Aalto University

Marine Technology

Annual Report 2020-2021

Foreword

The marine technology research group has closely followed the Aalto ambitious aims by focusing on high-level international research and teaching activities, as summarized in this report. RAI 2018 evaluation revealed that Marine Technology is one of the top research groups of the Mechanical Engineering department and was ranked as 39 by the Shanghai University ranking on 2021, being the 2nd best on these Academic subject areas-based rankings in Aalto University.

Aalto aims to tackle global grand challenges with high societal impact. In the Marine field, the sustainability and safety of ship design and operations are examples of grand challenges on which also our group is intensively working in research. The CoE funded by LR Foundation has continued the international co-operation to improve the safety of Polar shipping.

Aalto is looking after new approaches to improve education; Grand challenge is personalized learning, life-long-learning, and challenge-based-learning which should be offered with agility for those students studying their first degree, but also increasingly for those who aim to upgrade their professional knowledge, skills, and attitude with those needed to act in maritime industries. Life-wide-learning is essential for those who want to work with agility in competitive international markets. In addition to educating game-changers for the industry as master- and doctoral-level students, the Marine Technology research group has been highly successful in coaching postdocs to become professors to Aalto and other highly ranked international universities in recent years.

The excellent results of our research group have also resulted in the opening of 2 new professorships for our group, which were fulfilled successfully during 2020. These enable us to re-focus our activities to study the future challenges of the rapidly changing marine field, like data-driven ship design and operations and increased automation. With this, we can also educate better systems engineers for society who are also able to have deep expertise in the selected field of marine science and technology.

Espoo, December 9th 2021

Pentti Kujala


Our values and mission

Our core values

The core values of Aalto Marine Technology shape our research and education. At Aalto University, the core values we especially emphasize are sustainability, radical creativity, and entrepreneurial mindset. These define the interaction and work approaches in our unit.

Excellence: We constantly promote excellence in research and education. We work as a team that encourages, challenges, and supports each other and we operate both in long- and short-term perspectives. We are open to feedback from our fellow professionals and students to constantly improve and take our research and education to the next level. We contribute to the international scene by educating talent to industry and academia.

Collaboration: The quality of our interdisciplinary and multidisciplinary research and education depends on the collaboration between students, scientific staff, and support staff. We work together with a passion for executing excellent research and education.

Creativity and innovation: We promote freedom to be creative and critical. These elements are essential to innovating our research and education, providing answers to societal questions and challenges. This also forms a basis on modest and, in some cases, radical renewal of this traditional field of science and engineering.

Respect: Our research and education are done in an interdisciplinary and multidisciplinary environment. We learn from our colleagues and other disciplines and respect the expertise and entrepreneurial mindset of the professionals in our community. We value integrity, openness, equality, and the natural maritime environment we utilize and operate. We accept our differences and do not tolerate discrimination.

Engagement: We are engaged with our student community. We educate our Bachelor, Master, and Doctoral students to become excellent professionals. We promote the active participation of our students in their degree programs and encourage self-responsibility in their learning process.

Relevance: Our research and education have a significant impact on society and sustainability. Those who pass by our ecosystem become excellent professionals who contribute to society as engineers. We execute research aligned to the societal challenges rising in the daily work of the stakeholders of the maritime industry. We provide science-based solutions to these challenges.

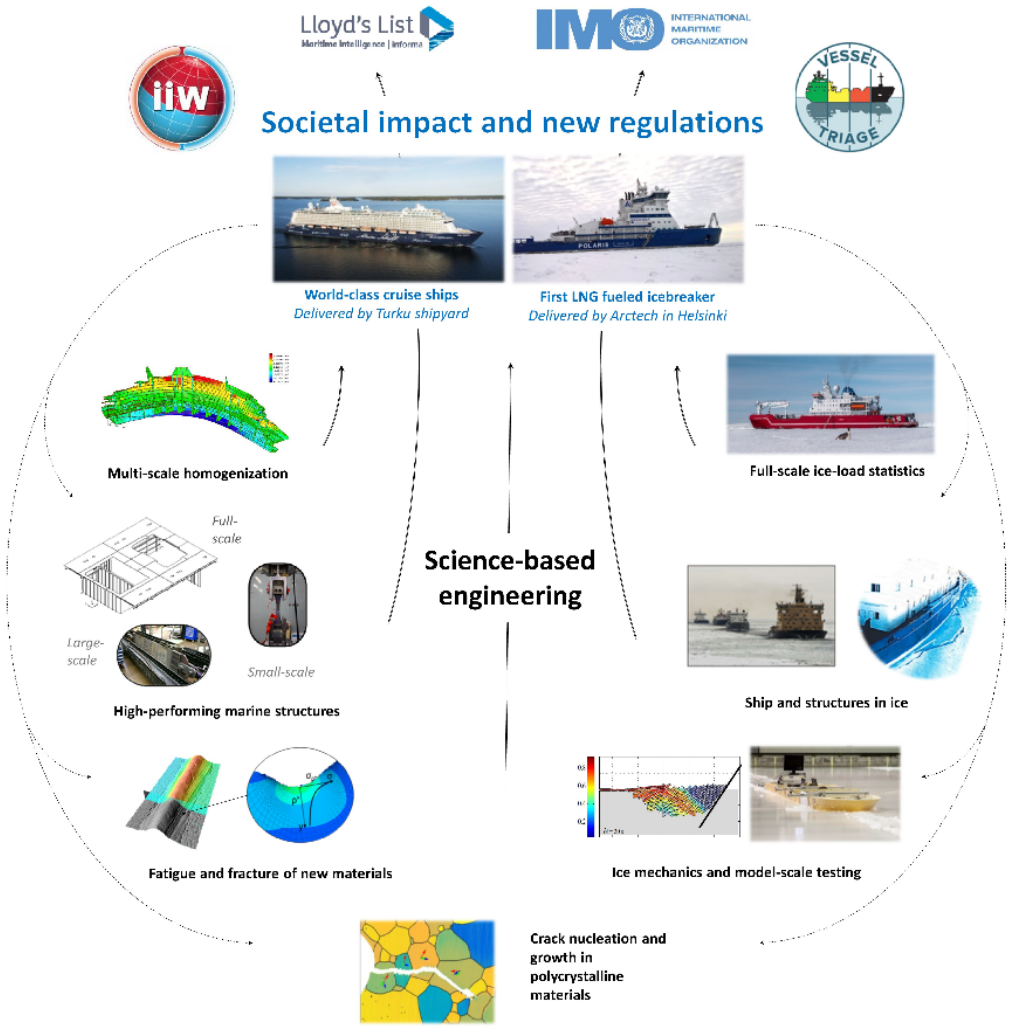
Our mission

The Marine Technology Unit at the Department of Mechanical Engineering of Aalto University School of Engineering has a responsible position in Finland to provide internationally recognized scientific research and education at the highest level in ship and marine technology. The unit acts as a nodal point to all maritime research and education in Finland and internationally on the fields focused on.

The research group on marine technology investigates the maritime phenomena and performs holistic safety analyses of marine traffic and structures based on the first principles of applied mathematics and mechanics. We also develop high-performing futuristic solutions and designs to meet requirements of the society.

An additional purpose is to advance the development of different ship and marine technology fields by producing and transferring new knowledge to industry and society. Teaching and research are the unit's primary duties, and its societal impact occurs through these fundamental activities. The basic ideas followed in scientific activity are a passion for marine technology, courage to face challenging problems of the society, freedom to develop new approaches and solutions, the responsibility of the actions taken and integrity of the link between research, education, and societal/industrial needs. This brings together the core values of Aalto and the unit.

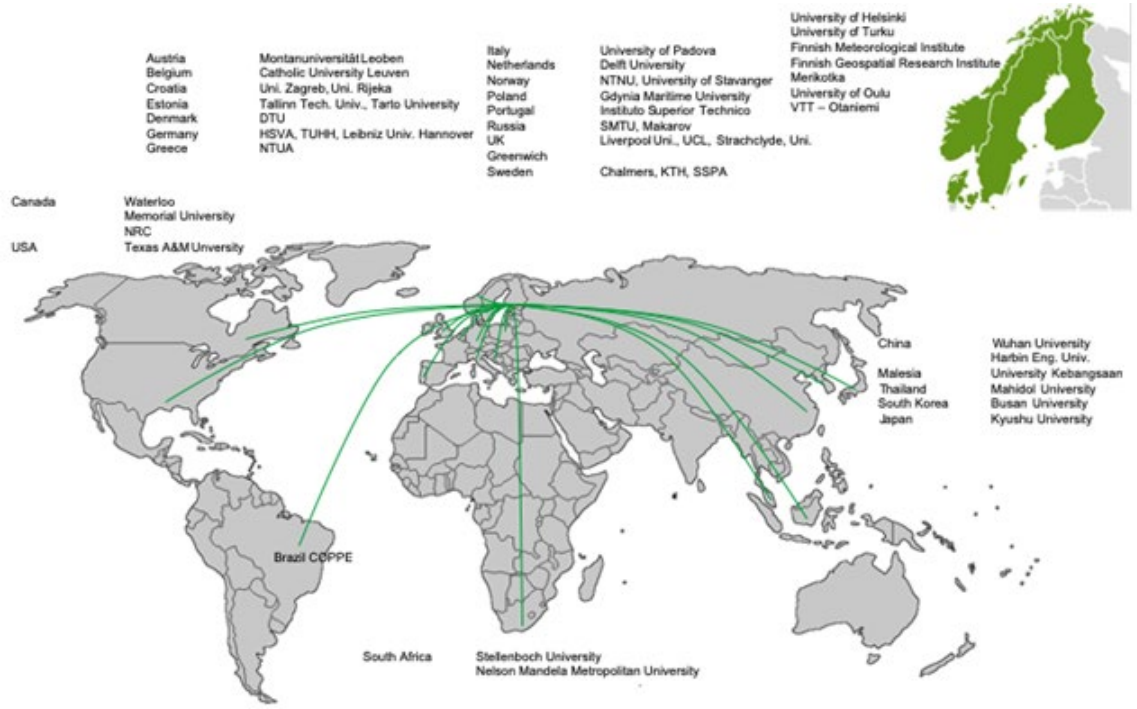
The research is integrated into the career paths of professors, lecturers, and postdocs and the degree education on B.Sc., M.Sc., and D.Sc. levels. The students are the significant contributors to the research, and post-doctoral researchers and professors advise their work. However, professors and postdocs produce publications also on their own. As a product of the teaching, students will deeply understand the field of interest and what is necessary to evaluate, gain, and apply their skills and knowledge into practice. The teaching aims to give the students a thorough education on applied mathematics and physics fundamentals, which does not become outdated and supports lifelong learning and research.



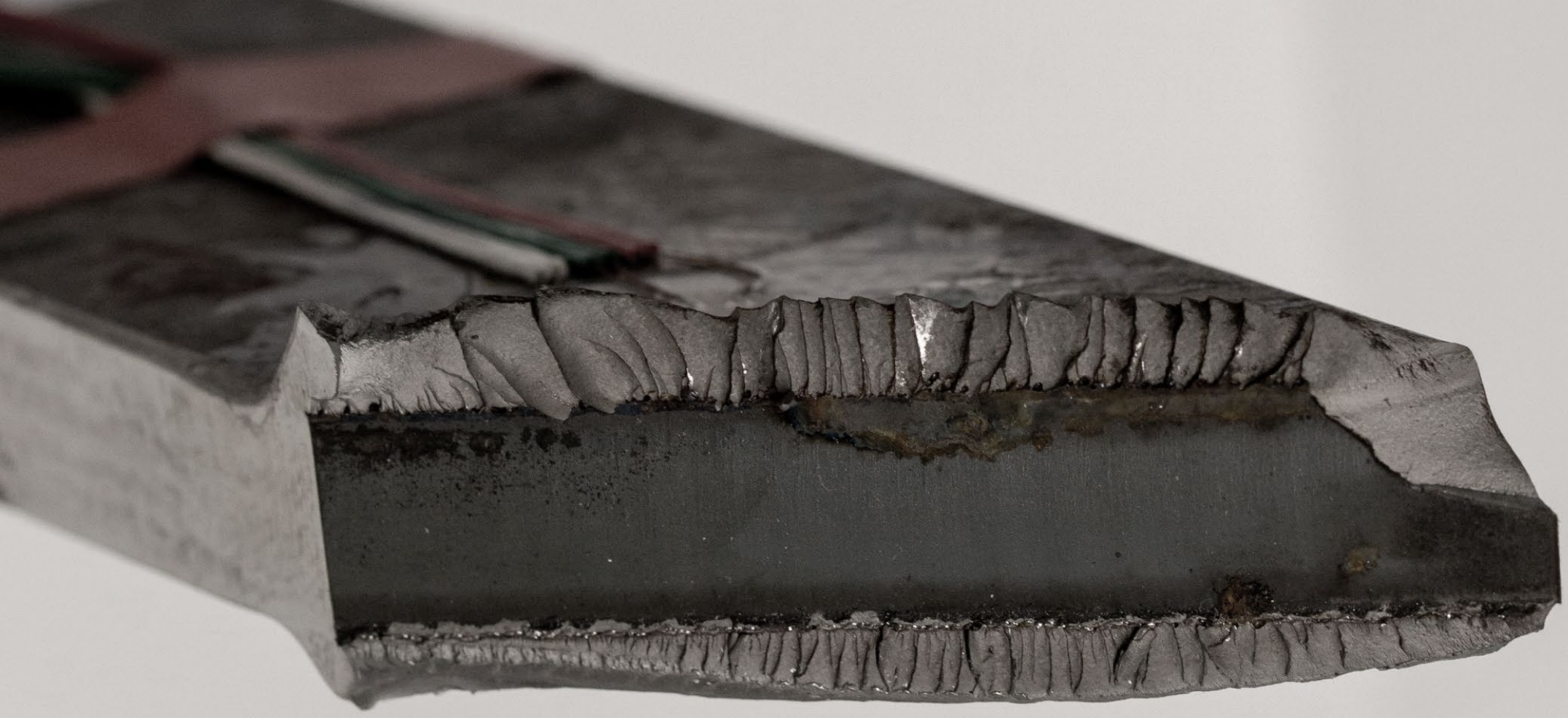
Operating environment

Earth is covered roughly 70% by the seas, and 90% of the world trade happens by the seas. Thus, the seas, shipping, and the use of the sea form the basis of everything, yet we often take this sensitive environment as granted. The maritime field has always been and will remain global, and they are very sensitive to market changes. For this reason, the group also operates on a worldwide scale, with partners from all around the world.

The Finnish Maritime Cluster has a strong position nationally and internationally. Marine Technology unit has a vital role in education and research as an academic actor and influencer on the national and European R&D scene, education networks, and scientific and expert committees in various topics. The role of Finnish subcontractors and other companies in the maritime field has become more significant when the whole cluster is considered. To affect the global markets better on selected themes, the European co-operation has become much more substantial. EU funding has concentrated on ship safety, environmental issues, and advanced design and production methods for structures. The funding in the university emphasizes the importance of research aiming at doctoral degrees and publications in refereed journals. The competition for basic funding is getting tighter. Networking and creating more extensive research projects are the ways to cope with the tightened economic situation.



A new feature in the maritime field is the extension of viewpoint to system-level solutions to ship fleet and regional maritime shipping system levels. At the same time, the complexity of the ship systems increases. This calls for heavier involvement of systems engineering disciplines in marine technology with data collection, analysis, and decision making. The Marine Technology unit contributes to the science, technology, and education on these emerging fields.



Research

Research Objectives

We are focusing our research on developing and applying the first principles of solid and fluid mechanics in marine technology and maritime systems. The complex marine applications require holistic risk- and experience-based designs with novel solutions. The fluid mechanics focuses on problems of open water with a free surface, hydroelasticity with strong interactions between the structure and the fluid, and interactions with ice. The solid mechanics focus on the interaction between load, response, and strength, with the main applications being fatigue, ultimate and accidental limit states in normal and arctic operation conditions.

