRIATIC AND MEASURES FOR THEIR SUPPRESSION

2.4 Pelić Vladimir, Mrakovčić Tomislav, Radonja Radoslav, Bukovac Ozren
THE INFLUENCE OF REDUCTION IN SAILING SPEED ON THE EFFICIENCY AND ENERGY POTENTIAL OF THE WASTE HEAT OF THE MARINE DIESEL ENGINE

13:30–14:30 Hladno Topli buffet / *Meal*

14:30–16:00 Izlaganja 3 /*Session 3*

Small and Pleasure Craft
Predavaonica P1 / *Room P1*
Predsjedavajući / *Chairman: Roko Dejhalla*

3.1 Matulja Tin, Hadjina Marko, Bolf Davor, Vrtovšnik Domagoj
METHODOLOGY FOR MANUFACTURING AN OPTIMAL HYDROFOIL FOR WINDSAILING

3.2 Sikirica Ante, Lučin Ivana, Matulja Tin, Banić Nikola
ENHANCING HYDROFOIL PERFORMANCE THROUGH NUMERICAL INVESTIGATION AND DESIGN OPTIMIZATION

3.3 Ugrin Damir, Matulja Tin, Marotti Enrico
WINDSURFING HYDROFOIL MOTION TECHNICAL MEASUREMENTS

3.4 Pejčinović Filip, Bolf Davor, Pozder Ljubomir, Zamarin Albert
EXPERIMENTAL TESTS REVIEW AND SAMPLE MANUFACTURING FOR OBTAINING MECHANICAL PROPERTIES OF COMPOSITE LAMINATE

3.5 POSTER Dujam Matija,Stojaković Adrian,Hadjina Marko,Dunja Legović,Turk Anton
COMPARISON OF THE CLASSIC METHOD OF HULL SHAPE ASSESSMENT OF A 5-METER L5 SAILBOAT WITH THE PHOTOGRAMMETRY METHOD

X. MEĐUNARODNO SAVJETOVANJE O MORSKOJ TEHNOLOGIJI in memoriam akademiku Zlatku Winkleru
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Program Savjetovanja
Conference Program

16:00–16:15 Stanka za kavu / *Coffee Break*

16:15 –17:15 Izlaganja 4 / *Session 4*

Construction and Design in Shipbuilding,
Intelligent Underwater Systems and Technologies
Renewable Energy Sources

Predavaonica P1 / *Room P1*
Predsjedavajući / *Chairman: Marko Hadjina*

4.1 Stanković Maša, Ugrin Andrej, Radić Lukša, Zamarin Albert
DESIGN OF THE HULL STRUCTURE OF DOUBLE-ENDED FERRIES FOR THE ADRIATIC

4.2 Vasiljević Antonio
SUBSEA RESIDENCY

4.3 Lučin Ivana, Kandukuri Surya Teja, Schlanbusch Rune, Čarija Zoran
OFFSHORE WIND ENERGY HARVESTING – EXAMPLE OF NORWAY–CROATIA TRANSNATIONAL EXPERIENCE EXCHANGE

17:15–17:30 Stanka za kavu / *Coffee Break*

17:30 –18:15 Izlaganja 5 / *Session 5*

Maritime Transport, Economy, Legislation

Predavaonica P1 / *Room P1*
Predsjedavajući / *Chairman: Tin Matulja*

5.1 Bonato Jasminka, Draščič Ban Biserka, Tudor Ivan
LINEAR TREND MODEL IN THE ANALYSIS OF SHIP LOSSES AND NAVIGATION SAFETY

5.2 Marijana Balas, Dejhala Roko, Prpić-Oršić Jasna
HYDRODYNAMIC ASPECTS OF A SHIP IN WEATHER ROUTING WITHIN THE CONTEXT OF SLOW STEAMING

5.3 Osundiran Adeola Oluwatoyin, Tshehla Magopa
AN EXAMINATION ON THE PIVOTAL ROLE AND CHLLENGES OF THE FEMALE SEAFARER

5.4 Slišković Merica, Ukić Boljat Helena, Radovanić Niko
POSTER BW CONVENTION IDENTIFIED DEFICIENCIES BY PORT STATE CONTROL IN PARIS MOU AREA

5.5 Knezović Ante, Perić Tina
POSTER THE PERCEPTION OF SPLIT AREA RESIDENTS ON THE IMPACT OF CRUISING TOURISM IN THE CITY OF SPLIT

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Program Savjetovanja
Conference Program

18:15–20:00 **Poster sekcija** / ***Poster session***
Predvorje fakulteta / *Entrance hall*
Predsjedavajući / *Chairman: Tin Matulja*

P.1 **Slišković Merica, Ukić Boljat Helena, Radovanić Niko**
BW CONVENTION IDENTIFIED DEFICIENCIES BY PORT STATE CONTROL IN PARIS MOU AREA

P.2 **Knezović Ante, Perić Tina**
THE PERCEPTION OF SPLIT AREA RESIDENTS ON THE IMPACT OF CRUISING TOURISM IN THE CITY OF SPLIT

P.3 **Obić Jan, Bolf Davor, Hadjina Marko, Zamarin Albert**
SHIP HULL EQUIPMENT SMART MODELLING IN 3DEXPERIENCE

P.4 **Rubeša Rajko, Hadjina Marko, Matulja Tin, Vrtovšnik Domagoj**
IMPLEMENTATION OF VARIOUS OUTSOURCED OUTFITTING DETAIL DESIGN APPROACHES IN PARTICULAR SHIPYARD

P.5 **Dujam Matija,Stojaković Adrian,Hadjina Marko,Dunja Legović,Turk Anton**
COMPARISON OF THE CLASSIC METHOD OF HULL SHAPE ASSESSMENT OF A 5-METER L5 SAILBOAT WITH THE PHOTOGRAMMETRY METHOD

2. dan – petak 17. studeni 2023.
2nd day – Friday, November 17, 2023

08:00–09:00 **Prijave sudionika** / ***Participants Registration***
Recepcija savjetovanja / *Conference desk*

9:00–10:15 **Izlaganja 6** / ***Session 6***
Computer applications in the design, manufacture and operation of marine technology facilities
Predavaonica P1 / *Room P1*
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10th INTERNATIONAL CONFERENCE ON MARINE TECHNOLOGY in memoriam of the academician Zlatko Winkler

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Faculty of Natural Sciences University of Pula, Croatia

IMPACT OF INVASIVE CTENOPHORA IN THE NORTHERN ADRIATIC AND MEASURES FOR THEIR SUPPRESSION

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CHANGES IN THE BIODIVERSITY OF ICHTHYOFAUNA OF THE MEDITERRANEAN/ADRIATIC SEA - ARE THERE ANY REASONS FOR CONCERN?

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ABSTRACT:
The marine biodiversity of the Mediterranean Sea today is faced with significant structural changes in flora and fauna. Similar changes were recorded in the Adriatic Sea. During the last few decades, various factors such as climate change, anthropogenic activities and Lessepsian migrations have changed the composition of the Mediterranean/Adriatic ichthyofauna. Extensive research carried out in the last decades allowed us to recognize species that were not previously recorded or reported from this area. So far, 188 exotic fish species have been recorded in the Mediterranean Sea, a large number of which are Lessespsis migrants of Indo-Pacific origin. Of the 15 Lessepsian fish species recorded in the Adriatic, *Lagocephalus sceleratus, Fistularia commersonii*, *Siganus luridus* and *Pterois miles* were the only species recorded more than once and with geographically scattered records suggesting a successful biological invasion. *Pterois miles* shows a rapid geographical spread in the Mediterranean Sea since 2010, mainly in the eastern part of the Mediterranean. Recent records of records in the Ionian and Adriatic point to the fact that this should be a warning sign and there is an urgent need to undertake and promote control measures. The influence of successful colonizers on the original communities in the Adriatic Sea is not yet fully known, but in the eastern part of the Mediterranean it is very large. However, the speed of biological invasions suggests that the potential negative effects may become very relevant in the near future.

