



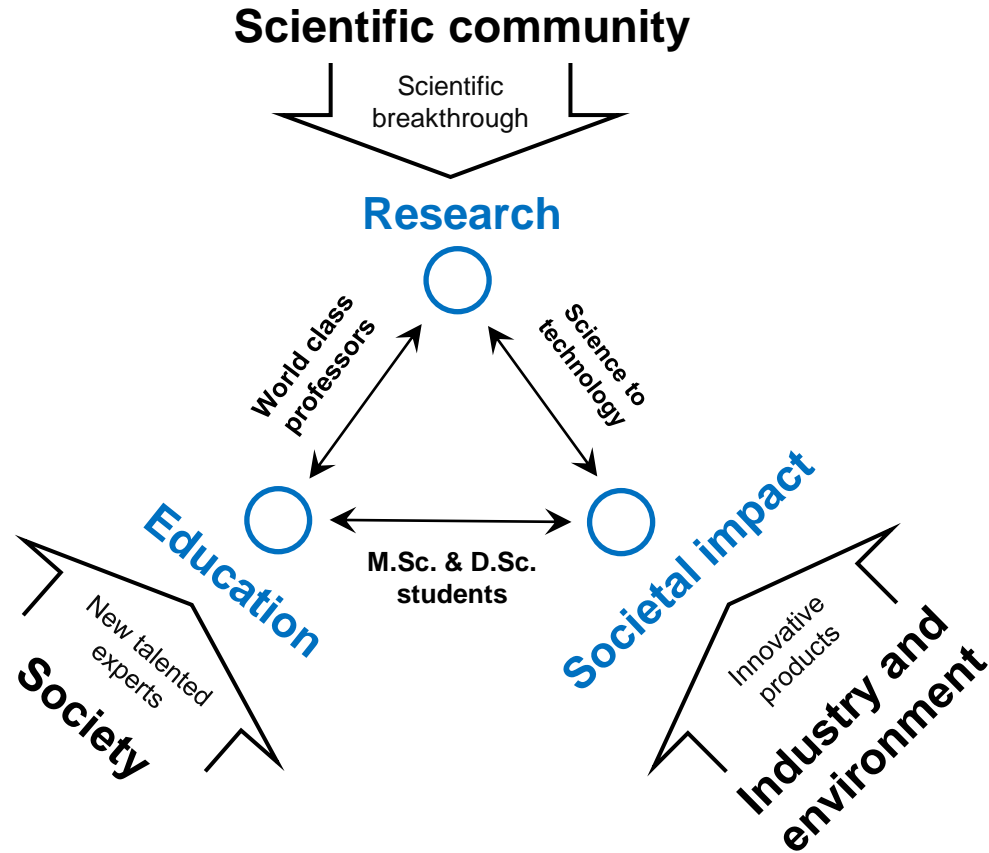
Aalto University
School of Engineering

Research & Education in Aalto Marine Technology

September 22nd, 2022

Heikki Remes

Impactful university





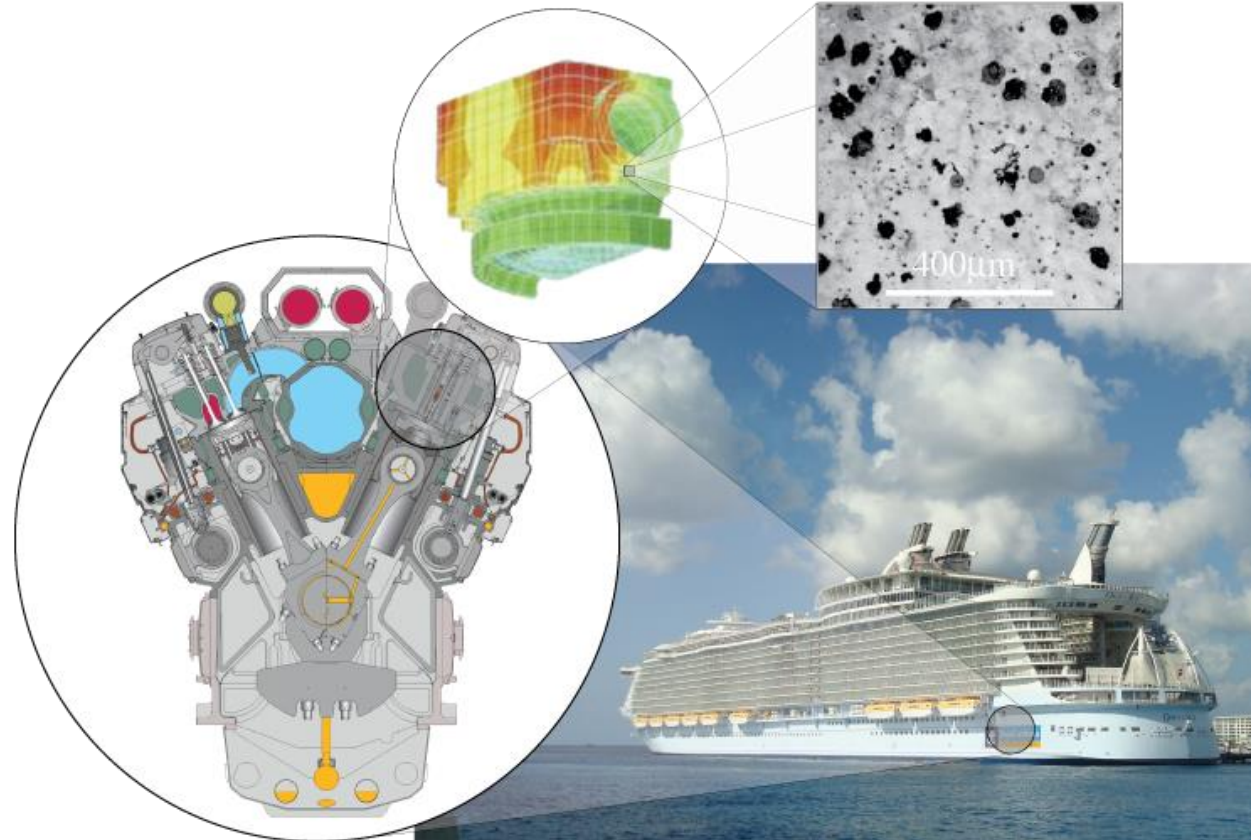
A luxury cruise ship concept by Aalto Master's students