We do extensively experimental research in full-scale and laboratory to deepen our understanding of fundamental physics. Based on these findings, we develop modelling techniques suitable for research and industrial needs. The unit is known for its research and teaching results and its significant societal and industrial impact.

The Marine Technology unit undertakes initiatives in research, and it concentrates on problems, which are on a high level scientifically and have a strong technological impact. The focus is on both long- and short-term projects that enable strategic developments and rapid actions to the emerging needs of society.

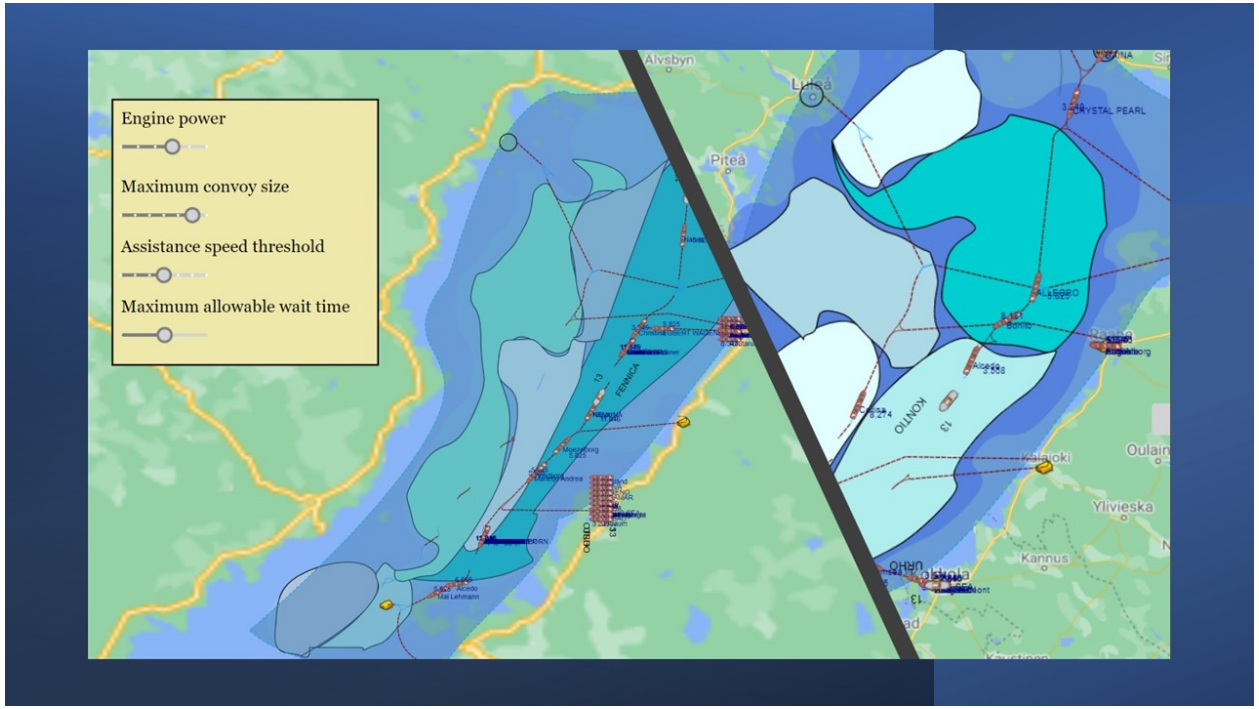
The research results of the unit are excellent. In the years 2020 and 2021, altogether 95 international, peer-reviewed journal papers and 23 conference papers have been produced. Most of these are published in high-impact journals, and the number of Scopus citations increases steadily. In addition, the group has had several invited talks in marine technology and generic scientific conferences.

Arctic Marine Engineering

To support safe, sustainable, and efficient ice navigation, the Arctic marine technology group is pursuing research on multiple fronts related to the design and operation of ice-going ships. The work is motivated because ice navigation is on the increase, driven by multiple factors, including the extraction of Arctic natural resources, trans-Arctic shipping, and Arctic tourism. In addition, ice navigation in regions with seasonal sea ice (e.g. the Baltic Sea) remains very significant.

To manage Arctic maritime activity related risks to humans and the polar environment, in January 2017 the International Maritime Organization (IMO) enforced the International Code for Ships Operating in Polar Waters (Polar Code). The code is fundamentally goal-based, allowing designers to deviate from established prescriptive rules, facilitating design optimization and innovation. However, for designers to be able to implement goal-based regulations, they need relevant and validated design tools and approaches and therefore we have presented an approach for holistic goal-based design of Arctic ships.

During 2020-201 the main ongoing projects have been: CoE CEPOLAR, EU funded SEDNA (Safe Maritime Operations under Extreme Conditions: the Arctic Case) project, EU-Russia funded INFUTURE (Future potential of Inland Waterways) project, EU-Russia funded SIMREC (Simulators for improving Cross-Border Oil Spill Response in Extreme Conditions) project and Ministry of Transport and Communications funded projects to develop a system-level simulation model of the Finnish winter navigation system. The main research topics covered by these projects have been: Development of the risk framework for performance-based design of ships on ice-covered waters, development of advanced simulation tools both on the system level to cover the whole ice going fleet and at ship level to simulate in detail the ice-breaking process of ships in various ice conditions. The extensive full-scale database of ice-induced loads and ship performance enables exact validation of the developed models and develops new statistical tools to handle the complicated random phenomena related to these topics.



Centre of Excellence on Arctic Marine Technology

The Centre of Excellence CEARCTIC project ended in 2018. The research has continued under new funding obtained from LRF for the same universities called CEPOLAR. The Centre of Excellence for Scenario-based Risk Management in Polar Waters (CEPOLAR) aims to tackle the issues associated with the new opportunities for ice-covered waters through guidelines that take a holistic view of the risks present in icy waters. The project is multidisciplinary, combining expertise in design methods, ice environment, ship-ice interaction, and structural damage and consequence analysis. When shipping moves more towards the North and South Pole, it brings with it an increased interest in the safety and sustainability of polar shipping, as well as in floating offshore installations operating in geographical areas with ice-infested waters. Current rules and regulations for the design of ice-going ships are either deterministic or address risks in a way that is only partly based on performance. All accident-borne limit states are not properly considered by the IMO Polar Code or the IACS unified requirements for polar ships. This necessitates the development of goal-based regulations for ship safety and sea traffic. Recommended practices will be developed to cover all key elements of polar ship design. This development work is conducted in collaboration with key stakeholders from the international maritime industry.

The project has continued as planned during 2020. Naturally, all the planned physical meetings did not take place because of the Covid-19. Still, the consortium has had meetings through TEAMS almost every second month, and some of the working groups have had meetings once a month virtually. In 2020, 17 journal papers were approved, three submitted, and four conference papers prepared. In addition, one doctor thesis was done.

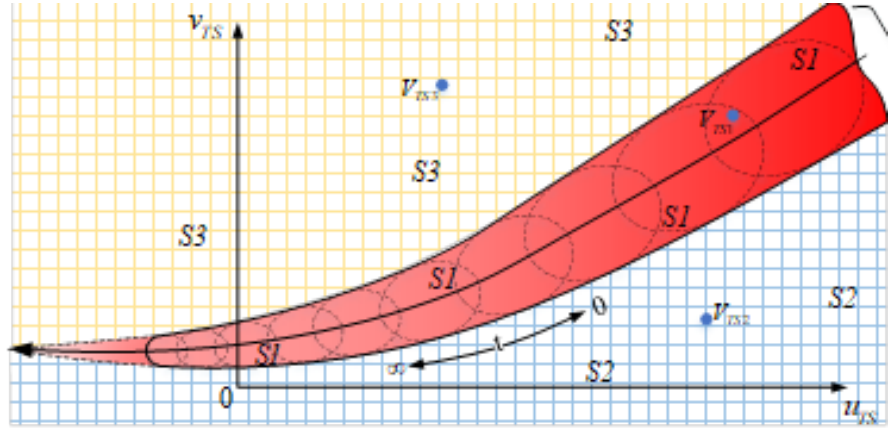
In 2021, primary efforts have been made for the final report of the work: Recommended practice for scenario-based risk management for ice-covered waters. The preliminary version of the report was ready in September 2021. This document aims to assist ship designers, operators, owners, and other stakeholders in managing those risks by outlining recommended practices for scenario-based risk management for ice-covered waters. Specific topics covered include ice condition forecasting, operational risk management, ice load assessment, hull structural design for ice loads, and accident consequence modelling. The work is ongoing with the stakeholders involved to prepare the final version of the report, which will be ready in June 2022.

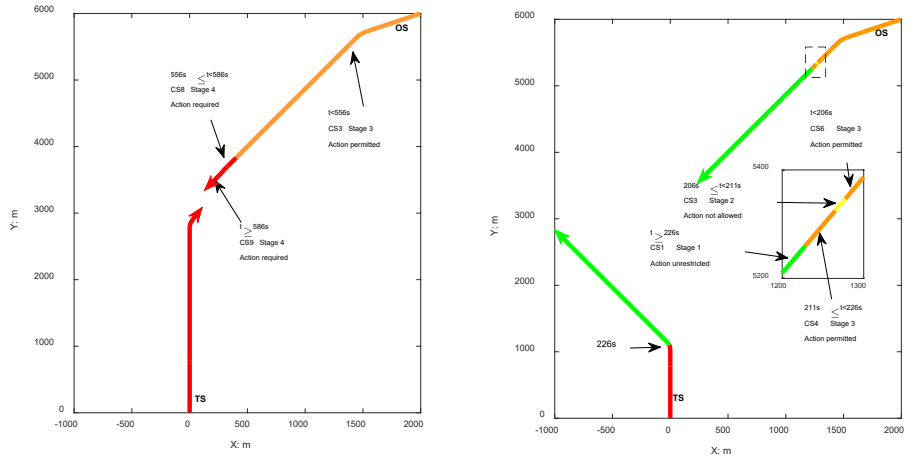
Risks and intelligence in marine systems

Our research focuses on risk and reliability analysis and safety science principles with application to ships' design and systems. Fundamental to this is the combination of principles of naval architecture with an impact on engineering science, future maritime policy, and regulations. As the foundations for futuristic ships are being set, a recent addition to our research interest is autonomous shipping and its implication on the human element of marine operations.

To date, research excellence has been reflected in the outcome of ongoing research projects funded by Business Finland and EU Horizons 2020. Examples have been the Business Finland Sea4Value project that assesses the reliability and safety of novel smart maritime technologies, ships, and service concepts and our work in EU project FLARE on the development of risk-based methodologies for "live" flooding risk assessment. During the last two years, Sea4Value has provided the basis to establish a service for remote pilotage operations in an intelligent fairway in Finland. Part of the work of this project has generated the structure of a proactive and novel safety management strategy for the design and operation of remote pilotage services and the functionality of the intelligent fairway. Recently, the FLARE consortium reviewed a range of potential applications of crashworthiness analysis for damaged ship stability and recommended their use for improved safety in design and operations. This philosophy aligns with and is supported by the principles of IMO FSA guidelines and MSC/Cric.1455 on alternative design and equivalent safety. It is envisaged that dissemination over the forthcoming year will shape future proposals in IMO MSC for implementing an improved version of SOLAS requirements for large passenger vessels.

On the academic front, our commitment to excellent research will be demonstrated through high-impact publications and the preparation of competitive project applications in national, regional, and international funding calls. Our goal is to develop a project portfolio that promotes the transfer of new knowledge between academia and industry, supports education, and shapes the profession's future.





Collision risk estimation in encounter ships (Du et al. 2021).

Risks and intelligence in marine systems

Most of our research activities are focused on the following research project:

Sea for Value (Sea4Value)

The mission of the Sea4Value / Fairway (S4VF) program is to provide blueprints towards digitalization, service innovation, and information flows in maritime transport. Its longer-term mission is in preparing for advanced autonomous operations and navigation. An essential step towards a smart and autonomous transport system is to ensure safe, sustainable, and efficient fairways for ships to enter and leave harbours. S4VF program improves the safe navigation for existing vessels and lays the foundation for future autonomous ships with an initial analysis of remote pilotage operations.

Autonomous Maritime School Network (AUTOMARE)

AUTOMARE aims at supporting the competitiveness of the Finnish maritime cluster through the cooperation of higher education institutions by promoting the multidisciplinary expertise of the maritime cluster. The project supports the adaptation and resilience transformation of the maritime cluster with the analysis of educational needs for the future professionals of the cluster. These needs are determined the notorious increment of automation and establishment of advanced technologies in ship navigation and maritime traffic.

Reliability and Safety Engineering and Technology for large maritime engineering systems (RESET)

RESET project provides the required dynamic approach for reliability and safety assessment. The overall aim of RESET is to bring together an international team of researchers with a wide variety of skills in reliability and safety research of large maritime engineering systems. The proposed research covers the fundamental study of reliability and safety, as well as applications in different maritime systems.

Enablers and Concepts for Automated Solutions (ECAMARIS)

The overall goal of ECAMARIS is to create enablers for autonomous solutions providing added value to the maritime industry. ECAMARIS focuses on autonomous ship technologies and concepts which serve as enablers for three use cases with estimated business and safety benefits to shipowners: relocation of ship bridge, conditionally and periodically less manned bridge, and conditionally and periodically unmanned bridge.

Risk analysis of Finnish fairways

The overall aim of this project is to perform a risk analysis of Finnish fairways in the context of pilotage operations. Considering the main objective of the Finnish pilotage services, the risk analysis focuses on hazards for navigational accidents, in particular ship groundings and ship-to-ship collisions.

Intelligent decision-making during winter navigation

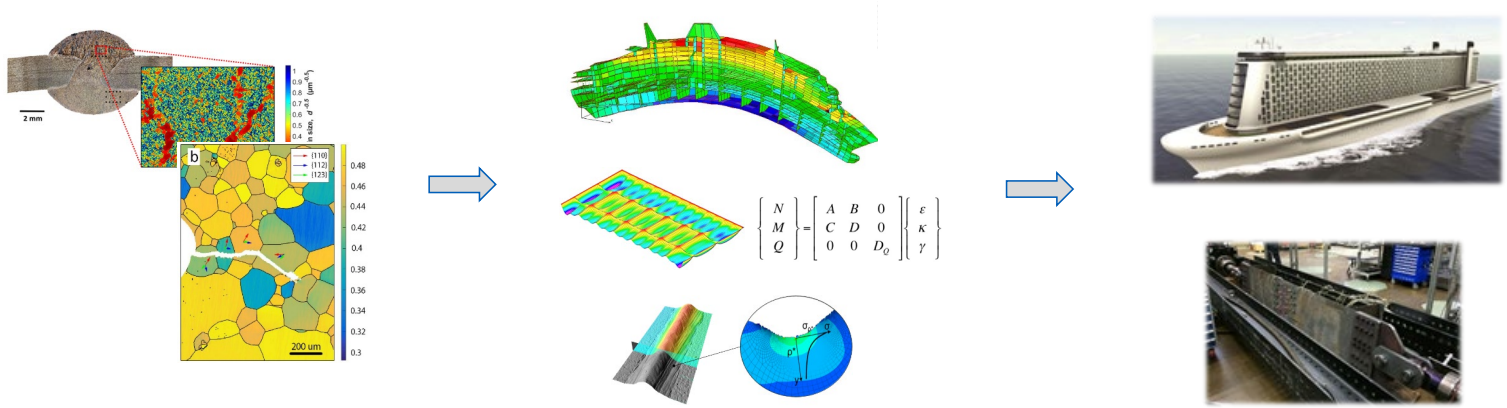
The aim of this project is to apply data-driven machine learning methods for intelligent decision-making during ship navigation in ice conditions. The decision-making framework targets autonomous ship operability evaluation, optimal ship routes generation, safe ship behavior prediction, and abnormal operation detection under the impact of ice conditions. The research will connect data and people by combining the historical data with expert knowledge for decision making. Interpretable machine learning models will be used to ensure automation transparency for end-users.