Keywords: *biodiversity, ichthyofauna, changes, Mediterranean/Adriatic Sea, biological invasion*

PROMJENE U BIORAZNOLIKOSTI IHTIOFAUNE SREDOZEMNOGA /JADRANSKOGA MORA – POSTOJE LI RAZLOZI ZA ZABRINUTOST?

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SAŽETAK:
Morska bioraznolikost Sredozemnog mora danas je suočena sa značajnim strukturnim promjenama flore i faune. Slične promjene zabilježene su i u Jadranskom moru. Tijekom posljednjih nekoliko desetljeća različiti čimbenici kao što su klimatske promjene, antropogene aktivnosti i lesepsijske migracije promijenili su sastav Sredozemne/Jadranske ihtiofaune. Opsežna istraživanja provedena u posljednjim desetljećima omogućila su nam da prepoznamo vrste koje prethodno nisu zabilježene ili prijavljene s ovog područja. U Sredozemnom moru je dosada zabilježno 188 egzotičnih vrsta riba od kojih su veliki broj lesespsijski migranti indo-pacifičkog podrijetla. Od 15 zabilježenih lesepsijskih vrsta riba u Jadranu, *Lagocephalus sceleratus, Fistularia commersonii*, *Siganus luridus* i *Pterois miles* bile su jedine vrste

zabilježena više puta i s geografski raštrkanim zapisima sugerirajući uspješnu biološku invaziju. Vatrenjača *Pterois miles* pokazuje brzo geografsko širenje u Sredozemnom moru od 2010. godine i to uglavnom u istočnom dijelu Sredozemlja. Nedavni zapisi o nalazima u Jonskom i Jadranskom moru ukazuju na činjenicu da bi to trebao biti znak upozorenja te postoji hitna potreba za poduzimanjem i promicanjem mjera kontrole. Utjecaj uspješnih kolonizatora na izvorne zajednice u Jadranskom moru još nije u potpunosti poznat no u istočnom dijelu Sredozemlja je vrlo velik. Međutim, brzina bioloških invazija ukazuje da bi potencijalni negativni učinci mogli postati vrlo relevantni u bliskoj budućnosti.

***Ključne riječi**: bioraznolikost, ihtiofauna, promjene, Sredozemno/Jadransko more, biološka invazija*

COASTAL ENVIRONMENT ALTERATIONS AND SENSORY LANDSCAPE

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ABSTRACT:
Coastal environment, its natural world, and humans, are besides climate change effects subject to significant pressures by maritime-related, tourism, energy, aquaculture, and other sectors, all resulting in chemical pollution of all environmental components, noise pollution, and visual pollution. Humans attempt to adapt, mainly through devising and applying technological solutions. The senses incorporate the environment into the body and there is a mismatch between the way senses evolved and present surroundings, causing the disruption of visual acuity, smell, taste, and hearing. The disruptions to sensory landscape have thus altered the relationships between the organisms and the environment. The perceptual world or 'umwelt' differs for each organism. The impacts of environmental alterations to sensory landscape disrupt human sensory functioning, resulting in health impacts. Habitat disturbance in aquatic environments caused by acidification, contaminants, noise, optical degradation, elevated temperature, and electromagnetic fields can severely impact animal sensory biology. The paper focuses on sensory system responses of both humans and the wildlife to anthropogenically-induced and climate changes, reviews the issues resulting therefrom, and proposes solutions.

Keywords: *coastal environment, sensory landscape, senses, climate change, pollution*

MIJENJANJE OBALNOG OKOLIŠA I OSJETILNI KRAJOZBRAZ

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SAŽETAK:
Obalni okoliš, njegov prirodni svijet i zajednice ljudi, su pored klimatskih promjena izloženi značajnim pritiscima industrija kao što su pomorstvo, turizam, energija, uzgoj ribe i druge, koje imaju za posljedicu kemijsko onečišćenje svih sastavnica okoliša, onečišćenje bukom, te vizualno onečišćenje. Ljudi se nastoje prilagoditi, uglavnom osmišljanjem i primjenom tehničkih rješenja. Osjetila utjelovljuju okoliš u tijelo i postoji nesklad između načina na koji su se osjetila razvijala i sadašnje okoline, što uzrokuje remećenje osjetila, kao što su oštrina vida, miris, okus i sluh. Tako su remećenja osjetilnog krajobraza izmijenila odnos između organizama i okoliša. Perceptivni svijet ili 'umwelt' razlikuje za svaki organizam. Utjecaj promjene okoliša na osjetilni krajobraz primjerice remeti funkcioniranje osjetila kod ljudi, što ima zdravstvene posljedice. Narušavanje staništa u vodenom okolišu uzrokovano zakiseljavanjem, onečišćivalima, bukom, optičkom degradacijom, povišenom temperaturom i elektromagnetskim poljima može imati ozbiljne posljedice za osjetilnu biologiju životinja. Rad je usredotočen na odziv osjetilnih sustava kako ljudi tako i divljine na antropogene i klimatske promjene, daje pregled problema koji iz toga proizlaze, te predlaže rješenja.

Ključne riječi: *obalni okoliš, osjetilni krajobraz, osjetila, klimatske promjene, onečišćenje*

IMPACT OF INVASIVE CTENOPHORA IN THE NORTHERN ADRIATIC AND MEASURES FOR THEIR SUPPRESSION

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ABSTRACT:
Mnemiopsis leidyi, a voracious planktonic predator, is one of the 100 worst invasive species on our planet. It has successfully made the transition from its native habitat along the Atlantic coast of the Americas to many Eurasian seas by ballast waters transport. From 2016, massive blooms of *M. leidyi* have appeared in the Northern Adriatic seasonally, covering hundreds of km^2. Since then, several monitorings ranging from local daily observations up to large scale surveys, have been conducted in order to quantify the seasonal distribution of *M. leidyi* and to investigate its impacts on the main components of the Northern Adriatic pelagic ecosystem. The results have revealed that specimens prevalently appeared in the surface layer, reaching densities of even 400 individuals per m^2. Such considerable quantities of *M. leidyi* reduced the abundance of zooplankton and displaced anchovies from their natural spawning and feeding areas. Moreover, substantial quantities of organic matter were released during those blooms, fueling the microbial loop. To prevent the adverse effects of *M. leidyi* blooms and limit their spreading by ships, we investigated the feasibility of onboard ballast waters treatments. We determined the survival of *M. leidyi* by exposing it to different stressors such as temperature, lack of oxygen, microwave radiation and ultrasound to monitor their survival times. We focused primarily on assessing the applicability of thermic treatment of ballast waters that rely on the existing ship infrastructure and energy sources, with the addition of low-tech such as tubes and additional insulation.

A thermal treatment, combined with deoxygenation, could eliminate all *M. leidyi* life stages in less than 12 h during winter, while the eradication would be faster in summer (7 h) if applied on Ro-Ro type ships. In addition, the implementation of *in situ* actions should be investigated, such as the introduction natural predators of *M. leidyi*.