Marine Technology education at Aalto university

M.Sc. Programme in Mechanical Engineering

Mechanics and systems across multiple length scales

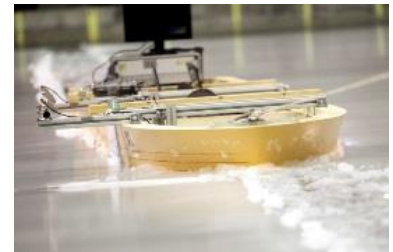
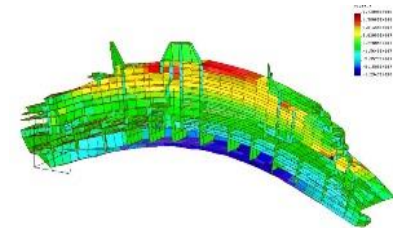
Common studies (30 cr.)
Advanced studies (30cr.)
Electives (30cr.)
M.Sc. Thesis (30 cr.)



Teaching in Marine Technology

- **In-depth understanding of maritime engineering; principles for design and construction**
 - Hydrodynamics, loads, structural analyses, stability, risk of marine traffic, and winter navigation
- **Problem-based learning; theory is supported by experimental work, computer simulations, and project works**
- **Study path examples:**
 - Naval Architecture
 - Arctic Marine Technology
 - Ship Project Engineer
 - Structural Expert
 - Hydrodynamic Expert
 - Smart Maritime Operations

The selected study path can be focused based on student interest by specialization courses from another Master's programme, e.g., a cross-disciplinary minor



Teaching in Marine Technology

Marine Major

Target Group and Learning Objectives: Naval architects and related engineering sub-fields with a focus on first principles.

Execution: 120 ECTS. Problem-based learning with a static curriculum and relevant cases from industry. Specialization in collaboration with university network (Nordic 5 Tech: NMME, CCE – CTH, NTNU, DTU)

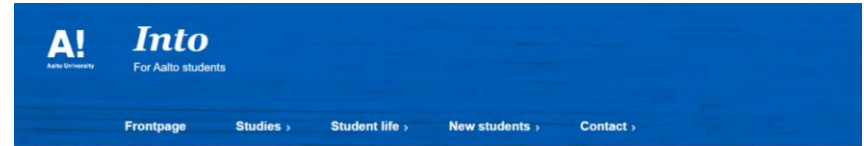
[Part of Nordic Master in Maritime Engineering](#)

Marine Minor

Target Group and Learning Objectives: Engineers, Economists, Architects, Industrial Designers, Natural Sciences. People who can utilize their expertise in maritime.

Execution: 10-25 ECTS. Courses offered inside Aalto and Finnish universities (UTU, ÅA, LUT, TUT, UW, OU) by distance learning, problem-based learning etc.

[Maritime technology education for all Finnish universities](#)



Marine Technology (minor)

Basic information

Code: ENG3080

Extent: 25 ECTS

Language: English

Organizing department: T212 Department of Mechanical Engineering

Teacher in charge: Jani Romanoff

Target group: Students from other Master's Programmes at Aalto. The master students from Department of Mechanical and Materials Engineering at Turku University have 10 students quota.

Application process: No

Quotas and restrictions: No

Prerequisites: Bachelor's degree. Student must take into account any course prerequisites (e.g. mechanics, mathematics). Please notice obligatory courses: Principles of Naval Architecture 5 ECTS and Marine and Ship Systems Engineering 5 ECTS.