Marine Structures and Production

Advanced marine structures and materials research focuses on the mechanical behavior of high-performance materials, material systems, and structures under load-effects caused by the interaction of ships and offshore structures within the maritime environment. To meet the increasingly stricter societal requirements for energy efficiency, we develop high-performing structures that utilize direct load analysis and modeling, new materials, and manufacturing methods for the maritime industry. In this work, it is essential to fundamentally understand the strength properties of structures produced on the industrial scale and in the actual operating conditions.

We are focusing our research on the load-carrying and failure mechanisms of steel structures under different load scenarios that affect the design of a ship. This requires investigations at length scales ranging from ship hull girder to material microstructural scale and interphases between fluid mechanics, solid mechanics, materials science, and random vibrations. Thus, we carry out extensive experimental and theoretical studies across these length scales and fields of science to gain a deep understanding of load effects, material, and structural behavior.

We use the latest numerical techniques to gain insight into theoretical modeling and prevailing assumptions. To simplify the design process of ships, we develop efficient theoretical models for complex structural systems. The developments of these methods are motivated by the challenges of large, complex marine structures and short design cycles. Although developed in the maritime field, they also have applications in other areas, such as nanotechnology, aeronautical and civil engineering.



Marine Structures and Production

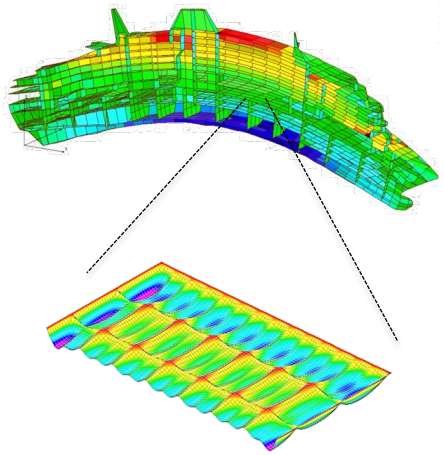
At present, most of our research activities are focused on non-linear multi-physics simulations, high-strength steel structures, and thin-plated and lattice-type sandwich steel structures. These solutions have the highest potential to improve the energy efficiency of ships. In these areas, the focus is on how the materials' microstructure and structural topology affect strength and stiffness and how non-linearities in load effects are transferred from ship level towards structural and material length scales. In particular, the interfaces between structures, e.g., welded joints, are crucial to structural safety, and they are thus in a significant role in our research activities.

The group currently holds three Academy of Finland projects on fatigue and fracture of steel structures and one Marie Curie Global fellow project on the micromechanics of sandwich structures. These academy projects support our long-term research strategy, and they have resulted in several scientific publications, invited talks, awards, and doctoral theses. To complement the scientific research, we have two significant EU projects to model ship collisions and groundings and apply advanced materials to the ship's primary structures. The first project focuses on Multiphysics simulations, including the effects of various levels of theoretical simplifications. In the second project, we transfer the knowledge and skills gained from basic research on high-strength and ultra-slender steel structures to industry usage and simultaneously obtain future research questions for our research group. This research is enabled by several academic and industrial Doctoral thesis.

Fatigue assessment of thin deck structures

(Analytical k_m formulation)

Nominal stress σ_N

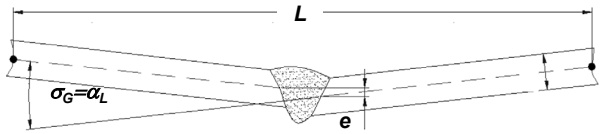


Structural stress σ_{HS}

$$\sigma_{HS} = k_m \cdot \sigma_N$$

Thick plates (t≥5mm)

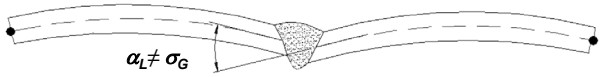
$$k_{m,a} = 1 + \frac{3\alpha L}{t}$$



Thin deck structures

(with non-linearity and curvature effects)

$$k_{m,a} = 1 + \frac{6y_0}{t}\left(\frac{\tanh(\beta)}{\beta}\right) + \frac{6a_0\pi}{t}\left(\frac{\beta \tan h(\beta)}{\pi^2 + \beta^2}\right)$$

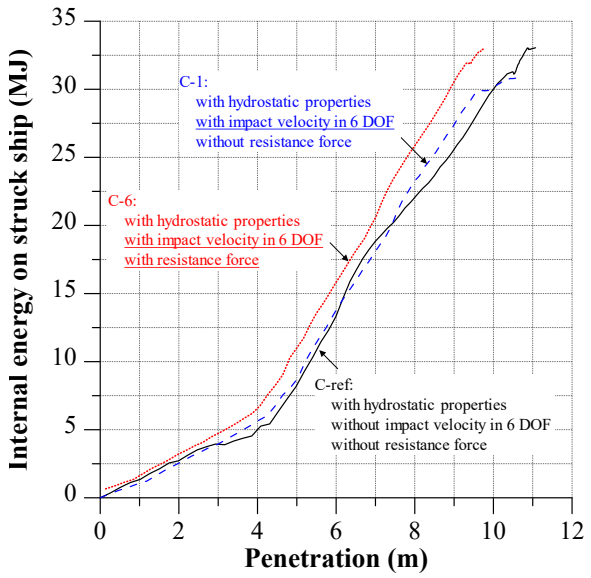


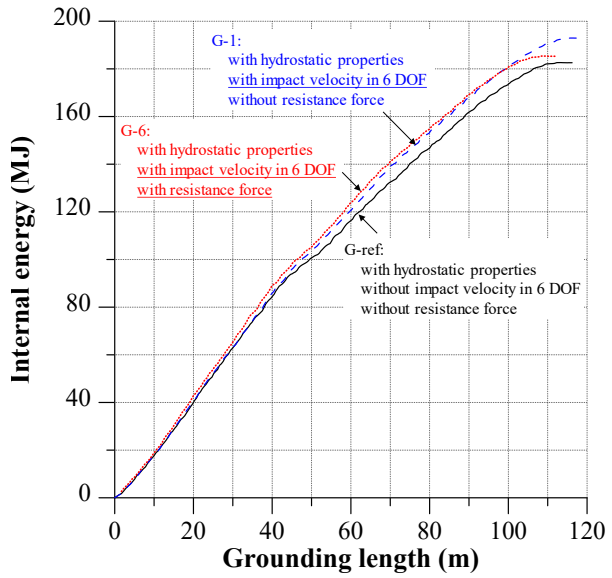
Mancini, F; Remes, H; Romanoff, J; Goncalves, R.B. Stress magnification factor for angular misalignment between plates with welding-induced curvature, Welding in the World, 2020, 64:729–751

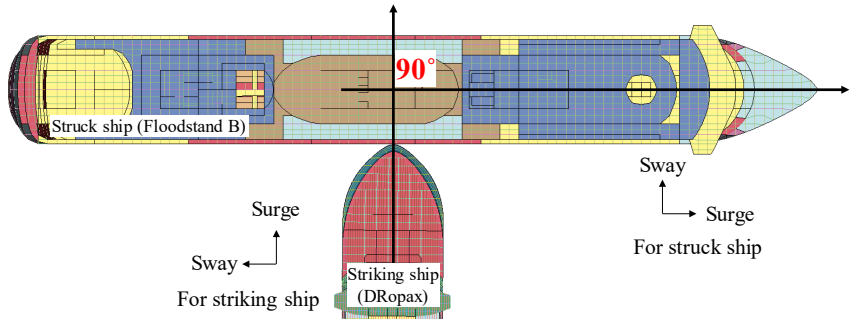
Marine Hydro Mechanics

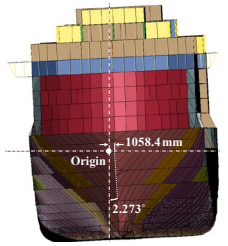
As part of our involvement with EU Horizons 2020 project on "**FL**ooding **A**ccident **RE**sponse (https://flare-project.eu/) we developed state-of-the-art fluid-structure interaction procedures to model the influence of crashworthiness on passenger ship damage stability for typical collision and grounding events.

Our new methods bring together structural dynamics with marine hydrodynamics accounting for wave radiation/diffraction, ship evasiveness, and viscous ship resistance. The simulations confirmed that realistic multiphysics modeling of ship damage extends may influence IMO SOLAS ship damage stability assessment standards. This is because of the influence of hydrodynamic restoring forces on ship responses.









The influence of fluid structure interaction modelling on the dynamic response of ships subject to collision and grounding, Kim, S. J., Körgesaar, M., Ahmadi, N., Taimuri, G., Kujala, P. & Hirdaris, S., Jan 2021, In: Marine Structures. 75, 17 p., 102875.

FLARE
FLOODING ACCIDENT RESPONSE

Finances and Projects

The fundamental scientific research is carried out mainly through projects funded by the Academy of Finland. Business Finland or the European Union are the main funders for applied research. Besides these projects, professors and postgraduates perform unprompted research, mainly funded by the tenure tracks and graduate school positions of the School of Engineering. Marine Technology is also linked to the center of excellence, CEARCTIC–center funded by Lloyd's Register Foundation.

2020

Total budget of the Marine Technology unit is 2,56 M€. The external budget funding is 47%, of which 42% is funding from EU, 32% from Academy of Finland and 4 % from Business Finland.

The division of the external project funding portfolio is as follows:

Business Finland	4%
Academy of Finland	32%
EU	42%
Others	22%
Total	**100%**

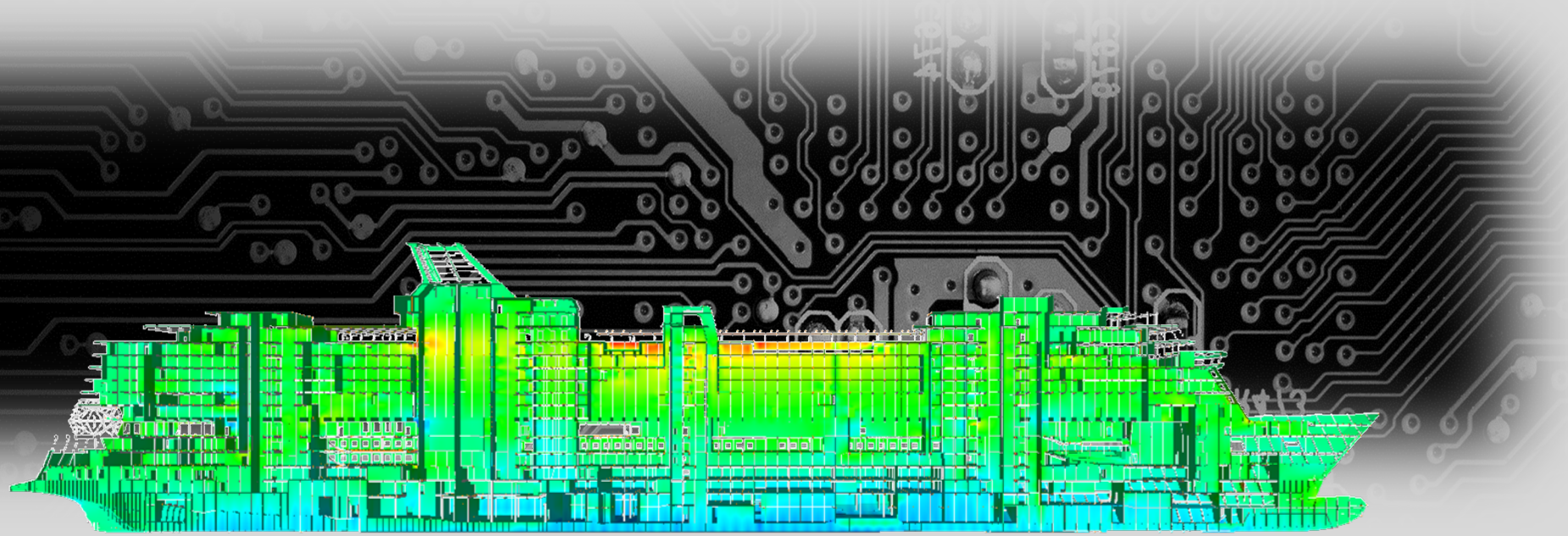
2021

Total budget of the Marine Technology unit is 2,42 M€. The external budget funding is 38 %, of which 31 % is funding from EU, 26 % from Academy of Finland, and 16 % from Business Finland.

The division of the external project funding portfolio is as follows:

Business Finland	16%
Academy of Finland	26%
EU	31%
Others	27%
Total	**100%**

Projects: Sea4Value, ECAMARIS, LRF Center II, SHIVER, RAAS, AUTOMARE, HSVA-PSC, WINSIM, Finnpilot, BALTIMARI, INFUTURE, SIMREC, Green Small Craft, MSCA-RISE-RESET, SEDNA, RAMSSES, FLARE, MKS Teollinen väitöskirjatyö, KOTKA/ MERILIIKENNE PROF., Vieraileva professori, Meriklusteri, Infra, MSCA-SANDFECH, Cruise & Ferry 2.0, FI-Tech, mFAT, StrainPaths, NanoCrack, FIRI/Aalto Ice Tank, A!OLE, Profi3, Profi2, Marine, A!OLE 2020



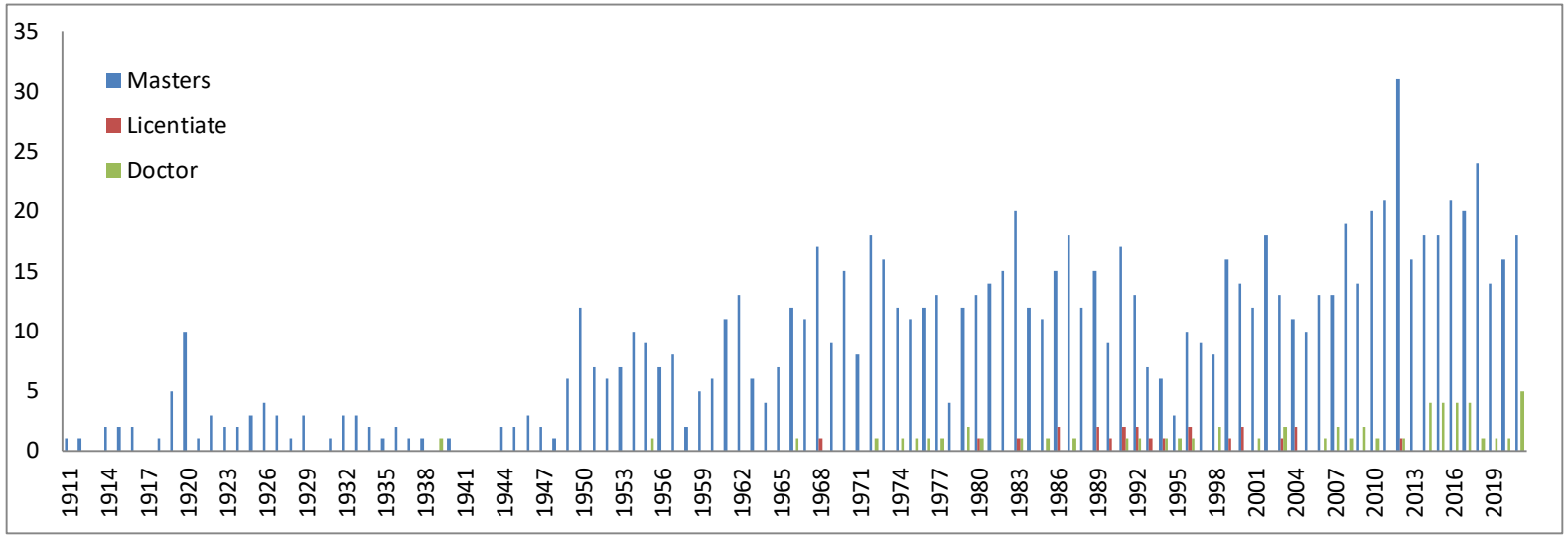
Education

Education and students

Our ambition is to educate students to become professionals who contribute to a better society and have excellent work prospects after graduation. We also understand our over 100-year-old position in Finland. Our role is internationally recognized science-based education at the highest level in ship and marine technology. We follow our core values in education, are proud of our students and alumni and their successes and capabilities to act as “game-changers” internationally. As a product of the teaching, students will profoundly understand the field of interest and what is necessary to evaluate, gain, and apply their skills and knowledge in practice. The education also aims to give the students a thorough understanding of applied mathematics and physics basics, which does not become outdated and supports lifelong learning and research.