Keywords: *Mnemiopsis leidyi, ballast waters, northern Adriatic, onboard thermal treatments, marine invasive species*

UTJECAJ INVAZIVNOG REBRAŠA U SJEVERNOM JADRANU I MJERE ZA NJEGOVO SUZBIJANJE

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SAŽETAK:
Proždrljivi planktonski grabežljivac, *Mnemiopsis leidyi*, ubraja se u 100 najgorih invazivnih vrsta na našem planetu. Ova je vrsta iz svog prirodnog staništa duž atlantske obale Amerika balastnim vodama dopremljena do euroazijskih mora gdje je i opstala. Od 2016. njene masovne pojave bilježimo sezonski i u sjevernom Jadranu gdje prekrivaju stotine km^2. Tada je započelo sustavno praćenje koje je uključivalo dnevno sakupljanje podataka na lokalnoj skali kao i povremene monitoringe na velikoj skali za kvantifikaciju sezonske distribucije *M. leidyi* i njenih utjecaja na glavnim komponentama ekosustava Sjevernog Jadrana. Rezultati su pokazali da je većina jedinki zabilježena u površinskom sloju mora gdje je gustoća populacije znala doseći i 400 jedinki po m^2. Takva impresivna brojnost rebraša negativno se odrazila na brojnost zooplanktona i populaciju inćuna koja je istisnuta sa svojih prirodnih hranilišta i

mrijestilišta. Nadalje, uslijed masovnih *M. leidyi* pojava oslobađaju su znatne količine organske tvari, čime se podržava mikrobna petlja. Kako bismo prevenirali negativne posljedice masovnih pojava *M. leidyi* istražili smo izvedivost mjera za obradu balastnih voda na brodovima. Izmjerili smo vremena preživljavanja *M. leidyi* pri raznim stresorima poput temperature, nedostatka kisika, elektromagnetskih mikrovalova i ultrazvučnih valova. Usredotočili smo se primarno na termičke tretmane koje koriste postojeću brodsku infrastrukturu i izvore energije uz ugradnju nisko-tehnoloških komponenti poput cijevi i dodatne izolacije. Rezultati modeliranja su pokazali da termičkom obradom uz deoksigenaciju se za manje od 12 h mogu u potpunosti ukloniti svi životni stadiji *M. leidyi* zimi, a ljeti i brže (7 h), kada bi se ista primjenjivala na Ro-Ro tipu broda. Uz to, trebalo bi razmotriti i *in situ* implementaciju drugih aktivnosti poput unosa prirodnih predatora *M. leidyi*.

Ključne riječi: *Mnemiopsis leidyi*, balastne vode, sjeverni Jadran, termička obrada na brodu, morske invazivne vrste.

THE INFLUENCE OF REDUCTION IN SAILING SPEED ON THE EFFICIENCY AND ENERGY POTENTIAL OF THE WASTE HEAT OF THE MARINE DIESEL ENGINE

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ABSTRACT:
One of the essential conditions for the sustainable development of maritime transport is the increase of energy efficiency, which contributes not only to economic efficiency but also to the reduction of pollutant emissions. The requirements for reducing pollutant emissions from ships are listed in the Annex VI of the MARPOL convention (International Convention for the Prevention of Pollution from Ships), which has been in force since May 15, 2005. Reduction of pollutant emissions can be achieved by adjusting the combustion process in the engine cylinder, after-treatment of exhaust gases, use of alternative fuels or reduction of sailing speed. Reduction of sailing speed is widely used in container ships, as it does not require additional investment and, if applied reasonably, has a positive effect on reducing fuel consumption and pollutant emissions. However, it leads to an increase in sailing time, and a greater reduction in sailing speed leads to a reduction in main engine efficiency and a reduction in the energy potential of the waste heat. In this paper, the effects of reducing the sailing speed on the efficiency and energy potential of the waste heat of a low-speed marine engine are investigated. The waste heat from the exhaust gases and the engine cooling system is used to generate steam and electricity and for desalination. Data from the manufacturer WinGD on fuel consumption and available waste heat for various engine loads as a function of the container ship's sailing speed were used for the study.

Keywords: *reduction of sailing speed, energy efficiency, waste heat*

UTJECAJ SMANJENJA BRZINE PLOVIDBE NA UČINKOVITOST I ENERGETSKI POTENCIJAL OTPADNE TOPLINE BRODSKOG DIZELSKOG MOTORA

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SAŽETAK:
Jedan od bitnih preduvjeta održivog razvoja pomorskog transporta je povećanje energetske učinkovitosti, koje doprinosi ne samo ekonomičnosti već i smanjenju emisija koje imaju negativan utjecaj na okoliš. Zahtjevi za smanjenje onečišćenja emisijom štetnih tvari s brodova navedeni su u Prilogu VI, MARPOL konvencije (*International Convention for the Prevention of Pollution from Ships*), koji je u primjeni od 15. svibnja 2005. Smanjenje emisija štetnih tvari moguće je postići prilagodbom procesa izgaranja u cilindru motora, naknadnom obradom ispušnih plinova, primjenom alternativnih goriva ili smanjenjem brzine plovidbe. Smanjenje brzine plovidbe često se primjenjuje kod kontejnerskih brodova, jer ne zahtijeva dodatna ulaganja, a uz racionalnu primjenu ima pozitivan utjecaj na smanjenje potrošnje goriva i emisije štetnih tvari. Međutim, pritom dolazi do produljenja trajanje putovanja, a veće smanjenje brzine plovidbe dovodi i do smanjenja efikasnosti pogonskog motora i smanjenja energetskog potencijala otpadne topline. U radu se analizira utjecaj smanjenja brzine plovidbe na učinkovitost i energetski potencijal otpadne topline sporookretnog brodskog motora. Otpadna toplina ispušnih plinova i rashladnog sustava motora koristi se za proizvodnju vodene pare i električne energije te za desalinizaciju. U istraživanju su korišteni podaci proizvođača WinGD o potrošnji goriva i raspoloživoj otpadnoj toplini za različita opterećenja motora u ovisnosti o brzini plovidbe kontejnerskog broda.

Ključne riječi: *smanjenje brzine plovidbe, energetska učinkovitost, otpadna toplina*

Izlaganja 3 / *Session 3*

Mali plovni objekti
/ *Small and Pleasure Craft*

METHODOLOGY FOR MANUFACTURING AN OPTIMAL HYDROFOIL FOR WINDSAILING

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ABSTRACT:
A methodology based on reverse engineering and a digital twin will be presented to optimize the design and manufacture of hydrofoils on special vessels. Windsurfing is a sport that is becoming more and more popular in our county, and it is precisely on this example that the proposed methodology will be applied. In the first phase, using modern laboratory measuring equipment, relevant data on speeds and fluid flow angles will be collected in real conditions when driving by professional driver Enrico Marotti. In the second phase, the tested hydrofoils will be 3D modeled by reverse engineering to create a database. In the third phase of the project, digital twins will be created, with the help of which a new, improved hydrofoil can be defined by applying numerical simulations and optimization techniques. In the fourth phase, the technological process of making an aluminum mold for new, improved hydrofoils will be designed. In the last phase, a prototype of the new hydrofoils will be made using the most modern technologies and materials and the use of numerically controlled machine tools. The prototype will be tested, if necessary optimized and directed into production by local stakeholders from the economy.

Keywords: *methodology, reverse engineering, digital twin, hydrofoil, windsurfing*

METODOLOGIJA ZA IZRADU OPTIMALNOG HIDROKRILA ZA JEDRENJE NA DASCI

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SAŽETAK:
U radu će se prikazati metodologija temeljena na reverznom inženjerstvu i digitalnom blizancu za optimizaciju projektiranja i izrade hidrokrila na specijalnim plovnim objektima. Jedrenje na dasci je sport koji u našoj županiji postaje sve popularniji, te će se upravo na tom primjeru primjeniti predložena metodologija. U prvoj fazi korištenjem suvremene laboratorijske mjerne opreme prikupit će se relevantni podaci o brzinama i kutevima nastrujavanja fluida u realnim uvjetima prilikom vožnje profesionalnog

vozača Enrica Marottija. U drugoj fazi će se testirana hidrokrila reverznim inženjerstvom 3D modelirati za izradu baze podataka. U trećoj fazi projekta kreirati će se digitalni blizanci, uz pomoć kojih se primjenom numeričkih simulacija i optimizacijskih tehnika može definirati novo, poboljšano hidrokrilo. U četvrtoj fazi će se projektirati tehnološki proces izrade aluminijskog kalupa za nova, poboljšana hidrokrila. U posljednjoj fazi će se primjenom najsuvremenijih tehnologija i materijala te upotrebom numerički upravljanih alatnih strojeva izraditi prototip novih hidrokrila. Prototip će se testirati, po potrebi optimirati te usmjeriti u proizvodnju lokalnim dionicima iz privrede.