Content and structure of the minor

The Marine Technology Minor offers students good overall knowledge of the engineering aspects related to marine environment. The main contents is to introduce design aspects related to environment, marine structures, transport and related systems and sub-systems. The studies cover design, manufacturing and operational aspects. The studies are build around expertise of each student by utilization of portfolio- and project-based teaching methods.

Learning outcomes

Upon completion of the Minor in Marine Technology, the student will comprehend the fundamental economical, technological and design phenomena related to engineering to marine environment. The student learns the methods for assessment of this phenomena and knows in which fields of science these are developed further and field experts exist. Student can also describe the position and relation of own expertise in the framework of engineering for maritime environment.

*New with high
future potential*

Recent developments and highlight

- **Marine Minor for Finnish Universities and other Aalto Schools (FITECH outcome)**
- **Minor for Strength analysis of Advanced Structures (Aalto – TAU education co-operation)**
- **Coordination for the Nordic Master in Maritime Engineering network**
- **Autonomous Maritime School Network (AUTOMARE) - Educational needs for Maritime Autonomous Surface Ships (Funded by Ministry of Education and Culture)**
- **Collaborative Maritime Education Framework Finland - Latin America (Funded by Finnish National Agency for Education)**
- **Three new textbooks (Basic Naval Architecture, Principles of Ship Buoyancy and Stability, Dynamics of a Rigid Ship -with applications)**



Strength Analysis of Advanced Structures (minor)

Basic information

Code at Aalto: ENG3091

Code at Tampere university: MTE.VV-A03

Extent: 20-25 ECTS

Language: English and some elective courses in Finnish

Organizing department: T212 Department of Mechanical Engineering (Aalto)

Teacher in charge: Heikki Remes (Aalto)/Mikko Kanerva (TAU)

Target group: Students from Master's Programmes at Aalto and TAU

Application process: Two application terms (autumn/spring). Application attachments: motivation letter and transcript of records. Application deadlines normally 15.8. and 15.12.

Quotas and restrictions: Max. 10 students TAU->Aalto and 10 students Aalto->TAU, total 20 students.

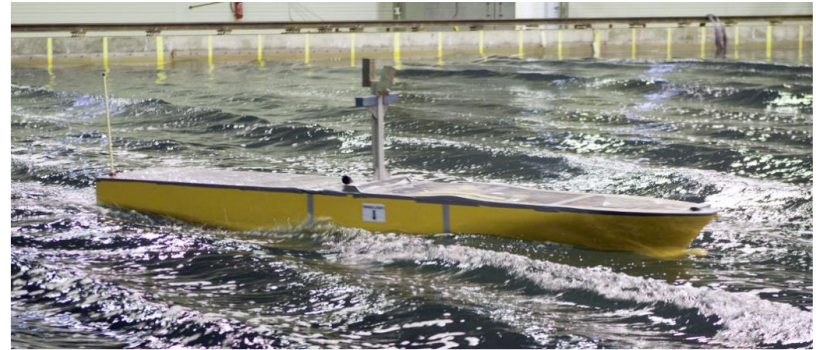
Prerequisites: Bachelor's degree. Student must take into account all course prerequisites.

Recent developments and highlight

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Maritime Engineering (Nordic Master), Master of Science (Technology)

This programme is based on the expertise of the participating universities within naval architecture, offshore engineering and maritime engineering. Nordic Master in Maritime Engineering (NMME) targets international students wishing to profit from the Nordic Five Tech universities long-standing tradition and competence in the field and Nordic students wishing to specialise in a specific area of expertise offered within the alliance. Member institutions of Nordic Master in Maritime Engineering are: Aalto University, Chalmers University of Technology, Technical University of Denmark (DTU) and Norwegian University of Science and Technology (NTNU)



Recent developments and highlight

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Identification and analysis of educational needs for naval architects and marine engineers in relation to foreseen context of Maritime Autonomous Surface Ships (MASS)