The education is based on developing career-based personalized study plans for our students through academic advising. This starts already at the Bachelor’s level, where maritime studies are not yet within the program, and the focus is on the fundaments of engineering. At the Master’s level, the marine technology professors advise every student with their study plans. In Doctoral and post-doctoral education, the intensity of the advising increases. The same principles are applied to the academic staff in their career paths. This philosophy has been proven to create the game-changers that society needs at all levels of academia and industry.

Our education has a strong basis on the collaboration between the schools of Aalto and the efficient utilization of networks within Finland and Scandinavia. This allows us to transfer our partner universities' latest knowledge to students in Aalto University. The international collaboration networks are the Nordic Masters in Maritime Engineering (NMME) and Cold Climate Engineering (CCE), which are education networks with the Nordic Five Tech Universities (Aalto, Chalmers, DTU, KTH, and NTNU). We have been coordinating the NMME programme since December 2020.



Master’s education

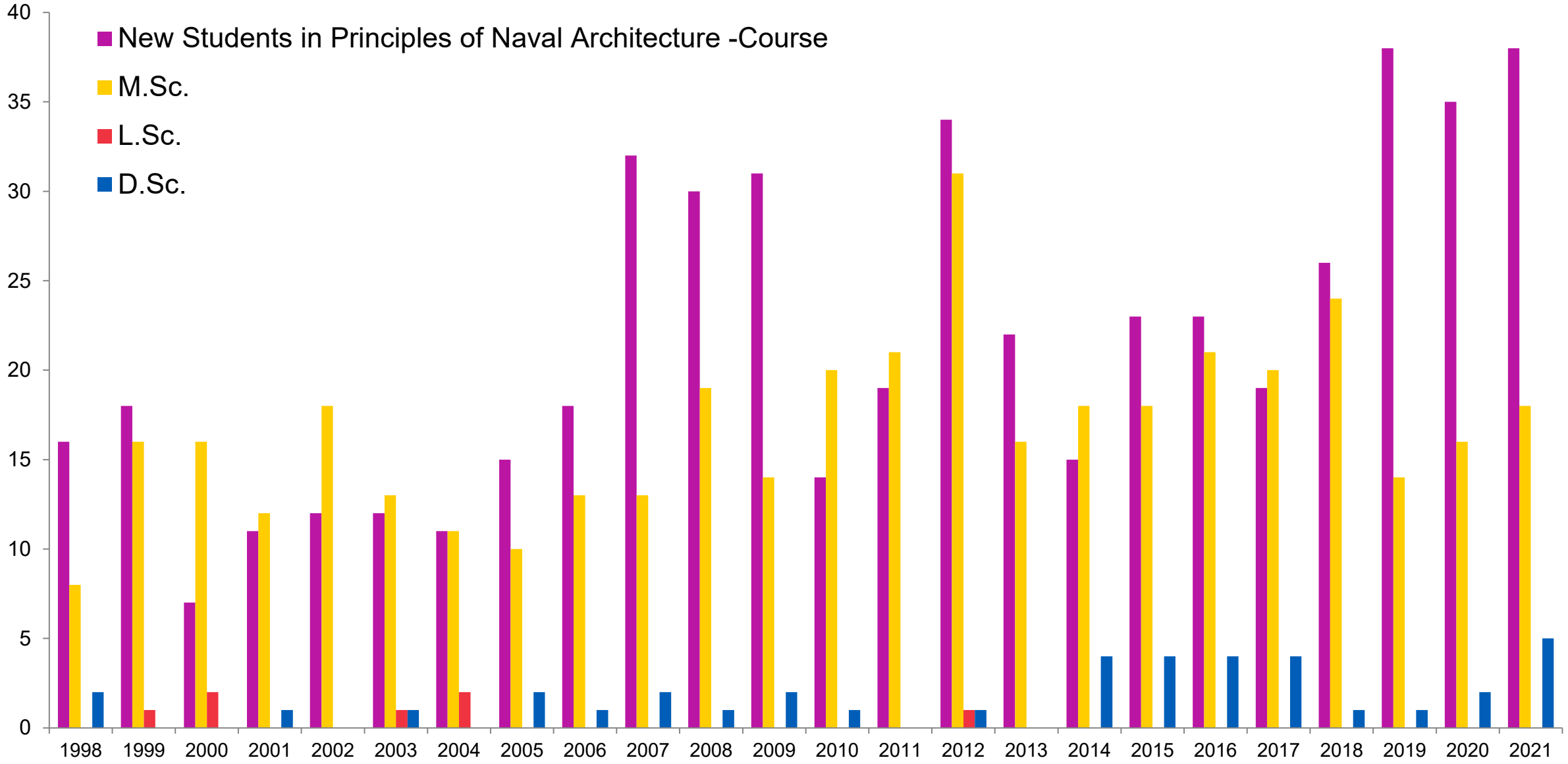
Our ambition is to educate M.Sc. students to become engineering professionals who contribute to a better society and have excellent work prospects in the industry. The M.Sc. students in the maritime field are encouraged to learn the fundaments of mechanical and civil engineering at their B.Sc. studies. This gives us as educators the possibility of focusing on teaching knowledge, skills, and attitudes that a modern naval architect must possess when entering the job market. For those taking a minor study on marine technology, the core idea is to enable the student to utilize their major field in maritime industries. The idea is to give just enough knowledge of the specifics of marine technology to operate in this exciting yet challenging field of engineering. The number of starting students was 35 in 2020 and 38 in 2021. There were 16 graduated students in 2020 and 18 in 2021.

Student project work example: a luxury arctic cruise ship concept

The marine technology intake for major M.Sc. studies is mainly enabled through the Mechanical Engineering program where maritime students can select different study options ranging from classical naval architecture to emerging fields of smart and sustainable maritime engineering. Altogether we offer 6 study tracks (Naval architecture, Arctic marine technology, Ship project engineering, Structures, Hydrodynamics, and Smart maritime operations) which can be flexibly modified based on students’ career plans. Alternatively, students can take their major from the offerings in the NMME or CCE programmes. On top of this, we have established two minors within a Finnish technical network university (FITech) for those interested in the field, i.e., the Marine Technology and Smart and Sustainable Marine Operations minors.

The education is problem and challenge-based, which means that the students work as groups on their ship projects throughout their studies. This simulates the situation faced in the ever-changing industry, where life-long learning is one of the essential skills to succeed as a “game-changer” in the international job markets. The student projects are assessed twice a year in the marine technology gala in which industry and other stakeholders give constructive and critical feedback to the student projects. This, together with solid professional education, secures the success of our students. The creative efforts of the students have also resulted in considerable public interest.

New and graduated students



Doctoral education and post-doctoral training

Our doctoral and post-doctoral education aims to educate advanced experts who contribute to a better society and have excellent academic and industrial expert positions prospects. For Doctoral studies, each student is recruited through a competitive process in which the motivation letter, research plan, and financial plan are executed before starting the thesis process. This way, the thesis process has a solid foundation and research direction from the beginning, making graduation in the objective time of 4 years possible. For those making doctoral studies part-time, often in industry, a similar process is made with the distinction of graduation time being extended to 8 years. As in the case of Master's level education, the thesis topics are selected carefully by analyzing the academic, industrial, and societal needs. Currently, the unit holds 15 full-time and 9 part-time doctoral students. In 2020 and 2021, seven D.Sc. degrees were awarded: Fang Li (2020, academic), Mari Åman (2020, academic), Marjo Keiramo (2021, industrial), Lu Liangliang (2021, academic), Bruno Reinaldo Goncalves (2021, academic), Lei Du (2021, academic), and Eero Avi (2021, industrial).

In post-doctoral training, the unit considers two different motivations for this career stage in academia. The main reason for academic postdoctoral training is to enable the participants to advance to academic careers in Aalto, elsewhere in Finland, or internationally. The aim of the training is to systematically develop an academic profile that places our alumni as top candidates for highly competitive academic positions. During 2020-2021 the following alumni got their professorship: Dr. Youjiang Wang and Osiris Valdez Banda. The second target of postdoctoral training is to enable those with a doctoral degree to enter the industry and accelerate the R&D cycles of companies with their expertise, and to help society to form new policies, rules, and regulations based on scientific evidence.

Example of a Doctoral thesis

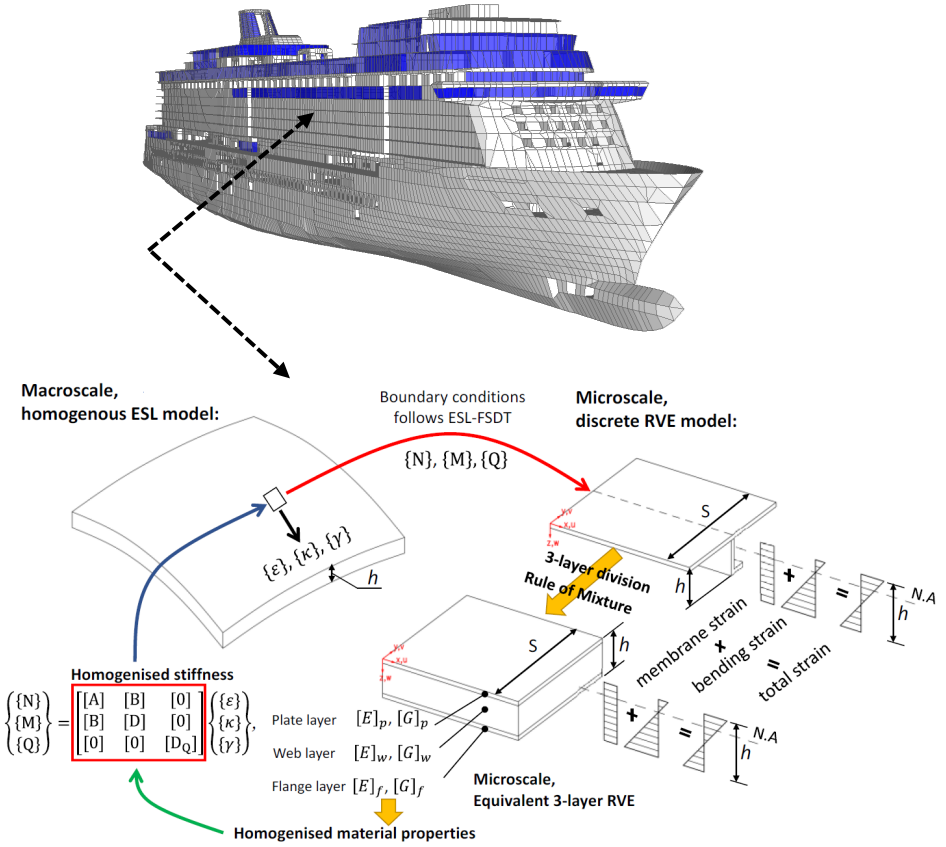
Equivalent shell element for passenger ship structural design

Eero Avi

Predicting the strength and vibration response of a large passenger ship is a challenging task, with several contributing factors. The calculation methods need to be computationally light to enable design optimization, but still accurate enough to describe both global and local behavior in a way that the design constraints are properly assessed.

The common approach to evaluate the structural response of a passenger ship is to use the finite element method, where the entire ship is described with a very coarse mesh, and the stiffeners together with plating are modeled using equivalent, homogenized elements. Since the available equivalent elements do not or only partly consider the bending properties of the stiffened panel, the local response needs to be analyzed separately using the time-consuming sub-modeling technique. The limitations become even more problematic in propeller- and machinery-induced forced vibration analysis, where a global coarse mesh model is not accurate and the couplings between the global and local models are difficult to define. This dissertation introduces a more advanced equivalent element modeling approach, which helps to overcome the named limitations.

According to the dissertation, the stiffened panel can be considered as a three-layer laminate shell element, where the first layer represents the plate, the second layer the stiffener web, and the third layer the stiffener flange. The element follows Equivalent Single Layer (ESL) First-order Shear Deformation Theory (FSDT), in which constitutive properties are found through a homogenization process. Despite that due to that, the local plate bending effects between the stiffeners are neglected, the dissertation also presents the methods of how they can be reincluded in static and vibration analysis. This enables significant computational savings in the design and further in the optimization problem, as layer-wise formulation enables stiffened panel scantlings to be changed without remeshing the model, as well as an accurate assessment of the stresses.



Example of a Doctoral thesis

Maritime Traffic Risk Analysis in the Northern Baltic Sea from AIS Data

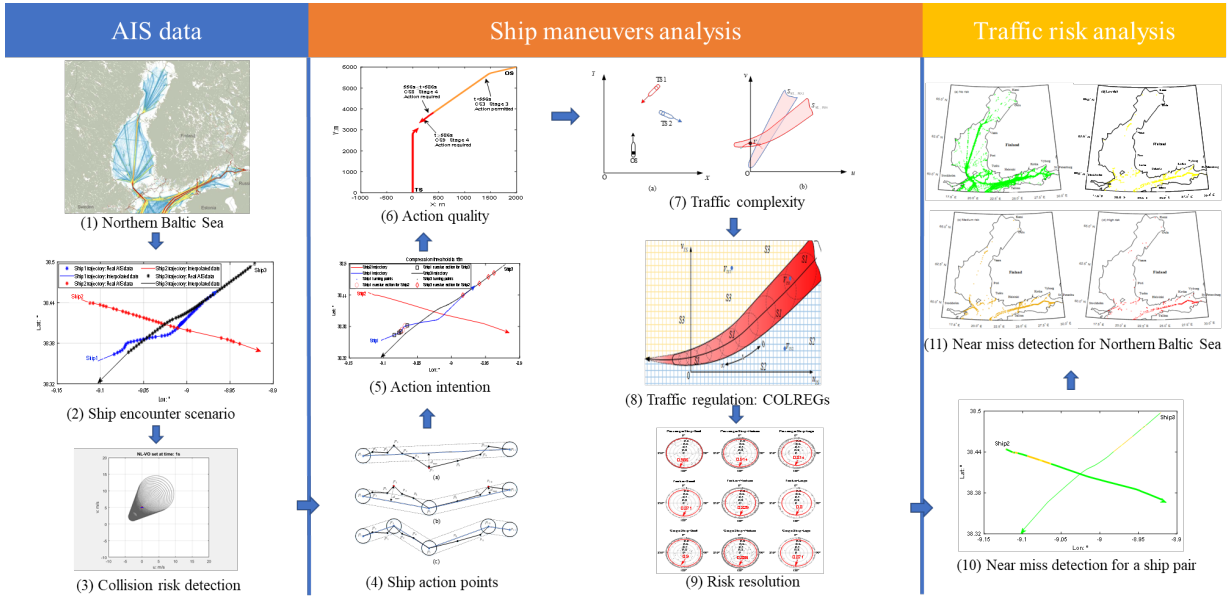
Lei Du

Ship collision is the most common type of accident in the Northern Baltic Sea, a busy and ecologically vulnerable sea area. Preventing ship collisions helps reduce environmental pollution, casualties, and economic losses. One widely used way to achieve a safe maritime transport system is to analyze non-accident critical events (such as near-miss) detected from AIS data, and then use these findings to develop preventive measures to enhance navigational safety. However, this method originated from other fields, and its validity has not been fully verified. Therefore, the direct utilization of non-accident critical events as a basis to correctly understand the maritime traffic risk remains challenging.