Ključne riječi: *metodologija, reverzno inženjersvo, digitalni blizannac, hidrokrilo, jedrenje na dasci*

ENHANCING HYDROFOIL PERFORMANCE THROUGH NUMERICAL INVESTIGATION AND DESIGN OPTIMIZATION

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ABSTRACT:
Numerical simulations can be a great asset in competitive sports as they provide a cost-effective way to explore different equipment designs without having to invest in materials to build prototypes and conduct experiments. When combined with design optimisation techniques, these tools can be differentiators in competitive sports as they can lead to significant performance improvements. In this paper, a reverse engineering approach to hydrofoil design and optimisation is presented and a preliminary numerical analysis of the flow around the hydrofoil is conducted. The results of the analysis indicate that computational fluid dynamics can be used to gain a better understanding of the hydrofoil's performance. Future steps are proposed that could help improve the hydraulic design and thus windsurfing performance.

Keywords: *Hydrofoil, CFD, 3D scanning, reverse engineering*

WINDSURFING HYDROFOIL MOTION TECHNICAL MEASUREMENTS

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ABSTRACT:
As a part of the hydrofoil optimisation project for windsurfing, a system for measuring vessel movement, weather elements and water conditions was developed. By measuring the movement speed, acceleration, angular velocity, inclination and direction of the vessel movement and weather elements in real time, the optimisation process of hydrofoils was accelerated. Measurements were performed with a measuring device attached to the observed vessel, while measurements of weather elements and sea conditions were performed with another device on the accompanying vessel. Wind speed, direction and temperature, environmental temperature, atmospheric pressure, surface water current and wave properties were measured. By combining data from both devices, a database was created on the state of the environment and the vessel movement. Analysis of the database provided the necessary data for the optimisation of the hydrofoil. The polar diagram of the vessel speed in relation to the speed and direction of the wind, together with the data on the inclinations of the hydrofoil and the angle between the direction of movement and the pointing direction at the moments of reaching the maximum movement speed, accelerate the hydrofoil optimisation process. The same measurement system can be used for measurements to optimise various properties of other vessels.

Keywords: *measurement, hydrofoil, polar speed diagram*

TEHNIČKA MJERENJA KRETANJA HIDROKRILA ZA JEDRENJE NA DASCI

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SAŽETAK:
U sklopu projekta optimizacije hidrokrila za jedrenje na dasci razvijen je sustav mjerenja kretanja plovila, vremenskih elemenata i stanja vode. Mjerenjem brzine kretanja, ubrzanja, kutne brzine, nagiba i smjera kretanja plovila te vremenskih elemenata u stvarnom vremenu, ubrzava se proces optimizacije hidrokrila za jedrenje na dasci. Mjerenja na promatranom plovilu izvedena su uređajem za mjerenje pričvršćenim na promatrano plovilo, dok su mjerenja vremenskih elemenata i stanja mora izvedena drugim sličnim uređajem na pratećem plovilu. Mjerene su brzina, smjer i temperatura vjetra, temperatura okoliša, atmosferski pritisak, brzina i smjer površinske vodne struje te visina, dužina, period i smjer valova. Spajanjem podataka s oba uređaja u stvarnom vremenu stvorena je baza podataka o stanju okoline i kretanju plovila. Analizom baze podataka dobiveni su podaci neophodni za optimizaciju hidrokrila. Polarni dijagram brzine kretanja plovila u odnosu na brzinu i smjer vjetra,

uz podatke o nagibima hidrokrila i kutu između smjera kretanja i smjera pramca plovila u trenutcima postizanja maksimalne brzine kretanja, omogućuju ubrzanje procesa optimizacije hidrokrila. Isti sustav mjerenja može se koristiti za mjerenja u svrhu optimizacije različitih svojstava drugih plovila.

Ključne riječi: *mjerenje, hidrokrilo, polarni dijagram brzine*

EXPERIMENTAL TESTS REVIEW AND SAMPLE MANUFACTURING FOR OBTAINING MECHANICAL PROPERTIES OF COMPOSITE LAMINATE

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ABSTRACT:
The manufacturing technology of composite laminate significantly affects its mechanical properties. The manufactured laminate/vessel may have substantially different mechanical properties than the rules and regulations suggested. When designing a composite marine structure, the designer should have as accurate information as possible about the mechanical properties since it is closely related to scantlings and the strength of the structural elements. The paper presents an overview of the experimental tests used to determine the mechanical properties of composite laminates for use in vessel structural design. A detailed method of sample manufacturing for assessing the proportion of fibers in the laminate according to the ASTM D2584 standard is given, as well as the preparation of samples for laboratory testing according to the ASTM D 3039/D 3039M standard to determine the modulus of elasticity, both in the fiber direction and perpendicular to the fibers. The specified methods of sample manufacturing can also be applied to samples of other recommended laboratory tests according to their specific requirements.

Keywords: *composites, laboratory testing, technology, samples*

PREGLED EKSPERIMENTALNIH METODA I NAČINA IZRADE UZORAKA ZA DOBIVANJE MEHANIČKIH OSOBINA KOMPOZITNOG LAMINATA

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SAŽETAK:
Tehnologija izrade kompozitnog laminata bitno utječe na njegove mehaničke osobine. Izgrađeni laminat/plovilo može imati bitno različite mehaničke osobine od onih koje predlažu pravila i propisi. Prilikom projektiranja strukture plovnog objekta projektant mora imati što je moguće točniji podatak o navedenim mehaničkim osobinama, budući o tome ovise dimenzije i čvrstoća strukturnih elemenata. U radu je prikazan pregled esperimentalnih metoda koje se koriste kod određivanja mehaničkih osobona

kompozitnog laminata za primjenu u projektiranju strukture plovnih objekata. Dan je i detaljan način izrade uzoraka za određivanje udjela vlakana u laminatu prema standardu ASTM D2584 kao i priprema uzoraka za laboratorijski test prema standardu ASTM D 3039/D 3039M u svrhu određivanja modula elastičnosti u snjeru i okomito na vlakna. Navedene metode izrade uzoraka moguće je primjeniti i na uzorke ostalih, preeporučenih laboratorijskih testova, uz primjenu specifičnih zahtjeva.

Ključne riječi: *kompoziti, laboratorijski test, tehnologija izrade, uzorci*

COMPARISON OF THE CLASSIC METHOD OF HULL SHAPE ASSESSMENT OF A 5-METER L5 SAILBOAT WITH THE PHOTOGRAMMETRY METHOD

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ABSTRACT:
This paper explores the comparison of two methods for assessing the hull shape of a 5-meter L5 sailboat. The classic way of obtaining the hull shape, involving manual measurements and traditional tools, is compared to the photogrammetry method, which relies on high-resolution photographs and software algorithms for analysis. Various aspects, including accuracy, speed, and practicality of both approaches, are analyzed in the study. The results suggest that the photogrammetry method has significant advantages in terms of accuracy and speed of shape assessment compared to the classic method. Photogrammetry enables more precise and faster measurement of various sailplane shape parameters, reducing the need for manual interventions and human subjective assessments. Additionally, the photogrammetry method provides high-quality visual data that can be used for further analysis and simulations.This paper suggests that the application of photogrammetry can enhance the process of obtaining the hull shape of 5-meter L5 sailboats, thereby increasing precision and efficiency in the field of engineering and design.