AutoMare EduNeed

Aalto University – Åbo Akademi University – University of Turku

April 2022

Recent developments and highlight

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Master's education

Master's theses in 2022

1. Alice Petry, Nonlinear material modelling for fatigue life prediction of welded joints in high strength marine structures.
2. Anniina Isokorpi, Taistelujärjestelmien integrointi perinteiseen laivatekniseen suunnitteluun.
3. Aqeel Rehman, Experimental study on friction coefficient correction method for model scale testing in brash ice channel.
4. Eetu Seppänen, Mallikoemenetelmän kehittäminen jäänmurtajan hinausominaisuuksien tarkasteluun.
5. Henri Palosuo, The feasibility of a hydrothermal carbonization (HTC) retrofit project in passenger vessels, 2021.
6. Jonas Korpela, Decarbonization of a Handymax bulk carrier.
7. Oskar Veltheim, Experimental validation of an inverse method for the determination of ice loads on a ship hull.
8. Pauli Ranta, Modular fuel solution in ship series.
9. Pawel Beszta-Borowski, Motions and hydrodynamics of a high-speed search and rescue vessel based on a time-efficient computational fluid dynamics procedure.
10. Petter Selänniemi, Newbuilt bulk carrier life-cycle study: emissions, cost, and long-term effects.
11. Rimo Timm, Lightweight structure for the deckhouses of workboats.
12. Sanna Granqvist, Implementation of methanol fuel to expedition cruise ship.
13. Sarah Blackwell, Estimating weight increase due to finite element reinforcements in concept design.
14. Severi Sarsila, Comparison of achieved fuel savings on ships by different wind propulsion devices using a 3-DoF resistance model.
15. Oskar Vainionpää, Optimization of retrofit sponson-ducktail for improved passenger ship stability.
16. Van Tran, Determination of propeller cavitation inception diagram by numerical methods.
17. Veer Samani, A preliminary analysis of the impact of autonomous maritime surface ships in marine technology education.

+ several ongoing



SNAME West Europe Section Award 2021

Pictured left to right:

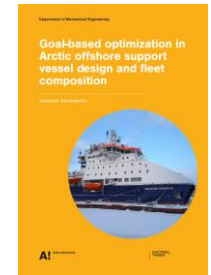
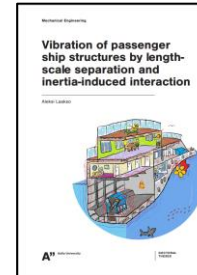
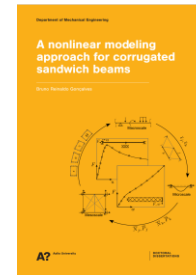
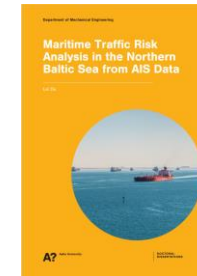
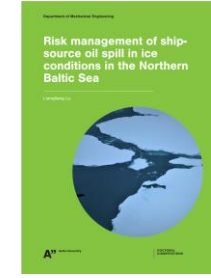
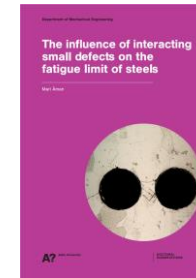
Prof. Garry Marquis / Dean of Engineering, Award recipient Mr. Aaro Karola and supervisor Dr. Spyros Hirdaris.



Doctoral education

Doctoral dissertations (2020-2022)

1. Mari Åman, The influence of interacting small defects on the fatigue limit of steels, 2020.
2. Fang Li, Numerical simulation of ship performance in level ice: evaluation, framework and modelling, 2020
3. Liangliang Lu, Risk management of ship-source oil spill in ice conditions in the Northern Baltic Sea, 2021.
4. Marjo Keiramo, Pathways of the Creative Journey - the Significance of a Cruise Ship Concept Design, 2021.
5. Lei Du, Maritime Traffic Risk Analysis in the Northern Baltic Sea from AIS Data, 2021.
6. Eero Avi, Equivalent shell element for passenger ship structural design, 2021.
7. Bruno Reinaldo Goncalves, A nonlinear modeling approach for corrugated sandwich beams, 2021.
8. Alekski Laakso, Vibration of passenger ship structures by length-scale separation and inertia-induced interaction, 2022.
9. Aleksandr Kondratenko, Goal-based optimization in Arctic offshore support vessel design and fleet composition, 2022.



Professors to other universities

1941



Claude Daley (1996)



Brian Veicht (1998)



Sören, Ehlers (2011)



Jakub Montewka (2015)



AALBORG UNIVERSITY
DENMARK

Halid Yildirim (2015)



Jasmin Jelovica (2017)



Weibin Zhang (2017)

Mihkel Kõrgesaar (2018)



TALLINN UNIVERSITY OF
TECHNOLOGY

Floris Goerlandt (2018)



Dalhousie
University

Jairan Nafar Dastgerdi (2019)



Amirkabir University of Technology
(Tehran Polytechnic)

Miguel Calles (2019)



Universidade Federal do ABC

Youjiang Wang (2021)



Sang Jin Kim (2022)



Kristjan Tabri (2022)



TALLINN UNIVERSITY OF
TECHNOLOGY

Li Fang (2022)