The primary aim of this thesis is to improve maritime traffic risk analysis to support decision making for the prevention of and response to collision risk from the traffic management perspective, with a focus on advancing the latest methodology of utilizing non-accident critical events detected from AIS data as the basis to assess traffic risk.

This thesis provides a comprehensive understanding and evidence about the state-of-the art of this non-accident critical event-based method. The challenges are identified and an alternative means to improve the maritime traffic risk analysis is proposed. Specifically, this thesis proposes a new framework which consists of several newly proposed methods for near miss detection from AIS data based on ship maneuvers.

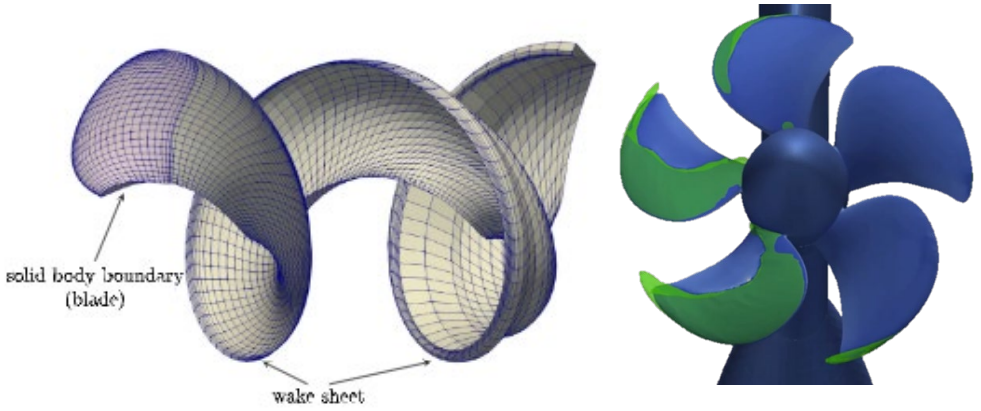
This thesis enhances the accuracy of traffic risk analysis based on AIS data and expand the scope of application of this non-accident critical event-based method. This thesis can support collision prevention, rapid response for ship collisions, water traffic control in real-time, and collision avoidance strategy making.



Postdoc training towards a professorship

Aalto Alumni Professorship in Shanghai Jiaotong University

Dr. Youjiang Wang was appointed as Associate Professor in Shanghai Jiao University, School of Naval Architecture, Ocean & Civil Engineering in September 2021. He currently works in the Design & Research Institute of Ship and Ocean Engineering. His academic research is focused on numerical methods for cavitation and underwater radiated noise from propulsors. His long-term objective is to develop high-efficient and quiet propulsion solutions for safe and sustainable ships using state-of-the-art design and performance assessment methods.



Dr. Youjiang Wang worked as a postdoc researcher in 2021 in the Department of Mechanical Engineering of Aalto University. His research focus has been on new CFD-based algorithms for the fast computation of marine propellers' noise. He also supervised various MSc students and contributed to the development of research proposals. His work was funded by Aalto University and the EU Baltic Interreg project on Green Cruising for High-speed Small Craft (Grant No. : 605111). Results from this work will be published in early 2022 at Ocean Engineering (Elsevier, ISSN: 0029-8018) and Procedia in Computer Science (Elsevier, ISSN: 1877-0509) Journals. Yuanjiang's work will be also presented in the International Conference on Industry 4.0 and Smart Manufacturing (ISM Nov. 2021, Austria) and the 7th International Symposium on Marine Propulsors (Oct 2022, Wuxi, China).

上海交通大學 SHANGHAI JIAO TONG UNIVERSITY

Aalto University

Interreg Baltic Sea Region

Postdoc training towards a professorship

Professorship in Aalto University

Osiris A. Valdez Banda was appointed as Assistant Professor of Marine Technology at Aalto University in February 2020. Osiris started his career as a maritime safety researcher at the Kotka Maritime Research Association and continued working as a doctoral and post-doctoral researcher at Aalto University (Marine Technology). As a doctoral and post-doctoral researcher, his work focused on the analysis of safety management practices of the Finnish Maritime Cluster, the analysis of the risk of maritime traffic and oil spills in sea ice conditions, and the elaboration of safety and risk management strategies for supporting the design and operation of smart ship and service concepts. As a professor, Osiris has now established the research group on “Safe and Efficient Marine Systems”. His research group focuses on the analysis of marine risks and safety systems engineering with applications in the concepts of smart shipping and ship winter navigation.

Special education organized

The rapidly changing needs of society call for advanced and timely measures for education. During 2020-2021 the unit organized several education through the national and Scandinavian networks in education in FITech Marine -minor and Smart and Sustainable Marine Operations –minor and in Nordic Master in Maritime Engineering (NMME) network.

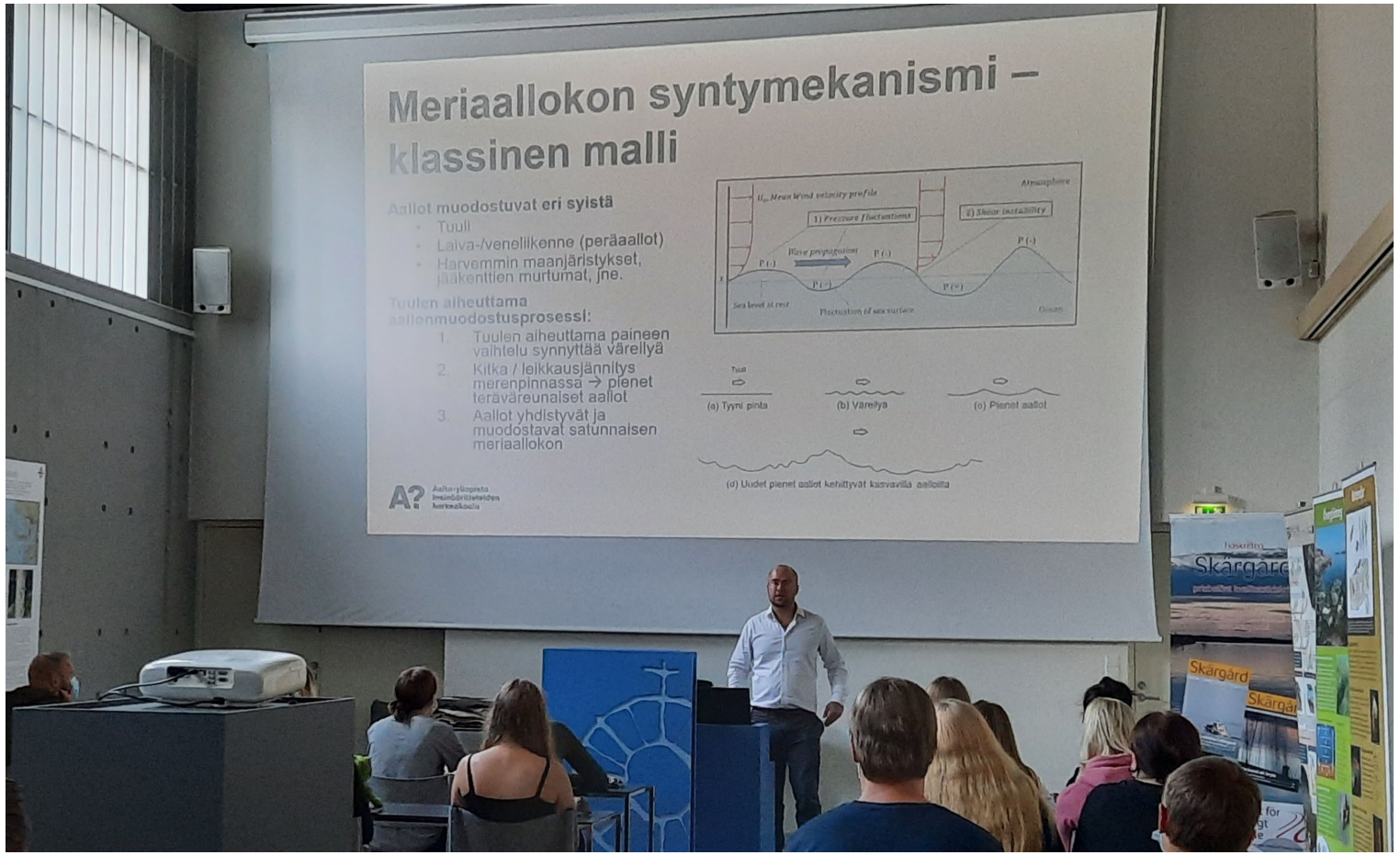
The minors are intended for those students who wish to specialize in some other field of technology, business, or arts and design within Aalto or in other universities in Finland. The main idea is to ensure enough maritime field information for those who want to operate with such expertise in maritime companies. In order to strengthen the collaboration in Finland, the unit made co-operation agreements with the University of Turku on maritime education and with the University of Tampere on lightweight structures.

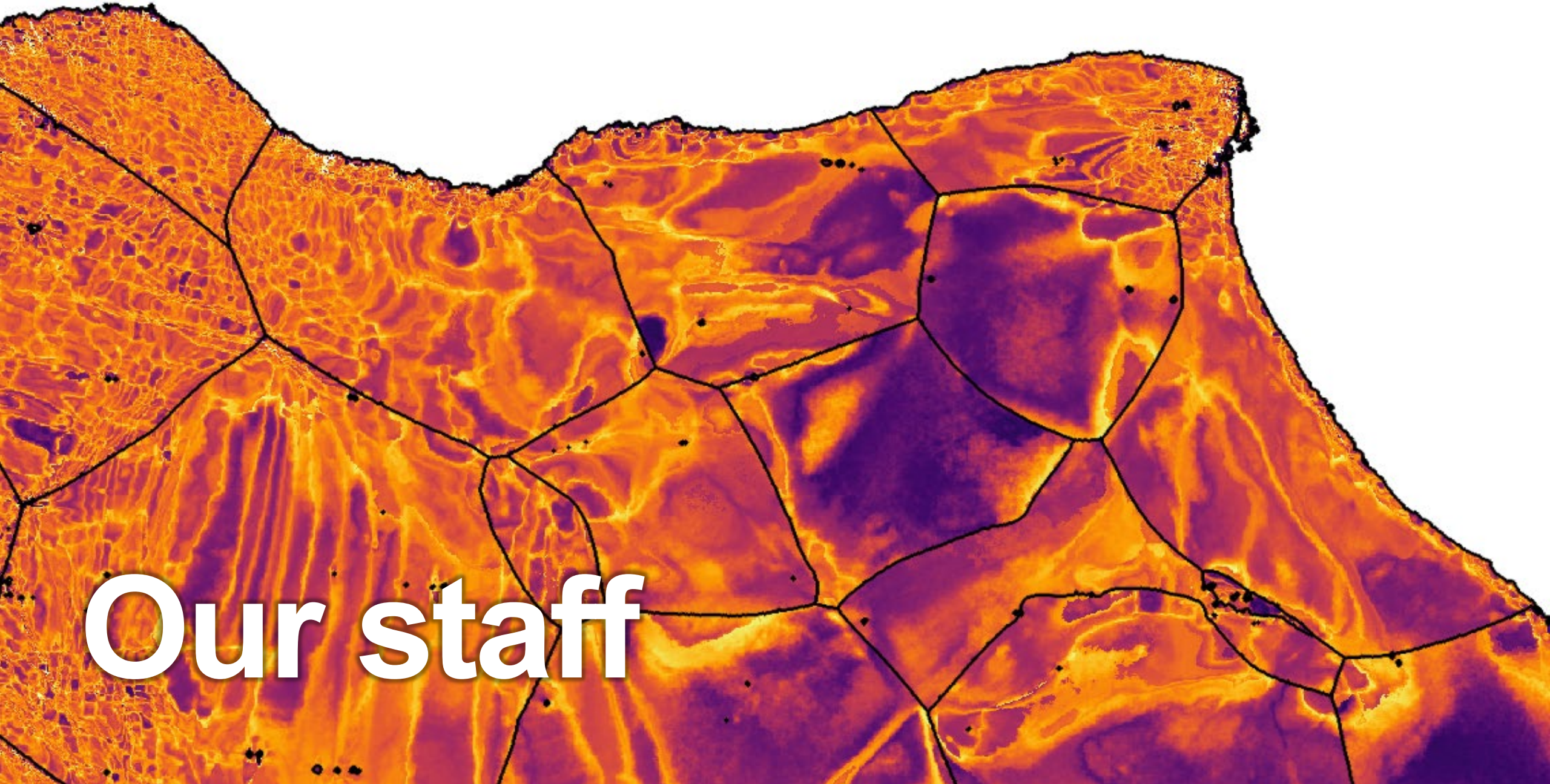
Since the start of 2021, the unit took the coordination of the Nordic Master in Maritime Engineering network. As part of the shift of coordination responsibility, the curricula of the program are being reviewed with the aim to ensure better visibility of the program in the post-covid19 period, where the expectation is that exchange students will become more active in joining these highly competitive international programs.

Recruitment of Future Talent by Involvement in Elementary and High school

Marine technology needs new talent to tackle the problems we face in maritime operations. Maritime is all around us, and it is by far the most sustainable form of transportation, although being also a slow one. Often the marine field is associated with a biased public image of polluting ships, dirty shipyards, and accidents harming the environment. What is not well known is that the current state of the field with advanced and clean technology, and Finland is known globally for the “game-changing” technical solutions, processes, and agile innovation ecosystem where the pioneering solutions are introduced to the global markets.

In August 2021, the group gave a guest lecture on sea waves in connection to a course in marine physics organized by the Turun Suomalainen Yhteiskoulu Upper Secondary School as a part of their marine study track. Related to the lecture, the students carried out a series of experiments in the sea. The course and the experiments took place on the island of Korpo located in the Turku archipelago.





Our staff

Our staff

We are proud of the commitment and ambitions of our employees - and we are always looking for the best employees. We appreciate especially those employees who love the challenge and work in interdisciplinary and multidisciplinary environments. Our employees also can efficiently connect research and education, making bridges between teaching, science, and society in the scope of maritime actions. Our employees are also committed to high academic standards and high-quality education, intellectual freedom to teach and learn, and who behave in a responsible manner, and respect the rights of the other members of our community. In the coming years, we want to continue investing in our employees, who together form the marine community at Aalto. We will devote more attention to career development, and we will do so in a systematic and structured way.

In 2020-2021, professors Pentti Kujala, Osiris Valdez Banda, Spyros Hirdaris, Mashrura Musharraf, Heikki Remes, and Jani Romanoff directed the research and education of marine technology, with assistance from the professor of practice Pekka Ruponen as part-time, one full-time lecturer on fluid mechanics and one laboratory manager. In addition, post-doctoral researchers, postgraduate students, research assistants, and the permanent laboratory staff participate in teaching and research activities. Pentti Kujala continued his work in the position of Professor in marine traffic safety; Osiris Valdez Banda (started March 2020) on safe and efficient marine systems, Mashrura Musharraf (started June 2021) on safe and efficient marine systems, Spyros Hirdaris on marine safety and hydrodynamics, Heikki Remes in advanced marine structures and production and Jani Romanoff as the professor of advanced marine structures and design. Tommi Mikkola as a lecturer of fluid mechanics and Otto Puolakka as a laboratory manager of Aalto Ice tank. Emeritus Professor Jerzy Matusiak stayed active after retirement, participating in teaching and research and helping younger colleagues on defining future directions of marine technology.