Key words: sailboat hull shape, manual measurements, photogrammetry method

USPOREDBA KLASIČNE METODE OČITANJA FORME 5-METARSKE JEDRILICE TIPA L5 S FOTOGRAMETRIJSKOM METODOM

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SAŽETAK:
Ovaj rad istražuje usporedbu dviju metoda za očitavanje forme 5-metarske jedrilice tipa L5. Klasična metoda očitanja forme, koja uključuje ručna mjerenja i tradicionalne alate, uspoređena je s fotogrametrijskom metodom koja se oslanja na fotografije visoke rezolucije i softverske algoritme za analizu. U istraživanju su analizirani različiti aspekti, uključujući točnost, brzinu i praktičnost oba pristupa. Rezultati sugeriraju da fotogrametrijska metoda ima znatne prednosti u točnosti i brzini očitavanja forme u usporedbi s klasičnom metodom. Fotogrametrija omogućava preciznije i brže mjerenje različitih parametara forme jedrilice, čime se smanjuje potreba za ručnim intervencijama i ljudskim subjektivnim procjenama. Osim toga, fotogrametrijska metoda pruža visokokvalitetne vizualne podatke koji se mogu koristiti za daljnje analize i simulacije. Ovaj rad sugerira da primjena fotogrametrije može poboljšati proces očitavanja forme 5-metarskih jedrilica tipa L5, čime se povećava preciznost i efikasnost u ovom području inženjeringa i dizajna.

Ključne riječi: *forma jedrilice, ručna mjerenja, fotogrametrijska metoda*

Izlaganja 4 / *Session 4*

Konstrukcija i projektiranje u brodogradnji, Inteligentni podvodni sustavi, Obnovljivi izvori energije

/ Construction and Design in Shipbuilding, Intelligent Underwater Systems and Technologies, Renewable Energy Sources

DESIGN OF THE HULL STRUCTURE OF DOUBLE-ENDED FERRIES FOR THE ADRIATIC

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ABSTRACT:
The main topic of this paper is a hull structure design of an 80 m double-ended ferry, intended for navigation in the Adriatic Sea. The structural ship elements were dimensioned according to the rules of the Croatian Ship Register using the Mathcad software. The preliminary drawing of the main midship frame was made in AutoCAD. Then follows the verification of previously calculated primary structural elements using beam finite element method model (DNV 3D-Beam software). The obtained results of main deck model and the racking model meet the strength criteria. Docking stress of the bottom structure was also checked and meets the strength criteria. Furthermore, the distribution of global longitudinal stresses in midship section is verified using the finite element method in DNV GeniE software.

Keywords: *passenger ferry, structural design, FEA*

PROJEKT STRUKTURE TRUPA DVOSTRANOG TRAJEKTA ZA JADRAN

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SAŽETAK:
Rad sadrži projekt strukture trupa dvostranog trajekta duljine 80 m namijenjen plovidbi po Jadranu. Pomoću Mathcad programskog paketa dimenzionirani su strukturni elementi prema pravilima Hrvatskog registra brodova te je napravljen pripadni nacrt glavnog rebra u softveru AutoCAD. Potom slijedi proračun i provjera strukturnih elemenata primjenom DNV 3D-Beam programskog alata. Dobiveni rezultati modela rešetkaste primarne strukture glavne palube te modela okvira boka garažnog prostora i nadgrađa zadovoljavaju kriterije čvrstoće. Provjereno je i naprezanje strukture dna uslijed dokovanja, koje također zadovoljava. Nadalje, primjenom metode konačnih elemenata pomoću DNV GeniE programskog paketa provjerena je raspodjela globalnih uzdužnih naprezanja u paralelnom srednjaku.

Ključne riječi: *putnički trajekt, čvrstoća broda*

SUBSEA RESIDENCY

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ABSTRACT:
Offshore infrastructure includes various facilities, such as oil and gas platforms, wind farms, and subsea pipelines that are used to extract or transport resources from the ocean floor. The future of offshore subsea infrastructures is inevitably connected to the concept of Subsea Resident Vehicles (SRVs). Offshore infrastructure includes a base for SRV's launch and recovery and provide a source of power and communication. Facilities that house and support SRVs are dedicated docking stations with auxiliary systems necessary for long-term habitation in the deep sea. SRVs performs various tasks offshore such as inspection of infrastructures and surrounding area, interventions, and guarding the site, ensuring infrastructure's safety. The topic of infrastructure safety becomes very important in the light of recent world's geopolitical developments. Although docking capability was intended only for bigger, work class vehicles, there is an increased interest in using smaller and cheaper vehicles for resident tasks lately. The paper presents latest result of the NTNU's AURLab related to subsea residency and development of a test and validation site for SRVs. Testing and validation of SRVs before taking over various offshore tasks is essential as they operate in a harsh environment for a long period of time without any physical support.

Keywords: *subsea docking, residency, underwater vehicles, subsea testing infrastructure*

OFFSHORE WIND ENERGY HARVESTING – EXAMPLE OF NORWAY-CROATIA TRANSNATIONAL EXPERIENCE EXCHANGE

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ABSTRACT:
The RePower EU plan has set the goal for an increase in wind energy capacity to 480 GW by 2030, with 300 GW from offshore wind farms, to achieve climate neutrality by 2050. Croatian wind energy potential of offshore wind farms has been recently evaluated at 25 GW in the "Action Plan for Renewable Energy Sources at Sea in Croatia". The main problem is that currently there are no offshore wind energy power plants, making it a new endeavor where many different issues with implementation can be expected. Norway has extensive experience in wind energy harvesting, where problems that Croatia is yet to encounter can be appropriately addressed before the problem emerges. Additionally, in Norway, considerable attention is being given to social acceptance, and large investments are made to reduce the negative environmental impact of such projects. Therefore, transnational cooperation can be greatly beneficial to achieving renewable energy goals. This paper presents some of the potential problems and issues that could be encountered during the implementation of offshore wind energy in the Croatian Sea. These issues and potential solutions were identified through the transnational experience exchange between Croatia and Norway, indicating the need for such cooperation.

Keywords: *renewable energy, offshore wind, RePowerEU*

Izlaganja 5 / *Session 5*

Pomorski transport, ekonomija i zakonodavstvo
/ Maritime Transport, Economy, Legislation

LINEAR TREND MODEL IN THE ANALYSIS OF SHIP LOSSES AND NAVIGATION SAFETY

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ABSTRACT:
By researching the available statistical data of the European Maritime Safety Agency (EMSA) on total losses in shipping, the most common cause, ship sinking, was analyzed in the period from 2015 to 2020. The data are useful for qualitative and quantitative assessments, and indicate factors that cause unwanted events. The aim of this paper is to highlight the possibility of prediction, which is crucial for the assessment of risk and safety in shipping, by applying a statistical model in the analysis of losses in shipping. In the analysis and processing of the available databases, Excel was used, as part of the Microsoft Office software package, which enables statistical analysis and drawing graphs.

Keywords*: statistical model, security, maritime, Excel*

MODEL LINEARNOG TRENDA U ANALIZI BRODSKIH GUBITAKA I SIGURNOSTI PLOVIDBE

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SAŽETAK:
Istraživanjem dostupnih statističkih podataka Europske agencije za pomorsku sigurnost (engl. EMSA) o ukupnim gubicima u brodarstvu , analiziran je najčešći uzrok, potonuće broda, u razdoblju od 2015. do 2020. Podaci su korisni radi kvalitativnih i kvantitativnih procjena, te ukazuju na čimbenike koji uzrokuju neželjene događaje. Cilj ovog rada je primjenom statističkog modela u analizi gubitaka u brodarstvu, istaknuti mogućnost predikcije, što je ključno za procjenu rizika i sigurnosti u pomorstvu. U analizi i obradi dostupnih baza podataka, primijenjen je Excel, kao dio programskog paketa Microsoft Office, koji omogućuje statističku analizu te crtanje grafova.