Marine Technology research

Marine Technology Research

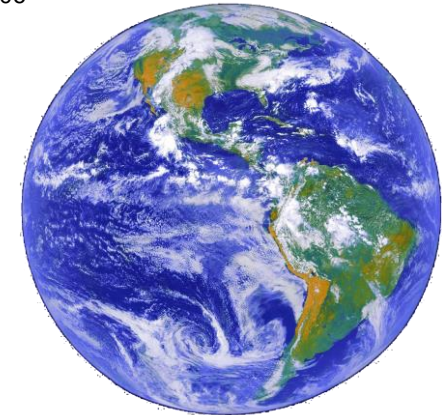
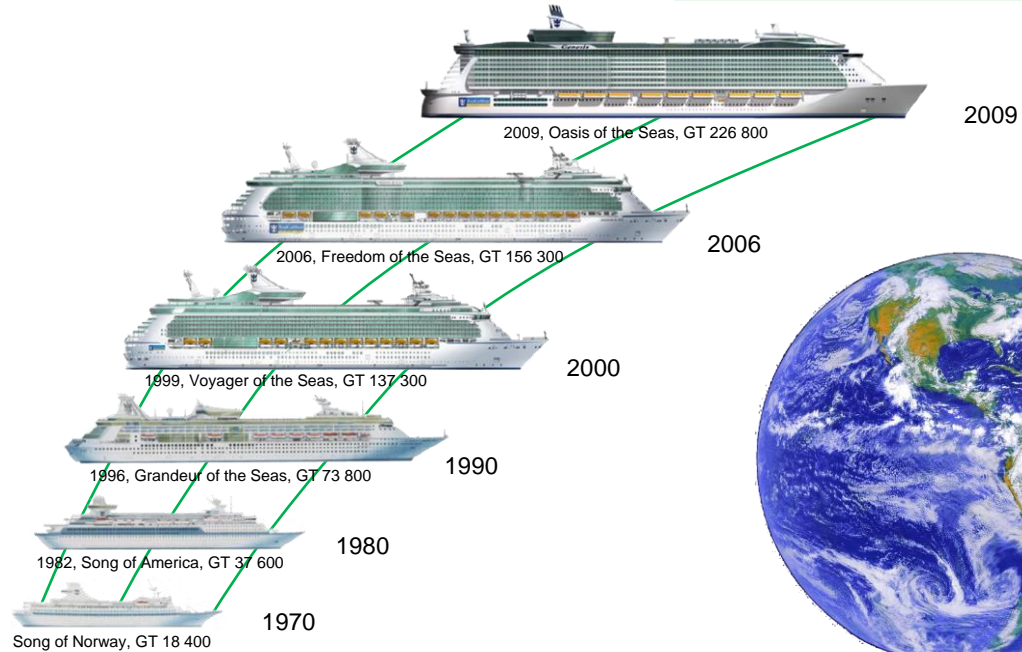
Significant impact on society
in Finland and worldwide



S. A. Agulhas II



Tempra



Marine Technology Research in Aalto

(Shanghai ranking 2022)

ShanghaiRanking: Aalto University ranks in top 100 worldwide in nine academic subjects

Published: 22.7.2022

Marine/Ocean Engineering, Business Administration, Management and Library & Information Science were the best performers among Aalto's subjects



Top 50 subjects in Finnish Universities in 2022

Subject	University	Ranking
Marine/Ocean Engineering	Aalto	21
Business Administration	Aalto	24
Ecology	Helsinki	26
Dentistry & Oral Sciences	Helsinki	31
Geography	Helsinki	35
Atmospheric Science	Helsinki	35
Management	Aalto	38
Communication	Helsinki	41
Education	Jyväskylä	44
Public Health	Helsinki	44
Telecommunication Engineering	Tampere	45
Library & Information Science	Aalto	46
Agricultural Sciences	Helsinki	46
Remote Sensing	Helsinki	47

Marine Technology Research in Aalto

(Shanghai ranking 2022)

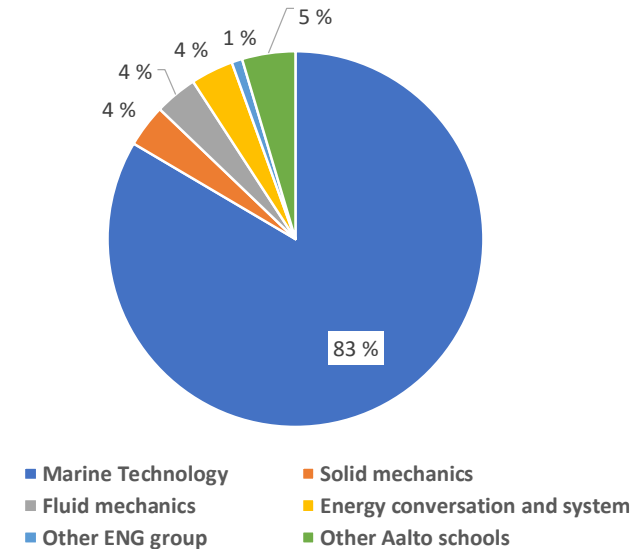
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Shanghai ranking 2022
Maritime/Ocean Engineering - publication share