Our Staff

Professors

Pentti Kujala, Jani Romanoff, Spyros Hirdaris, Heikki Remes, Mashrura Musharraf, Osiris Valdez Banda, Pekka Ruponen (part-time), Jerzy Matusiak (emeritus), Jakub Montewka (visiting)

Lecturers

Tommi Mikkola

Postdocs and Visiting Researchers

Ahmad BahooToroody, Martin Bergström, Victor Bolbot, Lei Du, Pasquale Gallo, Anssi Karttunen, Sang Jim Kim, Ketki Kulkarni, Mihkel Körgesaar, Arun Lakshmynarayanana Puramharikrishnan, Pauli Lehto, Liangliang Lu, Jolanta Mazurek, Jairan Nafar Dastgerdi, Hassan Saghi, Mikko Suominen, Youjiang Wang, Yoki Ono

Doctoral Students

Sabina Akter, Eero Avi, Sunil Basnet, Kennie Berntsson, Meriam Chaal, Lei Du (graduated 10/2021), Ali Hazrati Niyari, Janne Heiskari, Zongyu Jiang, Aaro Karola, Aleksandr Kondratenko, Fang Li (graduated 11/2020), Cong Liu, Liangliang Lu (graduated 6/2021), Federica Mancini, Abinab Niraula, Douglas Owen, Roman Repin, Juho Särkkä, Ghalib Taimuri, Iiro Vanne, Annie Yan, Mingyang Zhang, Mari Åman (graduated 12/2020)

Research Assistants

Zeiad Abdelghafor, Jacob Battcock, Sarah Blackwell, Erin Gillis, Yosri Hassan, Muhammad Khawar, Johannes Kleudgen, Aaron Körkkö, Anni Lindfors, Oskari Martikainen, Sid Oksala, Alice Petry, Aqeel Rehman, Emma Ryhänen, Veer Samani, Miko Sutinen, Ilari Tillikainen, Oskar Veltheim, Ewelina Ziajka-Poznanska,

Support Staff

Otto Puolakka, Teemu Päivärinta, Lasse Turja

New nominations

Vice Dean of Education (School of Engineering)

Associate Professor Jani Romanoff has been appointed Vice Dean for Education of the School of Engineering (ENG) for the period of 1.8.2021-31.07.2023. The position of vice dean for education research duties are related mainly to coordinate the education at the Bachelor of Science and Master's of Science levels. As part of the new task, he has started the renewal process of the B.Sc. Program which was renewed last time around 10 years ago.

Head of Marine Technology

Associate Professor Heikki Remes has been appointed head of Marine Technology research and education group on 1st of November 2021. Heikki replaces Professor Pentti Kujala, who leaves for retirement March 2022. The position of group head are related the coordinates of the research, education and service activities in the field of Marine Technology together with other professors in the field. The Marine Technology group belongs the Department of Mechanical Engineering and Aalto School of Engineering.

Assistant Professor Osiris A. Valdez Banda

D.Sc. Osiris Valdez Banda is Assistant Professor of Marine Technology. His work focuses on methods and processes for risk, safety and resilience engineering of maritime transport systems by developing innovative concepts, principles and models in the context of smart ships and maritime services. He is the Principal Investigator of Aalto School of Engineering in the projects Sea for Value- Fairways (S4Value) and Reliability and Safety Engineering and Technology for large maritime engineering systems (RESET), Enablers and Concepts for Automated Solutions (ECAMARIS), and Autonomous Maritime School Network (AUTOMARE). He leads the scientific committee member of the International Seminar on Safety and Security of Autonomous Vessels (ISSAV) and acts as a member of the scientific committee in International Ship and Offshore Structures Congress (ISSC) and European STAMP Workshop and Conference (ESWC). He is responsible for the courses Marine Risks and Safety, Marine and Ship Systems Engineering, and Safety Management of Complex Socio-technical Organizations. Before joining Aalto, Osiris worked in the safety, quality, and environmental management of port logistics and the petrochemical sector.

New nominations

Assistant Professor Mashrura Musharraf

Dr. Mashrura Musharraf joined the Marine Technology group at Aalto University in early 2021 as an Assistant Professor. She received her PhD (2018) and M.Eng. (2014) in Computer Engineering from Memorial University of Newfoundland, Canada. She has been an active researcher since 2012 with a vision to apply data mining, machine learning, and AI techniques to build and deploy human-centered systems and solutions and create a safer marine industry. Her expertise includes knowledge elicitation from subject matter experts, human performance data collection by conducting full-scale experiments in marine simulators, integration of different data types, and predictive and diagnostic data analysis using machine learning methods. The choice of the analytic tools used in her research is heavily influenced by their interpretability. As the foundations for futuristic ships are being set, her current and future research aims to achieve interpretability and transparency of the AI algorithms that would govern the decision-making in ship design and operation.

Staff Scientist Pauli Lehto

D.Sc. Pauli Lehto has been appointed as a Staff Scientist in Solid Mechanics starting 1st of March 2021. During his employment at Marine Technology between 2012-2019, he completed Master's and Doctoral Degrees, followed by a Post-Doctoral period starting at the end of 2019. During this time, he has been involved in several national and international projects where experimental testing has been carried out for a large variety of steel structures. His special expertise is the characterization and testing of complex structures and metallic materials across several length scales. In his new position, he will be responsible for the operation and development of the Solid Mechanics Laboratory. The laboratory offers highly customizable test setups in terms of physical size and load. To fully utilize these testing capabilities, modern digital measurement systems and BIG data post-processing algorithms will be incorporated in the near future. This gives the possibility to measure the behavior of structures in a highly detailed manner and to link experimental results with numerical simulations.

New postdocs in the group

Dr. Mikko Suominen joined Aalto's Maritime & Arctic Technology Group as a post-doctoral fellow in May 2020. His core research focuses on ice-induced loads on the ship hull and ship performance in ice measurements in model-scale and full-scale. He received his doctorate degree from Aalto University in 2018. After graduation, he worked as a project leader in Hamburg Ship Model Basin (HSVA). He has extensive experience from full-scale measurements focusing on local ice-induced load measurements on the ship hull and ice conditions and sound knowledge from model-scale testing in ice. His research interests are related to these topics with a special focus on measurement methods and technology, and scaling methods. He is currently involved in the project CEPOLAR: Centre of Excellence for Scenario-based Risk Management in Polar Waters.

Dr. Liangliang Lu works as a post-doctoral researcher in the Marine and Arctic Technology Group. He joined the group in 2017 as a doctoral candidate after obtaining Master's degrees from both Aalto University and the Norwegian University of Science and Technology. He also has some working experience as a naval architect in CSSC-SWS in Shanghai after Bachelor's degree and as an ice engineer in TOTAL in Paris before starting his doctoral study. His research interests are on maritime risk and safety especially in ice conditions, including accident analysis, oil spills and response modeling, and ice loads. He is currently involved in the CBC SIMREC project focusing on accidents and oil spills in extreme conditions and the LRF CEPOLAR project focusing on scenario-based risk management for ships in polar waters.

Dr. Fang Li obtained his D.Sc. degree from Aalto's Marine Technology Group and worked as a post-doctoral fellow since December 2020. His field of specialization is Arctic marine technology. Prior to the doctoral period, he received his BE degree from the Dalian University of Technology, China on Naval Architecture and Ocean Engineering, and a Master's degree from the Nordic master program at NTNU and Aalto on Maritime Engineering. His research interests are ice-going ship performance simulation, ice load estimation, and winter navigation. He is currently involved with the development of next-generation inland waterway vessels with icebreaking capability under the INFUTURE project, and evaluation of ice-going ships' performance in various ice conditions for the simulation of the winter navigation system.

Dr. Lei Du works as a post-doctoral researcher in the research group on Safe and Efficient Marine Systems from November 2021. He received his master degree from the Wuhan University of Technology in 2016. He started his PhD research work in this group in 2017 and successfully defended his doctoral dissertation in October 2021. His research interest mainly focuses on maritime traffic risk and intelligent ship navigation. He is currently involved in the Risk Analysis of Finnish Fairways research project focusing on traffic risk analysis based on AIS data.

New postdocs in the group

Dr. Yuki Ono starts a visiting post-doctoral researcher in the Marine and Arctic Technology Group from August 2021. He finished his bachelor, master, and doctoral degrees at Gifu University in Japan, currently working as a designated assistant professor. He worked for his research at EPFL in Switzerland and Aarhus University in Denmark during the doctoral period. The focus of the current study is to develop fatigue assessment methods for sustainable high-performance steel structures under multiaxial loading. The assessment methods include global approaches based on database analysis and local approaches based on fatigue failure mechanisms at the micro-level. The research is related to large welded thin-walled structures that utilize high-strength materials and advanced manufacturing technology.

Dr. Ahmad BahooToroody has been working as a postdoctoral researcher in the research group on Safe and Efficient Marine Systems since September 2020. With a Ph.D. in Reliability Engineering from the University of Florence, he was invited to liaise with researchers at TU Delft (The Netherlands), Norwegian University of Science and Technology (Norway), and University of Strathclyde (United Kingdom). His Ph.D. research focused on risk-based asset integrity modeling of the automotive process, and he completed oral defense with distinction. His research interests stand at uncertainty quantification, resilience and trustworthiness of engineering operations, condition-based maintenance optimization, and application of probabilistic methods and machine learning tools in dynamic modeling. He is actively contributing to research work on the projects S4Value, ECAMARIS, and AUTOMARE.

Dr. Victor Bolbot is a new post-doc researcher at the research team of Safe and Efficient Marine Systems. Before joining the group, Victor has worked as a Research Associate at the University of Strathclyde, Glasgow, Scotland, where he also received his doctoral degree in 2020. Victor has received his M.Sc. in Naval Architecture & Marine Engineering from the National Technical University of Athens in 2016. As a Master's and Ph.D. student, Victor has received multiple awards for his outstanding performance from distinguished organizations such as DNV, IMarEST, Limmat Stiftung, Thomaideion, TRA VISIONS 2020. Victor's research interests focus on but are not limited to the safety and cybersecurity assurance of complex and autonomous marine systems. He actively contributes to AUTOMARE, ECAMARIS, and Risk Analysis of Finnish Fairways research projects.

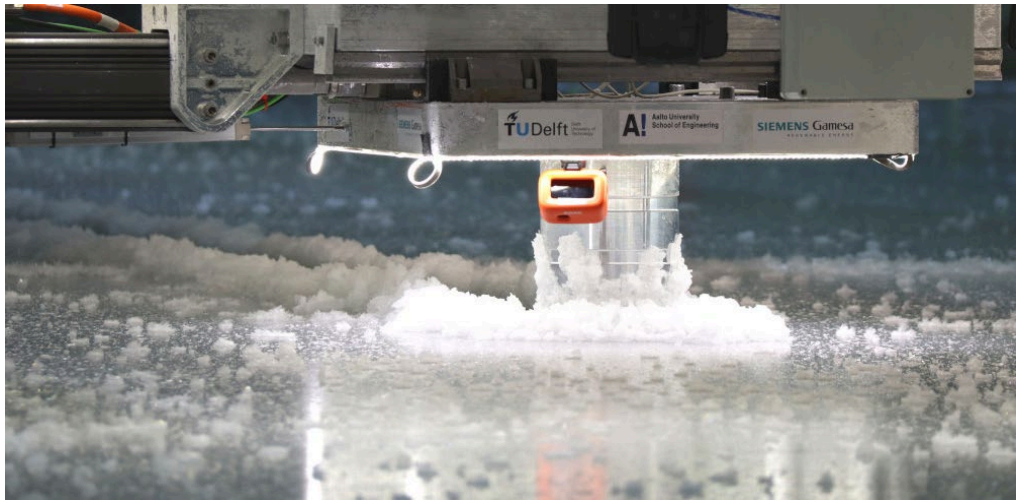

Our facilities

Aalto Ice and Wave Tank

In operation since early 2019, the renewed Aalto Ice and Wave Tank is approaching three years of service at the end of 2021. The extensive renovation between 2014–19, enabled by a targeted 8M Euro funding from the Finnish Ministry of Education and Culture and the Academy of Finland, resulted in significant improvements to almost all tank systems, which have since been put to good use.

Aalto Ice and Wave Tank carried out experiments for six user groups in 2020 and 10 user groups in 2021. Highlights of the season were the SHIVER campaign on a wind turbine–ice interaction, performed in cooperation with TU Delft and Siemens Gamesa, marine icing tests for the Sedna project in collaboration with University College London, and commissioning and tests with a new Saimax ship model in the future project. The tank also served commercial customers in several test campaigns and M.Sc. education in the MEC-E4004 Model Scale Testing in Ice -course.

The 2020–21 season also saw some finishing touches to the new systems, including final adjustments to the icing spray system, refrigeration plant tuning, ice pushing plate insulation, and additional tracking cameras. Other investments were acquiring two cold containers, commissioning intermediate movable beds and a pilot ice tank, and designing a new ship model automation system. At the end of 2021, the Academy of Finland granted funding to build a new wavemaker. This will strengthen our research capabilities for wave-ice, wave-ice-ship, and open water experiments.



Impact and service

Service

The Marine Technology research group aims to interact with society actively and service it with its capabilities. National and international networks are essential for high-quality research and education, and service activities are always strongly related to these core elements of academia.

Inside Aalto University, cooperation was practiced at all organizational levels ranging from structural research activities within Department on structures, Arctic technology, and energy efficiency to the university level through Aalto Ice Tank. The unit has also been active in the Finnish Institute of Technology (FITech), forming two minors associated with marine technology. Within the research projects coordinated by the Kotka Maritime Research Centre (Merikotka), the cooperation in selected research fields with the University of Helsinki and University of Turku continued. The Marine Technology research group also actively supports Finnish, regional, and international regulatory actors in policy issues related to its scientific expertise, e.g., concerning ship design, operational safety, and environmental pollution. For instance, group members have participated in expert working groups at the International Maritime Organization. The cooperation between the Western European Maritime Universities continued in an executive committee position by prof. Kujala, complemented by memberships on WATERBORNE that creates European research agenda. This involves a great deal of coordinated activity and Network of Excellence-type projects. The LRF research centre of excellence in Arctic Shipping and Operations, headed by Aalto University, with the partnering institutions, the University of Helsinki, the Norwegian University of Science and Technology, Hamburg University of Technology, and the Memorial University of Newfoundland, got the extension and continued its work.

Many Marine Technology Unit staff members serve the scientific community by acting as peer reviewers in international scientific journals and conferences. Several editorial positions are also within the group (e.g. Journal of Offshore Mechanics and Arctic Engineering, Journal of Ocean Engineering and Marine Energy, Journal for Engineering in Maritime Environment, Welding in the World), complemented by editorial board memberships (e.g., Marine Structures, Ship Technology Research, Ocean Engineering, Ships and Offshore Structures, International Journal of Structural Stability and Dynamics, Journal of Advanced Joining Processes, Metals). Senior faculty members have also been recognized nationally and internationally through invitations to act as examiners and opponents of several doctoral theses and acting as official discussers for the work performed by international scientific committees (ISSC). Also, the faculty members have been active in assessing research in different countries (e.g., TUDelft) and act as chairman of other institutions (e.g., Publication forum). The unit has membership in the Association of Finnish Marine Industries to interact with key industrial partners to create a future research agenda for applied research. The unit also acts in international scientific committees (International Institute of Welding, International Towing Tank Conference, and International Ships and Offshore Structures Congress), which perform state of the art reviews and benchmarks that can be used as background work of regulatory development. The unit has members also in global professional institutions for naval architects and engineering (Society of Naval Architects and Marine Engineers, The Institute of Marine Engineering Science and Technology, The Royal Institution of Naval Architects, The Federation of National Engineering European Associations, The Technical Chamber of Greece, The Engineering Council UK) to follow and impact the professional development of the field globally.