Ključne riječi: *statistički model, sigurnost, pomorstvo, Excel*

HYDRODYNAMIC ASPECTS OF A SHIP IN WEATHER ROUTING WITHIN THE CONTEXT OF SLOW STEAMING

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ABSTRACT:
The review paper addresses the intricate relationship between ship hydrodynamic performance and the implementation of weather routing within the context of slow steaming. The maritime industry, as a vital component of global trade, has faced increasing pressure to reduce its environmental footprint and operational costs. Slow steaming, characterized by reduced cruising speeds, has emerged as a sustainable approach to minimize fuel consumption and greenhouse gas emissions. Weather routing, on the other hand, optimizes ship routes based on meteorological and oceanographic conditions, with the aim of enhancing both safety and fuel efficiency. Ship hydrodynamics, encompassing resistance, propulsion, maneuverability, and seakeeping, directly impact a ship's performance. The relationship between these hydrodynamic aspects and weather routing in the context of slow steaming is crucial for optimizing fuel efficiency, reducing emissions, ensuring safety, and minimizing operational costs in the maritime industry. By integrating these factors, ship operators can achieve a more sustainable and efficient approach to sea transport within the context of slow steaming and weather routing.

Keywords: *ship, hydrodynamic performance, weather routing, slow steaming*

HIDRODINAMIČKI ASPEKTI BRODA KOD ODABIRA RUTE PREMA VREMENSKIM UVJETIMA U OKVIRU PLOVIDBE SMANJENOM BRZINOM

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SAŽETAK:
U preglednom radu obrađen je složeni odnos između hidrodinamičkih značajki broda i odabira rute prema vremenskim uvjetima u okviru plovidbe smanjenom brzinom. Pomorska industrija, kao vitalna sastavnica svjetske trgovine, suočena je sa sve većim pritiskom za smanjenje utjecaja na okoliš te snižavanje operativnih troškova. Plovidba smanjenom brzinom pokazuje se kao održivi pristup za smanjenje potrošnje goriva te emisija stakleničkih plinova. S druge strane, odabirom plovidbenog puta prema vremenskim uvjetima optimiziraju se rute brodova na temelju meteoroloških i oceanografskih uvjeta, s ciljem povećanja sigurnosti i učinkovitosti goriva. Hidrodinamika broda, koja obuhvaća otpor, propulziju, upravljivost i pomorstvenost, izravno utječe na plovidbene značajke broda. Odnos između ovih hidrodinamičkih značajki i odabira rute prema vremenskim uvjetima u okviru plovidbe smanjenom brzinom ključan je za optimizaciju učinkovitosti goriva, smanjenje emisija,

osiguravanje sigurnosti i minimiziranje operativnih troškova u pomorskoj industriji. Ujedinjavanjem ovih čimbenika operateri brodova mogu postići održiviji i učinkovitiji pristup pomorskom prijevozu u okviru plovidbe smanjenom brzinom i odabira rute prema vremenskim uvjetima.

Ključne riječi: *brod, hidrodinamičke značajke, odabir rute prema vremenskim uvjetima, plovidba smanjenom brzinom*

AN EXAMINATION OF THE PIVOTAL ROLE OF FEMALE SEAFARERS AND THE UNDERLYING CHALLANGES

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ABSTRACT:
Female seafarers are a set of women that work inside the vessel or any type of maritime transport under fluctuating weather conditions over a period of time with the sole aim of ensuring a seamless transportation of oil, chemicals, containers,passengers, cargoes and other types of freight from origin to destination. Even though the safety and security of women at sea is not guaranteed, it has not in any way dissuaded these calibre of women from pursuing this career path. This job description is quite rigourous and this study categorises the work of the female seafarer into operational, navigational, health safety, communication and leadership duties. Any interruption in any of these duties will have severe financial implications. The pivotal role of female seafarers is to boost international trade. Hence both female and male seafarers are drivers of international trade. There are several reasons why a woman will embrace this job in spite of the inherent challenges as this study indicates. One of the several reasons that the respondents indicated was to increase the number of female seafarer from 1.2%. The focus of this research is to examine the pivotal role of women at sea to the global economy and the underlying challenges. A structured questionnaire is developed and sent to a set of 50 female seafarer. Hence, this research contributes to the body of knowledge on the role of women at sea, and what can be done to motivate them to continue with this herculean tasks of contributing to the global economy

Keywords: *female seafarers, maritime transport, global, economy, pivotal*

BW CONVENTION IDENTIFIED DEFICIENCIES BY PORT STATE CONTROL IN PARIS MOU AREA

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ABSTRACT:
The growth and development of maritime activities and the associated increase in the number of ships also increase the pressure on the marine environment. In addition to the positive impacts of maritime transport, including social and economic components, the threats to the marine environment, including ballast water, cannot be ignored. The objective of the Ballast Water Convention is to control and manage ballast water and sediments from ships, as they are recognized as pollutants. The aim of this paper is to present the implementation of the Ballast Water Convention in the Paris Memorandum of Understanding (MOU) area. The purpose of reviewing annual reports and inspection results fromParis MOU is to to identifydeficiencies in the implementation of requirements of the the Ballast Water Convention. Since the Ballast Water Convention was ratified in September 2017, the recording of deficiencies in this category by Port State Control starts from that date. The analysis covers the period 2017-2022, with special attention to the most frequently identified deficiencies. The results show that the largest number of deficiencies was recorded in 2022 and that the most common deficiency in all years observed was the Ballast Water Record Book.

Keywords: *ballast water, Ballast Water Convention, Paris Memorandum, inspection, deficiencies*

UTVRĐENI NEDOSTACI LUČKIH INSPEKTORA NA PODRUČJU PARIŠKOG MOU U PROVEDBI ZAHTJEVA BW KONVENCIJE

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SAŽETAK:
Rast i razvoj pomorskih djelatnosti dovodi i dopovećanje broja brodova čime se posljedičnopovećava i pritisak na morski okoliš. Brojni su pozitivni učinci pomorskog prometa, uključujući ekonomsku i socijalnu komponentu, no ne smijuse zanemariti ni utjecaji na morski okoliš, uključujući balastne vode. Upravo Konvencija o balastnim vodama uključuje kontrolu i upravljanje balastnim vodama i sedimentima s brodova, obzirom da su prepoznati kao onečišćivači. Cilj ovog rada je prikazati provedbu Konvencije o balastnim vodama na području Pariškog memoranduma o razumijevanju. Pregledana su godišnja izvješća Pariškog memoranduma o razumijevanju, kao irezultati inspekcija, a sve u cilju kako bi se utvrdilinedostataci u provedbi zahtjeva Konvencije

o balastnim vodama. S obzirom na to da je Konvencija o balastnim vodama ratificirana u rujnu 2017. godine, od tog datuma počinje evidentiranje nedostataka u ovoj kategoriji. Analiza obuhvaća razdoblje 2017.-2022., s posebnim osvrtom na najčešće uočene nedostatke. Rezultati pokazuju da je najveći broj nedostataka zabilježen u 2022. godini te da je najčešći nedostatak u svim promatranim godinama bila Knjiga o balasta.