Marine Technology group: Staff & focus areas

Risks and Intelligence in Marine System



Osiris Valdez Banda

Mashrura Musharraf

Arctic Marine Engineering



Pentti Kujala

Marine Structures and Production



Jani Romanoff

Heikki Remes

Marine Hydro Mechanics



Spyros Hirdaris

Tommi Mikkola

Pekka Ruponen



Marine Technology group - focus areas

Risks and Intelligence in

Osiris

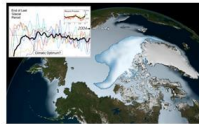
Arctic Marine Technology

Ice-loads, ship-ice interaction, ship performance in ice, goal-based design for arctic

Altimetry



Modeling

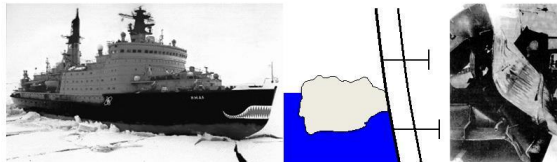


Observations



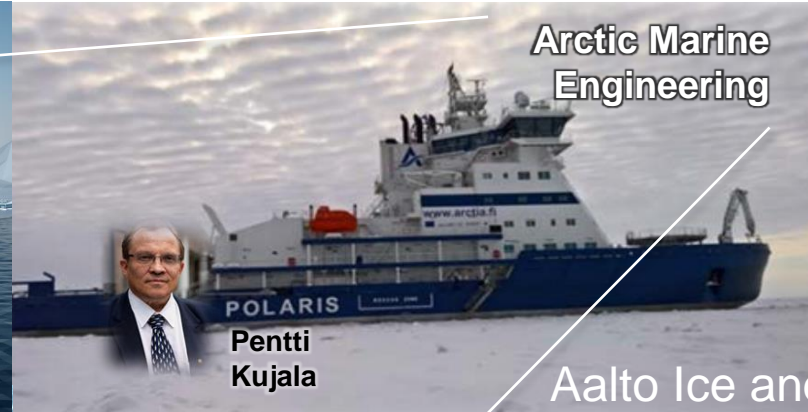
Predictions for the sea ice cover
Concentration, Thickness, Movement...

Structure-ice interaction



Joint Center of Excellence for Arctic Shipping and Operations
Funded by Lloyd's Register Foundation (2013-2022)