Special Issue and associated booklets

1. Pentti Kujala, Spyros Hirdaris, Martin Bergström (2021). Recent Advances on Safe Maritime Operations under Extreme Conditions, MDPI, Bassel, Switzerland, ISBN: 978-3-0365-1918-0

2. Spyros Hirdaris, Tommi Kristian Mikkola (2021). Ship Dynamics for Performance Based Design and Risk Averse Operations, MDPI, Bassel, Switzerland, ISBN 978-3-0365-0617-3

3. Osiris Valdez Banda, Pentti Kujala, Spyros Hirdaris (2021). Virtual special Issue: Autonomous vessels safety, Safety Science. https://doi.org/10.1016/j.ssci.2020.105144

4. Martin Bergström, Pentti Kujala, Spyros Hirdaris. Environmental Risk Assessment of Marine Activities in Ice-Covered Waters towards Sustainability. https://www.mdpi.com/journal/sustainability/special_issues/Risk_Marine_Ice-covered_Waters_Sustainability

applied sciences

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Recent Advances on Safe Maritime Operations under Extreme Conditions

Guest Editors:

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Message from the Guest Editors

Dear Colleagues,

The increased activity in the Arctic involves hazards such as a harsh environment, especially the ice cover and cold temperature among others. This effect on Arctic operations is a complicated task to solve. The focus of this Special Issue will be research related to the recommended practice on scenario-based risk management for Polar shipping and risk-based guidelines considering holistically the impact of risks on ice infested waters. These can include: (a) Definition of ice conditions, (b) ship–ice contact, (c) numerical models/idealizations, (d) definition of limit states for ice-strengthened structures, and (e) holistic risk–reward analysis for Polar navigation. Articles submitted to this Special Issue can also deal with the most significant recent developments in the abovementioned areas. We invite researchers to contribute original research articles as well as review articles that will stimulate the continuing

Recognitions and awards

EU Research Award 2020

Professor Pentti Kujala has won the Transportation Research Award 2020 in the field of waterborne transportation for his extensive track record of projects aimed at improving the safety of shipping in ice-covered waters of the Baltic Sea as well as Arctic and Antarctic waters. These projects were funded by the European Commission, the Lloyd's Register Foundation and the Finnish government.

Kujala's scientific impact can be measured through the roughly 300 publications he authored or co-authored during this period, with about 3400 citations. His key impact to policy development is the validation of a new risk-assessment system for voyages into Polar waters, POLARIS, which uses ice load and ship strength analysis methods together with extensive full-scale Data (7 years) from the Arctic and the Antarctic.

The TRA competition is held to recognize and celebrate leading researchers who have recently contributed to EU-funded projects in the field of transportation, demonstrated excellence and have made a proven impact in their field of research.

The first project coordinated by Kujala was Sixth Framework Programme (FP6) project SAFEICE (Increasing the safety of icebound shipping, 2004-2007), which aimed to create a scientific basis for ice class rules (ship hull strength) and for placing requirements on ice classes with partners from Europe, Canada, Russia and Japan. This work continued in the FP7 project SAFEWIN (Safety of winter navigation in dynamic ice, 2009-2013), which studied the influence of dynamic, moving ice on ships and worked to develop an operational ice compression prediction system. At present, this research continues as part of the H2020 project SEDNA (Safe maritime operations under extreme conditions: the Arctic case). Other key projects related to the same topic have been funded by the Lloyd's Register Foundation (LRF). Kujala worked to launch and afterwards, as its chair, managed the Centre of Excellence CEARCTIC (Scenario based risk management for arctic shipping and operations, 2013–2018), which aimed to develop holistic risk analysis methods for the design of ships for arctic operations and transport. The work continues in the new LRF-funded Centre of Excellence, CEPOLAR (Recommended practice of scenario-based risk management for Polar waters). Its aim is to prepare recommended practices for safe and economic ship design and operations for Polar waters. Nationally funded projects include funding from TEKES and the Academy of Finland to instrument the Finnish-built ship Agulhas II for full-scale ice load measurements in Antarctica (2012–2018) as well as the recent Baltic Sea BONUS projects STORMWINDS and BALTIMARE, which include studies on the safety of winter navigation in the Baltic Sea. All these efforts and projects have resulted in a remarkable impact to improve the safety of shipping in ice-covered waters.

Recognitions and awards

SNAME (USA) is an International Society advancing the Art, Science and Practice of Naval Architecture and Marine Engineering. Aalto University participates in their West Europe Section with the aim to broaden the exposure, experience, and future career prospects of our graduates.

The *"2021 SNAME Graduate Honour Prize"* was awarded to Aaro Karola for his MSc thesis on *"Nonlinear effects in wave loads analysis for a mega cruise liner"*. The support of Aaro's research by Meyer Turku is highly acknowledged.

The award was presented by our Dean Prof. Gary Marquis on behalf of Mr. Keith Lilley (President, West Europe SNAME section). It gives us great pleasure to announce Aaro's great achievement and wish him every success for the future.

MEYER TURKU SHIPYARD 1737

THE SOCIETY OF NAVAL ARCHITECTS & MARINE ENGINEERS

Aalto University

SNAME West Europe Section Award ceremony - 13.10.21, Aalto University, FI (Pictured left to write : Prof. Garry Marquis / Dean of Engineering, Award recipient Mr. Aaro Karola and supervisor Dr. Spyros Hirdaris).

Recognitions and awards

Aalto Excellence in University Ranking

ICT and digitalisation
Shanghai | telecommunication engineering

31

Arts and design
QS | art & design

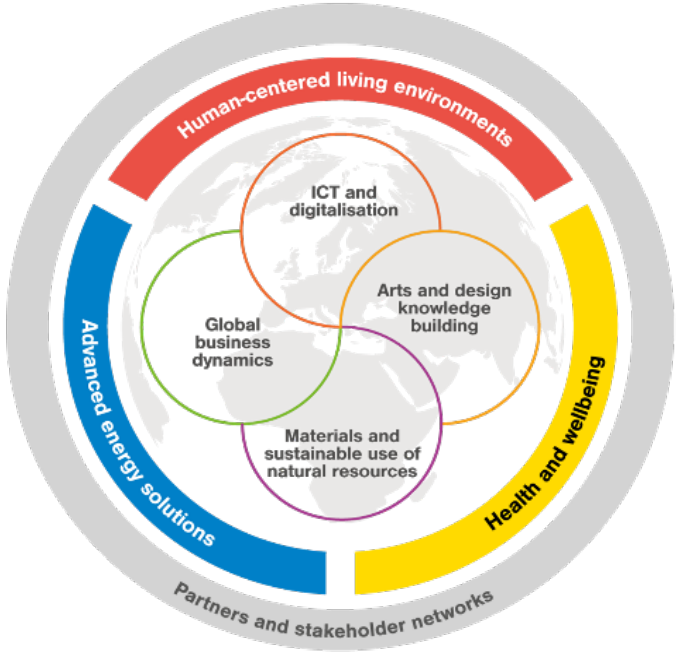
13

Materials and sustainable use of natural resources
Shanghai | mining and mineral engineering

46

Global business dynamics
Shanghai | management

49



Young universities
QS | 50 under 50

7

University-industry collaboration
CWTS Leiden Ranking | university-industry collaboration

14

Marine/Ocean Engineering
Shanghai | marine/ocean engineering

39

Advanced energy solutions
Shanghai | electrical & electronic engineering

51-75

Technology challenger universities
THE | outside the box thinkers

Among 55 identified universities

Human-centred living environments
QS | architecture/ built environment

51-100
(2015: 51-100)

Health and wellbeing
Shanghai | medical technology

101-150

Publications

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95. **The influence of obliquely perforated dual-baffles on sway induced tank sloshing dynamics,** Saghi, H., Mikkola, T. & Hirdaris, S., 1 Nov 2021, In: Proceedings of the Institution of Mechanical Engineers. Part M: Journal of Engineering for the Maritime Environment. 235, 4, p. 905-920 15 p., 1475090220961920.
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2. **Advanced Damage Stability Analyses for Design of Cargo Ships,** Lindroth, D., Tompuri, M., Ruponen, P., Haruyama, M. & Alway, A., 1 Jan 2021, Practical Design of Ships and Other Floating Structures - Proceedings of the 14th International Symposium, PRADS 2019 - Volume 1. Okada, T., Kawamura, Y. & Suzuki, K. (eds.). Vol. 1. p. 655-666 12 p. (Lecture Notes in Civil Engineering; vol. 63 LNCE).
3. **Potential of Homogenized and Non-local Beam and Plate Theories in Ship Structural Design,** Romanoff, J., Goncalves, B. R., Karttunen, A. & Reddy, J. N., 1 Jan 2021, Practical Design of Ships and Other Floating Structures - Proceedings of the 14th International Symposium, PRADS 2019 - Volume 2. Okada, T., Kawamura, Y. & Suzuki, K. (eds.). p. 184-196 13 p. (Lecture Notes in Civil Engineering; vol. 64 LNCE).
4. **Zero Gravity: a novel cantilever beam utilizing elastic torsion for structures and architecture,** Elmas, S., Filz, G. H., Markou, A. & Romanoff, J., Aug 2021, IASS Annual Symposium 2020/21 & the 7th International Conference on Spatial Structures: Inspiring the Next Generation. Guilford, UK. IASS, 10 p. (Proceedings of IASS Annual Symposia).
5. **Analysis of the Grounding Avoidance Behavior of a Ro-Pax Ship in the Gulf of Finland using Big Data,** Zhang, M., Montewka, J., Manderbacka, T., Kujala, P. & Hirdaris, S., 11 Oct 2020, 30th International Ocean and Polar Engineering Conference. INTERNATIONAL SOCIETY OF OFFSHORE AND POLAR ENGINEERS, p. 3558-3567 10 p. (Proceedings of the International Offshore and Polar Engineering Conference; vol. 2020-October).
6. **An intelligent method for real-time ship collision risk assessment and visualization,** Du, L., Valdez Banda, O. & Kujala, P., 2020, Developments in the Collision and Grounding of Ships and Offshore Structures. Guedes Soares, C. (ed.). p. 293-300 8 p. (Proceedings in Marine Technology and Ocean Engineering; vol. 4).
7. **A Quasi-dynamic Approach for the Evaluation of Structural Response in Ship Collisions and Groundings,** Kim, S. J., Körgesaar, M., Taimuri, G., Kujala, P. & Hirdaris, S., 11 Oct 2020, 30th International Ocean and Polar Engineering Conference. INTERNATIONAL SOCIETY OF OFFSHORE AND POLAR ENGINEERS, p. 3174 - 3180 7 p. (Proceedings of the International Ocean and Polar Engineering Conference).
8. **A ship safe speed identifying method from risk perspectives in arctic waters,** Zhang, C., Zhang, D., Zhang, M., Cao, W. & Mao, W., 1 Jan 2020, Proceedings of the 29th European Safety and Reliability Conference, ESREL 2019. Beer, M. & Zio, E. (eds.). p. 1874-1880 7 p. (Proceedings of the 29th European Safety and Reliability Conference, ESREL 2019).
9. **ASIS web girder test: A miniature experiment,** Calle Gonzales, M., Kujala, P., Salmi, M. & Mazzariol, L. M., 2020, Developments in the Collision and Grounding of Ships and Offshore Structures. Guedes Soares, C. (ed.). p. 3-8 6 p. (Proceedings in Marine Technology and Ocean Engineering; vol. 4).

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10. **Characterization of Microstructurally Small Fatigue Crack Behavior,** Malitckii, E., Remes, H., Lehto, P. & Bossuyt, S., 19 May 2020, (E-pub ahead of print) ICTAEM 2020 : Proceedings of ghe Third International Conference on Theoretical, Applied and Experimental Mechanics. p. 332-333 2 p. (Structural Integrity; vol. 16).
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13. **Event Risk Classification Method for Pollution Preparedness and Response,** Laine, M., Valdez Banda, O. & Goerlandt, F., 2020, Developments in the Collision and Grounding of Ships and Offshore Structures. Guedes Soares, C. (ed.). p. 347-354 (Proceedings in Marine Technology and Ocean Engineering; vol. 4).
14. **Future scenarios for arctic shipping,** Bergström, M., Leira, B. J. & Kujala, P., 2020, Polar and Arctic Sciences and Technology. The American Society of Mechanical Engineers (ASME), V007T07A006. (Proceedings of the International Conference on Offshore Mechanics and Arctic Engineering - OMAE; vol. 7).
15. **LADRC-based Path Following Control for Cylindrical Drilling Platform Towing System,** Tao, J., Du, L., Sun, H., Sun, Q., Xie, G. & Zhou, Q., 6 Nov 2020, Proceedings of the 2020 Chinese Automation Congress, CAC 2020. IEEE, p. 5368-5373 6 p. 9327631
16. **Prediction Model of Human Error Probability in Autonomous Cargo Ships,** Zhang, D., Zhang, M., Yao, H., Kai, Z. & Fan, C., 2020, Proceedings of the International Seminar on Safety and Security of Autonomous Vessels (ISSAV) and European STAMP Workshop and Conference (ESWC) 2019. Alejandro Valdez Banda, O., Kujala, P., Hirdaris, S. & Basnet, S. (eds.). Sciendo, p. 110-124 15 p.

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18. **Semi-dynamic ship domain in the encounter situation of two vessels,** Gil, M., Montewka, J., Krata, P., Hinz, T. & Hirdaris, S., 1 Jan 2020, Developments in the Collision and Grounding of Ships and Offshore Structures - Proceedings of the 8th International Conference on Collision and Grounding of Ships and Offshore Structures, ICCGS 2019. Soares, C. G. (ed.). 1 ed. London, UK, Vol. 4. p. 301-307 7 p. (Proceedings in Marine Technology and Ocean Engineering; vol. 4).
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20. **Some new insights towards goal-based design of Arctic ships,** Bergström, M., Idrissova, S., Shamaei, F., Huuhtanen, J., Li, F., Hirdaris, S., Ni, B. & Kujala, P., 27 Apr 2020. 10 p.
21. **The Risks of Remote Pilotage in an Intelligent Fairway – preliminary considerations,** Lahtinen, J., Valdez Banda, O., Kujala, P. & Hirdaris, S., 2020, Proceedings of the International Seminar on Safety and Security of Autonomous Vessels (ISSAV) and European STAMP Workshop and Conference (ESWC) 2019 . Banda, O. A. V., Kujala, P., Hirdaris, S. & Basnet, S. (eds.). 1 ed. Sciendo, Vol. 1. p. 48-57
22. **The use of big data analytics for passenger ship safety – Some recent advances,** Hirdaris, S., 6 Oct 2020.
23. **Wave propagation in continuous sea ice: An experimental perspective,** Passerotti, G., Alberello, A., Dolatshah, A., Bennetts, L., Puolakka, O., Von Bock Und Polach, F., Klein, M., Hartmann, M., Monbaliu, J. & Toffoli, A., 18 Dec 2020, Polar and Arctic Sciences and Technology. The American Society of Mechanical Engineers (ASME), 8 p. V007T07A010. (Proceedings of the International Conference on Offshore Mechanics and Arctic Engineering - OMAE; vol. 7).
24. **Scale-model ridges and interaction with narrow structures**, Shestov, A., Ervik, Å., Heinonen, J., Perälä, I., Høyland, K. V., Salganik, E., Li, H., van den Berg, M., Jiang, Z., Puolakka, O. (2020) Part 1: Overview and scaling. 25th IAHR International Symposium on Ice, Trondheim, June 14 to 18, 2020.
25. **Scale-model ridges and interaction with narrow structures,** Salganik E., Ervik Å., Heinonen J., Høyland K. V., Perälä I., Puolakka O., Shestov A., van den Berg M. (2021) Part 2: Thermodynamics of ethanol ice. Proceedings of the 26th International Conference on Port and Ocean Engineering under Arctic Conditions (POAC), June 14-18, 2021, Moscow, Russia.