Ključne riječi: *balast, Konvencija o balastnim vodama, Pariški memorandum, inspekcija, nedostatci*

THE PERCEPTION OF SPLIT AREA RESIDENTS ON THE IMPACT OF CRUISING TOURISM IN THE CITY OF SPLIT

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ABSTRACT:
Cruising tourism is a part of the shipping industry which is growing constantly both in the number of ships and their capacity. The same trend is happening in Port of Split, the second-largest cruise port in the Republic of Croatia. Large cruise ships bring to the recipient country lots of benefits but at the same time, they have a negative impact on the environment. A survey was conducted on a sample of 134 residents of Split to examine their perception of cruise tourism in their city and their awareness of its positive and negative impacts. This enabled us to identify the parameters of the greatest importance to the local population and to draw conclusions on their perception of the advantages and disadvantages of the increased number of cruise ship traffic in the Port of Split.

Keywords: *cruise tourism, cruise ship, residents' perception, Split.*

PERCEPCIJA STANOVNIKA SPLITA O UTJECAJU KRUZING TURIZMA NA GRAD SPLIT

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SAŽETAK:
Kruzing turizam je dio brodarske industrije koja konstantno raste kako u broju brodova tako i u njihovoj veličini. Isti trend događa se i u Luci Split, drugoj najvećoj luci za brodove za kružna putovanja u Republici Hrvatskoj. Veliki brodovi za kružna putovanja donose zemlji u koju uplovljavaju brojne prednosti, ali u isto vrijeme imaju negativan utjecaj na okoliš. Istraživanje je provedeno na uzorku od 134 stanovnika Splita kako bi se ispitala njihova percepcija kruzing turizma u njihovom gradu te svijest o njegovim pozitivnim i negativnim utjecajima. To nam je omogućilo da identificiramo parametre od najveće važnosti za lokalno stanovništvo i donesemo zaključke o njihovoj percepciji prednosti i nedostataka povećanog prometa brodova na kružnim putovanjima u luci Split.

Ključne riječi: *kruzing turizam, brod za kružna putovanja, percepcija stanovnika, Split*

Izlaganja 6 / *Session 6*

Primjena kompjuterskih aplikacija u projektiranju, proizvodnji i održavanju postrojenja morske tehnologije **/** *Computer applications in the design, manufacture and operation of marine technology facilities*

TXT AND TIF FILE COMPRESSION USING LZW, HUFFMAN, AND ARITHMETIC CODING

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ABSTRACT:
The paper compares compression methods such as Lempel-Ziv-Welch (LZW), Huffman, and arithmetic coding applied to different large text and image datasets. Comparison is done based on metrics such as execution time and compression ratio. LZW produced results of about 30 % median compression ratio for all text records and a median of about 70 % for image records. In addition, Huffman coding produced a compression rate of about 40 % median for text data and a median of about 55 % for image data. Finally, arithmetic coding yielded results of about 70 % median for text compression and about 55 % median for image data compression. The time required was lowest for LZW, followed by Huffman, and worst for arithmetic coding.

Keywords: *coding, LZW, Huffman, arithmetic coding, compression*

KOMPRESIJA TXT I TIF DATOTEKA KORIŠTENJEM LZW, HUFFMAN, I ARITMETIČKOG KODIRANJA

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SAŽETAK:
Ovaj rad daje usporedbu nekoliko metoda kompresije podataka, kao što su Lempel-Ziv-Welch (LZW), Huffman i aritmetičko kodiranje primijenjeno na različite velike tekstualne i slikovne skupove podataka. Usporedba je provedena na temelju metrika kao što su vrijeme izvršenja i omjer kompresije. LZW je rezultirao medijanom omjera kompresije od oko 30 % za sve tekstualne zapise i oko 70 % za slikovne zapise. Nadalje, Huffmanovo kodiranje je rezultiralo madijanom kompresije od oko 40 % za tekstualne podatke i oko 55 % za slikovne podatke. Konačno, aritmetičko kodiranje je rezultiralo medijanom kompresije teksta od oko 70 % i oko 55 % za kompresiju slikovnih podataka. Vrijeme izvršavanja je bilo najkraće za LZW, zatim je slijedilo Huffmanovo kodiranje, a najsporije je bilo aritmetičko kodiranje.

Ključne riječi: *kodiranje, LZW, Huffman, aritmetičko kodiranje, kompresija*

ON THE DEVELOPMENT OF NUMERICAL OCEAN FOR SEAKEEPING SIMULATIONS IN OPENFOAM®

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ABSTRACT:
The ongoing trend of using numerical simulations in marine hydrodynamics yields the need to describe the potential of developing a numerical environment relevant for seakeeping simulations in CFD, more precisely in an open-source software OpenFOAM®. In that manner, the main objective of this paper is to investigate the numerical parameters that affect the well-known issues of dissipative and dispersive errors that are present with long gravity-driven waves within the finite volume method. The performance of various methods for the discretization of the temporal derivatives in Navier-Stokes equations is investigated along with the convective term discretization. Gradient schemes are also investigated since their choice can heavily influence the pressure calculation and consequently, the forces acting on the floating body. Furthermore, the inclusion of a standard two-equation turbulence models leads to an undesirable build-up of turbulent viscosity bellow the free surface, resulting in wave damping. Therefore, turbulence modelling is also addressed with standard turbulence. Finally, a combination of optimal settings is proposed and tested. Potential applications of the numerical ocean are discussed, especially with respect tothe problem involving seakeeping and propulsion in irregular waves.

Keywords: *Numerical ocean, OpenFOAM®, free surface flows, irregular seas*

RAZVOJ NUMERIČKOG OCEANA ZA SIMULACIJE POMORSTVENOSTI U OPENFOAM®

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SAŽETAK:
Upotreba sve složenijih numeričkih simulacija u brodskoj hidrodinamici dovodi do potrebe za opisom razvoja numeričkog oceana relevantnog za simulacije plovidbe u CFD-u, točnije u računalnom programu otvorenog koda OpenFOAM®. U tom svjetlu, glavni cilj ovog rada je istražiti numeričke parametre koji utječu na numeričke probleme disipativnih i disperzijskih efekata koje su prisutne kod opisivanja gravitacijskih valova u metodi konačnih volumena. U svrhu određivanja kompromisnog rješenja između točnosti i vremena računanja, provode se studije sistematskog profinjavanja mreže. Uz metode diskretizacije konvektivnog člana, istražuje se i učinkovitost različitih metoda diskretizacije vremenskih derivacija u Navier-Stokesovim jednadžbama. Numeričke sheme gradijenata također se istražuju budući da njihov odabir može značajno utjecati na estimaciju tlakova i posljedično na sile koje djeluju na plutajuće tijelo. Nadalje, uz uključivanje standardnih, dvo-jednadžbenih modela turbulencije, dolazi do neželjenog porasta turbulentne viskoznosti ispod slobodne površine što uzrokuje prigušivanje valova. Stoga se problematika modeliranja turbulencije također obrađuje, uz

standardne modele turbulencije zajedno sa stabiliziranim verzijama, specifičnim za primjenu sa valovima. Na kraju se predlaže i testira kombinacija optimalnih postavki te se raspravlja o potencijalnim primjenama numeričkog oceana, posebno za probleme pomorstvenosti i propulzije pri nepravilnim valovlju.

Ključne riječi: *Numerički ocean, OpenFOAM, strujanja sa slobodnom površinom, nepravilno valovlje*

GRAPH NEURAL NETWORK FOR STRESS PREDICTIONS IN STIFFENED PANELS

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ABSTRACT:
Graph neural network (GNN) is a particular type of neural network which processes data that can be represented as graphs. This allows for efficient representation of complex geometries that can change during conceptual design of a structure or a product, such as ships structures, replacing computationally expensive finite element analysis (FEA) in optimization. In this study, we demonstrate our novel graph embedding technique where separate plate domains are represented as vertices. This approach is considered using Graph Sampling and Aggregation (GraphSAGE) to predict stress distributions in stiffened panels with varying geometries under patch loading. Parametric study is performed to examine the effect of structural geometry on the prediction performance. Our results demonstrate the immense potential of graph neural networks with the proposed graph embedding method as robust reduced-order models for 3D structures.