Arctic Marine Engineering



Pentti Kujala

Aalto Ice and Wave Tank



Spyros Hirdaris


Tommi Mikkola

Pekka Ruponen

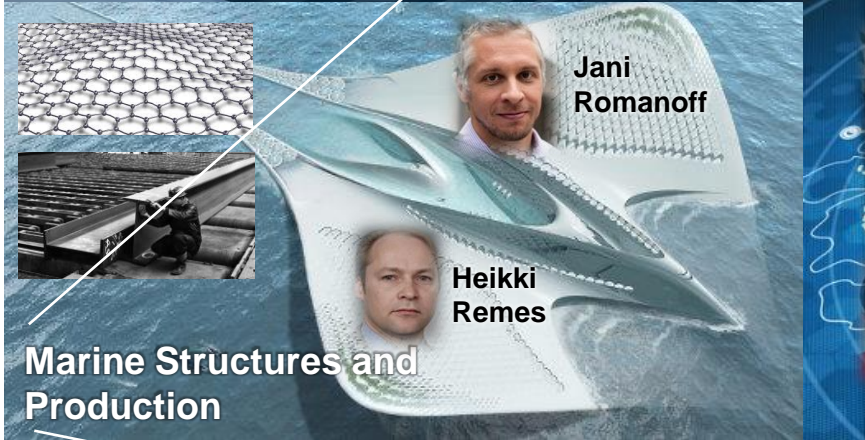
Marine Hydro Mechanics

Marine Technology group - focus areas

Risks and Intelligence in Marine System



Osiris Valdez Banda



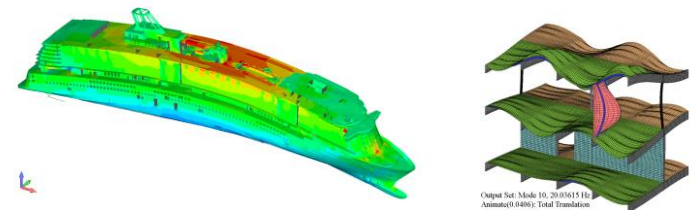
Mashrura Musharraf

Jani Romanoff

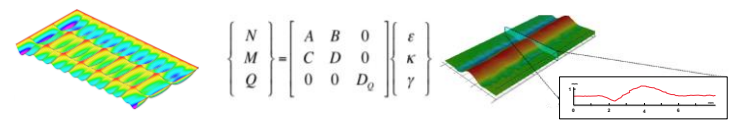
Heikki Remes

Marine Structures and Production

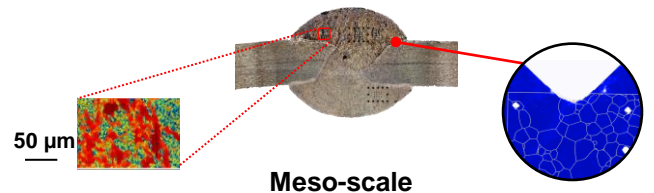
Advanced marine structures



Full-scale



Macro-scale



Meso-scale

Marine Technology group - focus areas

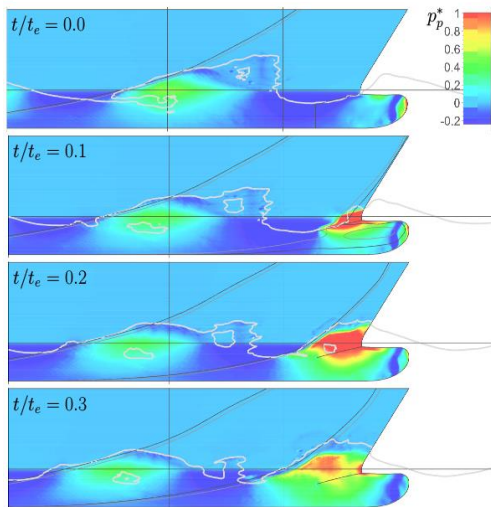
Risks and

Int

Ma

Hydro-mechanics and CFD

Nonlinear hydrodynamics, wave load predictions, hydro-elasticity



Arctic Marine Engineering



Pentti Kujala



Spyros Hirdaris

Tommi Mikkola

Pekka Ruponen

Marine Hydro Mechanics

Marine Structures and Production

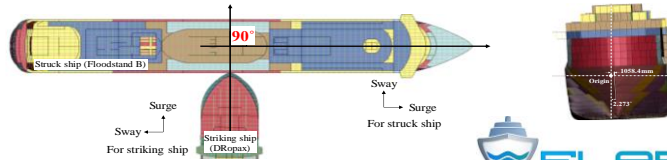
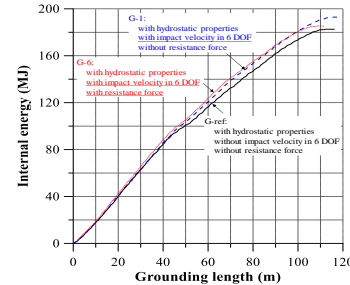
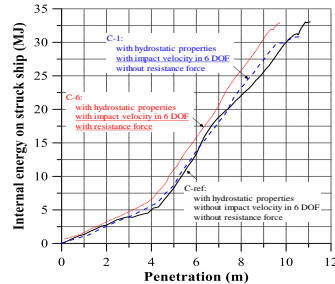
Marine Technology group - focus areas

Risks and Intelligence in Marine System

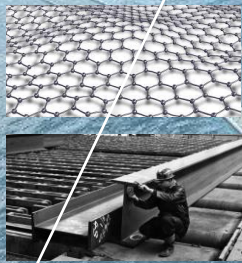
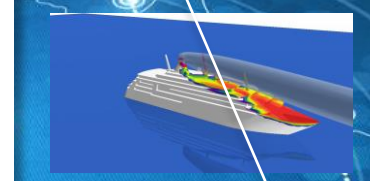


Crashworthiness and damage stability

Fluid-structure interaction with crashworthiness, flooding accident response in relation to damage ship stability