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26. **Scale-model ridges and interaction with narrow structures,** Heinonen J., Tikanmäki M., Mikkola E., Perälä I., Shestov A., Høyland K. V., Salganik E., van den Berg M., Li H., Jiang Z., Ervik Å., Puolakka O. Part 3: Analysis of Ridge Keel Punch Tests. Proceedings of the 26th International Conference on Port and Ocean Engineering under Arctic Conditions (POAC), June 14-18, 2021, Moscow, Russia
27. **Scale-model ridges and interaction with narrow structures,** Jiang Z., Heinonen J., Tikanmäki M., Mikkola E., Perälä I., Shestov A., Høyland K. V., Salganik E., van den Berg M., Li H., Ervik Å., Puolakka O. Part 4: Global loads and failure mechanisms. Proceedings of the 26th International Conference on Port and Ocean Engineering under Arctic Conditions (POAC), June 14-18, 2021, Moscow, Russia

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Lecture Notes on Basic Naval Architecture, Hirdaris, Spyros**.** Aalto University publication series SCIENCE + TECHNOLOGY, 6/2021, 160 p. http://urn.fi/URN:ISBN:978-952-64-0486-8

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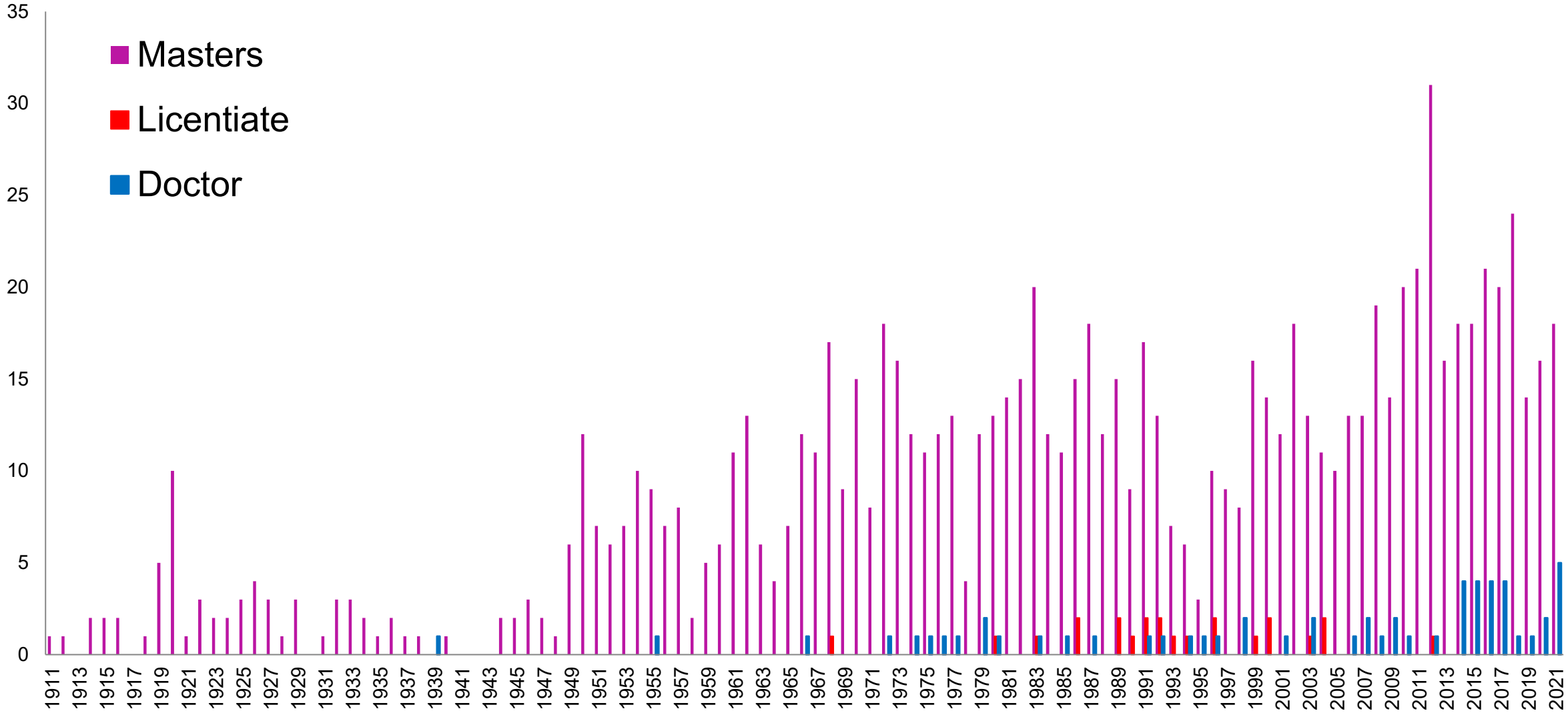

Graduated Students

Bachelor of Science

1. Antila, Frans, “Arktisen meriliikenteen vaihtoehtoiset polttoaineet”, Aalto University, School of Engineering, 2020.
2. Chen, Kai, “Laivan propulsiolaitteet”, Aalto University, School of Engineering, 2020.
3. Erkkilä, Viljami, ” Kasvavien ympäristövaatimusten vaikutus merikuljetuksiin”, Aalto University, School of Engineering, 2020.
4. Kjellberg, Akseli, “Tulevaisuuden matkustajalaivan suunnittelu ja järjestelmät estämässä”, Aalto University, School of Engineering, 2020.
5. Korpela, Jonas, “Käyttäjälähtöinen suunnittelu tulevaisuuden matkustajalaivoissa”, Aalto University, School of Engineering, 2020.
6. Lagström, Tommy, “Jämförelse av olika transportkedjor mellan Tyskland och Finland”, Aalto University, School of Engineering, 2020.
7. Linder, Anton, “Laminaattiteoria”, Aalto University, School of Engineering, 2020.
8. Lokka, Eelis, ”Kelluvien offshore-rakenteiden vakavuuslaskenta”, Aalto University, School of Engineering, 2020.
9. Ranta, Pauli, ”Laivan jäissäkulku ja sen simulointi Itämerellä”, Aalto University, School of Engineering, 2020.
10. Reijonen, Pietari, ”Risk analysis of fueling operations in non-hub airports”, Aalto University, School of Engineering, 2020.
11. Salomaa, Vili-Petteri, ”Aerodynamic flow control methods”, Aalto University, School of Engineering, 2020.
12. Seppänen, Eetu. ”Laivan suorituskyvyn mittaaminen merikoejoilla”. Aalto University School of Engineering, 2020.
13. Suokas, Miko-Markus. ”Keulapaksunnos eli -bulbi ”. Aalto University School of Engineering, 2020.
14. Suortti, Juho, ” Puu- ja teräslaivat – mitä seuraavaksi?”, Aalto University School of Engineering, 2020.
15. Termonen, Topi, ”Laivan operointidatan keruu ja hyödyntäminen”, Aalto University School of Engineering, 2020.
16. Vainionpää, Oskar, ”Hidasajon tavoitteet, edut ja haasteet rahtilaivaliikenteessä”, Aalto University School of Engineering, 2020.
17. Veltheim, Oskar, ”Laivojen kohtaamien jääkuormien laskentamenetelmät”, Aalto University School of Engineering, 2020.
18. Voutilainen, Juhan, ”Laivojen ympäristömääräykset Koillisväylän merireitin alueella”, Aalto University School of Engineering, 2020.

Bachelor of Science

19. Julin, Emilia, “Aktiiviset toimenpiteet vuotavan laivan vakavuuden parantamiseksi”, Aalto University, School of Engineering, 2021.
20. Ruusuvuori, Elias, “Arktisen meriliikenteen sääntelykehys”, Aalto University, School of Engineering, 2021.
21. Hakonen, Urho, ”Arktisten alusten suunnittelun historia”, Aalto University, School of Engineering, 2021.
22. Solmu, Elmeri, “Elinkaarisuunnittelu laivojen törmäyskestävissä rakenteissa”, Aalto University, School of Engineering, 2021.
23. Klemola, Harri, “Laivan kulkuasennon optimointi”, Aalto University, School of Engineering, 2021.
24. Ronni, Janne, “Laivan pohjan likaantuminen ja sen vaikutukset laivan operointiin”, Aalto University, School of Engineering, 2021.
25. Sevón, Miku, “Laivojen runkorakenteiden nykyaikaiset tuotantomenetelmät”, Aalto University, School of Engineering, 2021.
26. Haapasalo, Kalle, ”Poikkitieteellinen risteilylaivasuunnittelu”, Aalto University, School of Engineering, 2021.
27. Wilhelmson, Axel, ”Risks in Interactions between Autonomous and Human Operated Ships”, Aalto University, School of Engineering, 2021.
28. Kemppinen, Inkeri, ”Risteilylaivojen päästöjen vähentäminen ja jätteiden käsittely”, Aalto University, School of Engineering, 2021.
29. Wulff, Lukas, ”The Covid-19 Effects on the Safety of Maritime Traffic”, Aalto University, School of Engineering, 2021.
30. Tevajärvi, Juho. ”Vierintälaakereiden värähtelyn taajuussisällön analysointi kunnonvalvonnassa”. Aalto University School of Engineering, 2021.
31. Metsola, Janika. ”Laivan vakavuus aallokossa”, Aalto University School of Engineering, 2021.
32. Mazanikov, Ivan. ”Koillisväylän historia, nykypäivä ja tulevaisuus”, Aalto University School of Engineering, 2021.
33. Hanhirova, Sampo. ”Purjeveneen aero- ja hydrodynamiikka”, Aalto University School of Engineering, 2021.
34. Danielsson, Emil. ” Digitala produktionsmetoder inom skeppsbyggnad”, Aalto University School of Engineering, 2021.

Master of Science

1. Aarskog, Tor Magnus Konradsen, “Analysis of Full Scale Structural Vibrations On S.A. Agulhas II”, Aalto University, School of Engineering, 2020.
2. Eetu Vilen, “Evaluation of software tools in performing advanced evacuation analyses for passenger ships”, Aalto University, School of Engineering, 2020.
3. Ekman, Essi Tuulia, “Development of simplified non-linear response analysis procedure for ship structures”, Aalto University, School of Engineering, 2020.
4. Haarakallio, Aleksi Antero, “Matkustajalaivan konehuoneen modularisoinnin analysointi ja kehittäminen”, Aalto University, School of Engineering, 2020.
5. Heiskari, Janne Matias, “On the design criteria of large insulating glass structures in cruise ships”, Aalto University, School of Engineering, 2020.
6. Ilichko, Evgueni, “Optimization of wastewater treatment systems in passenger ship design”, Aalto University, School of Engineering, 2020.
7. Imala, Mikk-Markus, “Higher-order coupled beam theory”, Aalto University, School of Engineering, 2020.
8. Jiang, Zongyu, “Experimental investigation of ice loads on vertical and slope offshore structures”, Aalto University, School of Engineering, 2020.
9. Kourula, Lauri Tapio, “Vibration condition monitoring of a slow and large rolling element bearing”, Aalto University, School of Engineering, 2020.
10. Laitinen, Markus, “Evaluation of Commercial Computational Fluid Dynamics Codes in Aerodynamic Analysis of Transonic Flows Over Wings and Airfoils”, Aalto University, School of Engineering, 2020.
11. Mahhankov, Aleksandr, “Achieving Shipping Sustainability by Emerging Marine Engineering Technologies”, Aalto University, School of Engineering, 2020.
12. Noutio, Jaana Johanna, “Improving the ship structural design process by using beam models", Aalto University, School of Engineering, 2020.
13. Särkkä, Juho Volmari, “Viscoelastic Structures in Passenger Vessel Noise Control”, Aalto University, School of Engineering, 2020.
14. Tilander, Jeremias Eero August, “Hydroelasticity analysis of a passenger ship in waves”, Aalto University, School of Engineering, 2020.
15. Valkeinen, Jonas Kristian, “Risks and performance requirements on autonomous berthing systems”, Aalto University, School of Engineering, 2020.
16. Vilen, Eetu Aleksanteri, “Evaluation of software tools in performing advanced evacuation analyses for passenger ships”, Aalto University, School of Engineering, 2020
17. Abdelghafor, Zeiad, “CFD Modelling and Analysis of Ship Handling Operations, MSc in Mechanical Engineering” , Aalto University, School of Engineering, 2021.
18. Ahola, Veikko Antton Ilmari, “The Potential of Fuel Cells as Prime Energy Producers on Cruise Ships”, Aalto University, School of Engineering, 2021.
19. Colmenero Díaz, Ovidio, “Multi-scale simulation of low-speed impact loads on Carbon Fibre Reinforced Polymer (CFRP) panels”, Aalto University, School of Engineering, 2021.

Master of Science

20. Hämäläinen, Werner, “Structural Solutions and Design Process for Architectural Exterior Elements of Cruise Ships”, Aalto University, School of Engineering, 2021.
21. Heikkinen, Pekka, “Theoretical calculation method for the steering moment of a thruster in a crash stop situation”, Aalto University, School of Engineering, 2021.
22. Heinolainen, Joakim, “On the Use of Computational Fluid Dynamics for the Prediction of Wake Field in Ship Design”, Aalto University, School of Engineering, 2021.
23. Jerne, Alexander Giacomo, “Effects of elastic buckling at subcritical loads on the load carrying mechanism of a modern passenger ship”, Aalto University, School of Engineering, 2021.
24. Khawar, Muhammad Bilal, ”A statistical approach to estimate ice loads based on collision-energy- method and image processing of ice floe field”, Aalto University, School of Engineering, 2021.
25. Martikainen, Oskari Johannes, “A contactless inverse method for fatigue crack size measurements”, Aalto University, School of Engineering, 2021.
26. Mastomäki, Lassi Elias, “Weight and cost development in ship projects”, Aalto University, School of Engineering, 2021.
27. Mustaniemi, Joona, “Propeller-induced forced vibration attenuation in a ship hull”, Aalto University, School of Engineering, 2021.
28. Pettineo, Enrico, “Dynamic response analysis of a semi-submersible floating wind turbines under combined ice and aerodynamic loads”
29. Polishchuk, Artemii, “Analysis of performance of extra high strength steels in ship structures under local loads”, Aalto University, School of Engineering, 2021.
30. Pruzsina, Áron Attila, “Design of Electric Pod Propulsion Concepts for use in Displacement Crafts”, Aalto University, School of Engineering, 2021.
31. Tillikainen, Ilari Tapio, “Measurement of microstructurally small fatigue crack using digital image correlation”, Aalto University, School of Engineering, 2021.
32. Westberg, Petter, “Ship Digital Twin Potential with Shipyard Perspectives” Aalto University, School of Engineering, 2021.
33. Eronen, Mikko, “Evaluation of available waste heat recovery systems for a passenger cruise ship”, Aalto University, School of Engineering, 2021
34. Seppälä, Riikka, “Liukulaakerin jäännösjännitykset”, Aalto University, School of Engineering, 2021
35. Abdelghafor, Zeiad, “CFD Modelling and Analysis of Ship Handling Operations”, Aalto University, School of Engineering, 2021

Doctor of Science

1. Mari Åman. The influence of interacting small defects on the fatigue limit of steels. Doctoral thesis. Aalto University School of Engineering, 2020.

2. Fang Li. Numerical simulation of ship performance in level ice: evaluation, framework and modelling. Doctoral thesis. Aalto University School of Engineering, 2020.

3. Marjo Keiramo. Pathways of the creative journey – the significance of a cruise ship concept design. Doctoral thesis. Aalto University School of Engineering, 2021.

4. Lu Liangliang. Risk management of oil ship-source oil spill in ice conditions in the Northern Baltic Sea. Doctoral thesis. Aalto University School of Engineering, 2021.

5. Bruno Reinaldo Goncalves. A nonlinear modeling approach for corrugated sandwich beams. Doctoral thesis. Aalto University School of Engineering, 2021.

6. Lei Du. Maritime Traffic Risk Analysis in the Northern Baltic Sea from AIS data. Doctoral thesis. Aalto University School of Engineering, 2021.

7. Eero Avi. Equivalent shell element for passenger ship structural design. Doctoral thesis. Aalto University School of Engineering, 2021.

Professors to other universities

1941 →

Claude Daley (1996)

Brian Veicht (1998)

Sören, Ehlers (2011)

Jakub Montewka (2015)

Halid Yildirim (2015)

Jasmin Jelovica (2017)

Weibin Zhang (2017)

Mihkel Körgesaar (2018)

Floris Goerlandt (2018)

Jairan Nafar Dastgerdi (2019)

Miguel Calles (2019)

Youjiang Wang (2021)

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