Keywords: *Machine learning, Deep learning, Graph embedding, Graph Neural Networks, Stiffened panels*

Izlaganja 7 / *Session 7*

Tehnologija brodogradnje i Brodogradilišta /
Shipbuilding Technology and Shipyards

THE ESTIMATION OF THE PRODUCTION TIME FOR STEEL HULL ELEMENTS USING THE FINITE STATE METHOD

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ABSTRACT:
The steel hull process of a shipyard transforms steel plates and profiles into elements needed to build the ship hull and superstructure. The production time for these elements is the basic input to schedule the whole shipbuilding process. Therefore, it is important to implement time estimation approaches based on production system engineering. In this study, the recently developed finite state method for serial and splitting lines is employed to describe the steel hull process of a shipyard semi-analytically. Two typical ship sections are chosen to estimate the corresponding key performance indicators as the production rate, the work in process, and probabilities of starvation and blockade. The production time is estimated based on the production rate and the cycle time. These results are compared to the results obtained through a simulation approach using the software tool Enterprise Dynamics. The conclusion highlights the advantages and disadvantages of both approaches.

Keywords: *steel hull process, production system engineering, key performance indicators, production time, finite state method*

PRORAČUN VREMENA TRAJANJA PROIZVODNOG PROCESA OBRADE METALURGIJE TRUPA BRODA PRIMJENOM METODE KONAČNIH STANJA

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SAŽETAK:
Limovi i profili se kao elementi brodskog trupa obrađuju u sklopu procesa obrade metalurgije trupa, a sam vremenski raspored brodograđevnog procesa se temelji na pojedinačnim vremenima izrade. Prema tome je od velike važnosti razviti pristup za proračun trajanja proizvodnje temeljen na proizvodnom inženjerstvu. U ovom istraživanju se koristio poluanalitički pristup, metoda konačnih stanja, za opisivanje serijskih linija i granajućih linija kako bi se opisao proces obrade metalurgije trupa jednog brodogradilišta. Izabrane su dvije tipične brodske sekcije za proračun ključnih značajki poput očekivanog broja gotovih proizvoda, očekivanog broja poluproizvoda na međuskladištima, te vjerojatnosti blokade i praznog hoda stroja. Vrijeme trajanja proizvodnje za promatrane sekcije se temelji na ključnoj značajki očekivani broj gotovih proizvoda i trajanju ciklusa. Dobiveni rezultati su uspoređeni sa odgovarajućim

rezultatima dobivenim simulacijskim pristupom koristeći računalni program Enterprise Dynamics. U zaključku su istaknute prednosti i nedostaci poluanalitičkog i simulacijskog pristupa.

Ključne riječi: *proces obrade metalurgije, proizvodno inženjerstvo, ključne značajke, vrijeme proizvodnje, metoda konačnih stanja*

STRAIN AND STRESS CALCUALTIONS FOR BLOCKS MANIPULATION IN SHIP PRODUCTION PROCESS

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ABSTRACT:
The paper researches the problem of ship block sections transporting and manipulating during the ship construction with an emphasis on the issue of deformations and accuracy in the pre-assembly and assembly. For the purpose of stress and deformation analysis, and for the improvement of relevant procedures in the production process, a section of the ship's hull was modeled and prepared for meshing in the specialized FEA tool. The deformations and stresses in the section were analyzed for different scenarios of suspension of the section on lugs and its rotation according to the defined conditions. After the analysis was carried out, suggestions for improvement were given for the purpose of reducing deformations, increasing accuracy and reducing labor costs.

Keywords*: shipbuilding, FEA, stresses, deformations, cost reduction, efficiency*

ANALIZA NAPREZANJA I DEFORMACIJA PRI MANIPULACIJI SEKCIJAMA U PROCESU GRADNJE BRODA

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SAŽETAK:
U radu je istraživan problem transporta i okretanja sekcija pri gradnji trupa broda sa naglaskom na problematiku deformacija i točnosti sekcija u predmontaži i montaži sekcija broda. U svrhu analize naprezanja i deformacija, a za unapređenje relevantnih postupaka u proizvodnom procesu, modelirana je sekcija trupa broda te je izvršena priprema za mreženje u odabranom FEA alatu. Analizirane su deformacije i naprezanja u sekciji za različite scenarije zavješenja sekcije na uškama i njenog okretanja prema definiranim uvjetima. Po provedenoj je analiza dani su prijedlozi unapređenja u svrhu smanjenja deformacija, povećanja točnosti i smanjenja troškova rada.

Ključne riječi: *brodogradnja, FEA, naprezanja, deformacije, smanjenje troškova, efikasnost*

IMPLEMENTATION OF VARIOUS OUTSOURCED OUTFITTING DETAIL DESIGN APPROACHES IN PARTICULAR SHIPYARD

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ABSTRACT:
In today competitive shipbuilding market, it is not unusual that shipyards are using outsourced detailed documentation into their production program or to continue outfitting a ship that originally had been designed and started in another shipyard or design office. That involves some difficulties in adapting to different requirements which can require overhead organisation, a multiskilled work force, and the ability to respond rapidly to emerging conditions that affect a ship's operating schedule. Also, the detail design approach in various design offices is mostly different, and can be a result of differences in information included within detail documentation, such as more or less advanced outfitting approach, zone-oriented outfitting versus discipline, or system oriented outfitting approach. In this paper the outfitting process in a particular shipyard is observed through comparison between two principles of production design approaches, one originally made in observed shipyard and one which was designed in outsourced design office. The main goal of this paper is to develop a procedure of evaluating ship outfitting processes, using detail design as a way to establish appropriate shipbuilding production process. Hence, it should reduce building costs related to adopting different types of outsourced detail design documentation to the own shipyard production process.

Keywords: shipbuilding, detail design, outsourcing, outfitting process, advanced outfitting

IMPLEMENTACIJA RAZLIČITIH PRISTUPA IZVEDBE DETALJNE DOKUMENTACIJE U BRODOGRAĐEVNI PROCES

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SAŽETAK:
Na današnjem kompetitivnom tržištu brodogradnje nije neobično da brodogradilišta koriste detaljnu dokumentaciju vanjskih izvođača u svom proizvodnom programu ili da nastave opremati brod koji je izvorno projektiran i započet u drugom brodogradilištu ili projektnom uredu. To uključuje određene poteškoće u prilagodbi različitim zahtjevima koji mogu zahtijevati organizacijske prilagodbe, fleksibilnu radnu snagu i sposobnost brzog reagiranja na nove uvjete koji utječu proces gradnje broda. Također, pristup

izrade detaljne dokumentacije u različitim projektnim uredima uglavnom je različit, a može biti rezultat razlika u informacijama uključenim u detaljnu dokumentaciju, kao što je više ili manje napredna metodologija opremanju, opremanje orijentirano na zone ili disciplini, ili pristup opremanju orijentiran na sustav. U ovom se radu proces opremanja u određenom brodogradilištu promatra kroz usporedbu dvaju principa pristupa projektiranju proizvodnje, jednog koji je izvorno izrađen u promatranom brodogradilištu i drugog koji je projektiran u vanjskom projektnom uredu. Glavni cilj ovog rada je razviti postupak vrednovanja procesa opremanja broda, koristeći detaljni dokumentaciju, a u svrhu uspostavljanja odgovarajućeg proizvodnog procesa. Definirani pristup smanjiti će troškove vezane uz implementaciju različitih vrsta vanjske detaljne dokumentacije u proizvodni proces brodogradilišta.

Ključne riječi: *brodogradnja, detaljni dizajn, outsourcing, opremanje, napredno opremanje*

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