Arctic Marine Engineering



Marine Structures and Production

Heikki Remes

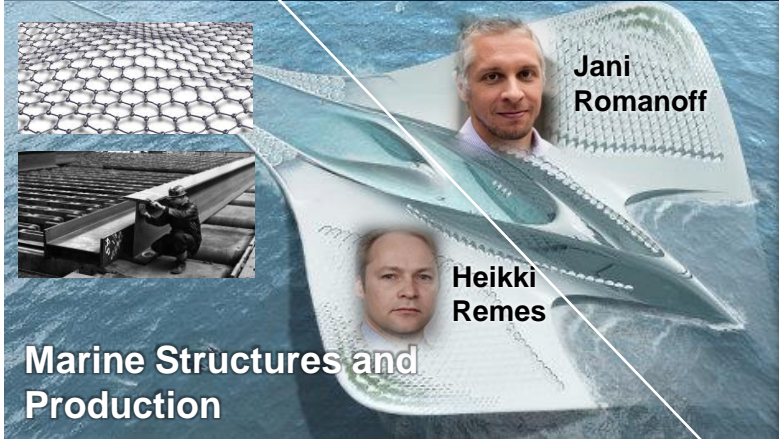
Tommi Mikkola

Pekka Ruponen

Marine Hydro Mechanics

Marine Technology group - focus areas

Risks and Intelligence in Marine System



Arctic Marine

Safe and Efficient Marine Systems

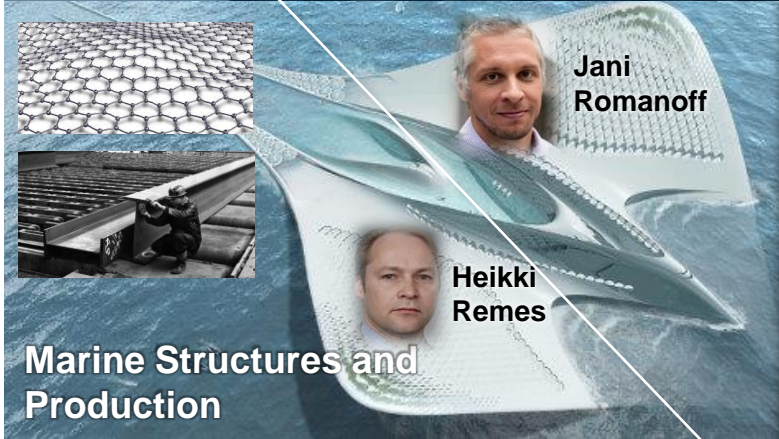
Marine safety, autonomous systems, smart shipping, risk management, and resilience engineering



HAZARD ANALYSIS PROCESS FOR AUTONOMOUS VESSELS

Marine Technology group - focus areas

Risks and Intelligence in Marine System



Arctic Marine

Safe and Efficient Marine Systems

Marine safety, autonomous systems, smart shipping, risk management, and resilience engineering

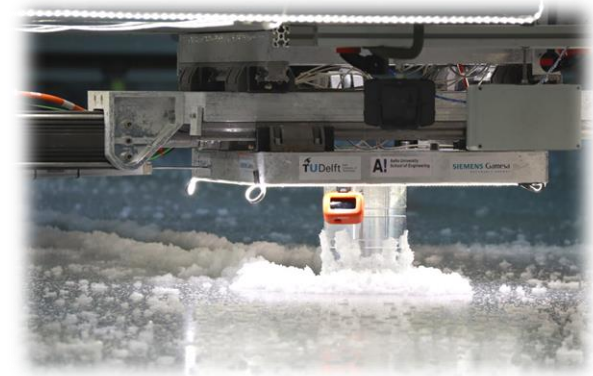


**Human-centered automation –
Making automation using ML/AI
interpretable**

Main research facilities

Aalto Ice and Wave Tank

- *Size: 40m x 40m x 2.8m*
- *Ice, wave, and open water test*
- *Reduced-scale tests with marine and offshore structures*

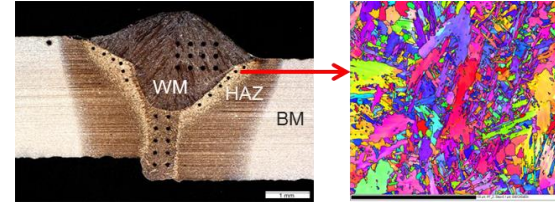


Main research facilities

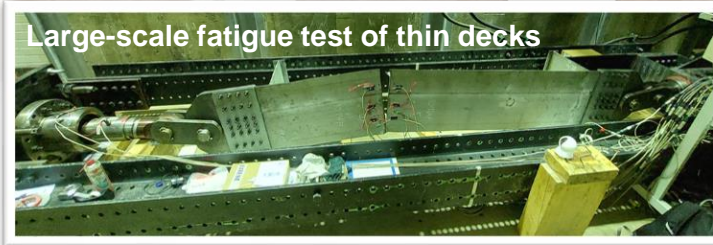
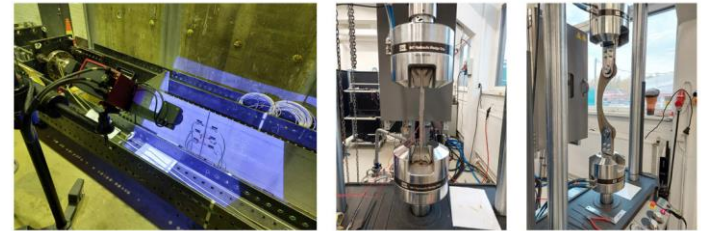
Solid Mechanics laboratories



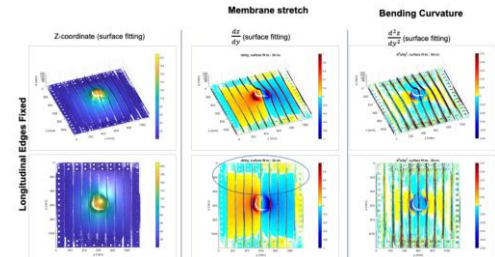
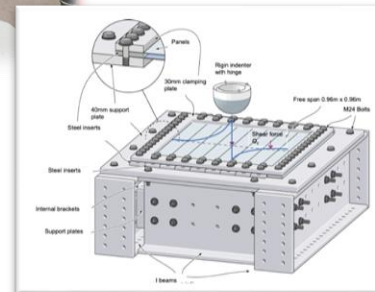
Material characterisation



Material, component and structural testing



Large-scale fatigue test of thin decks



Research collaboration towards societal impact



News

Meyer Turku inaugurates sponsored lecture hall in Otaniemi

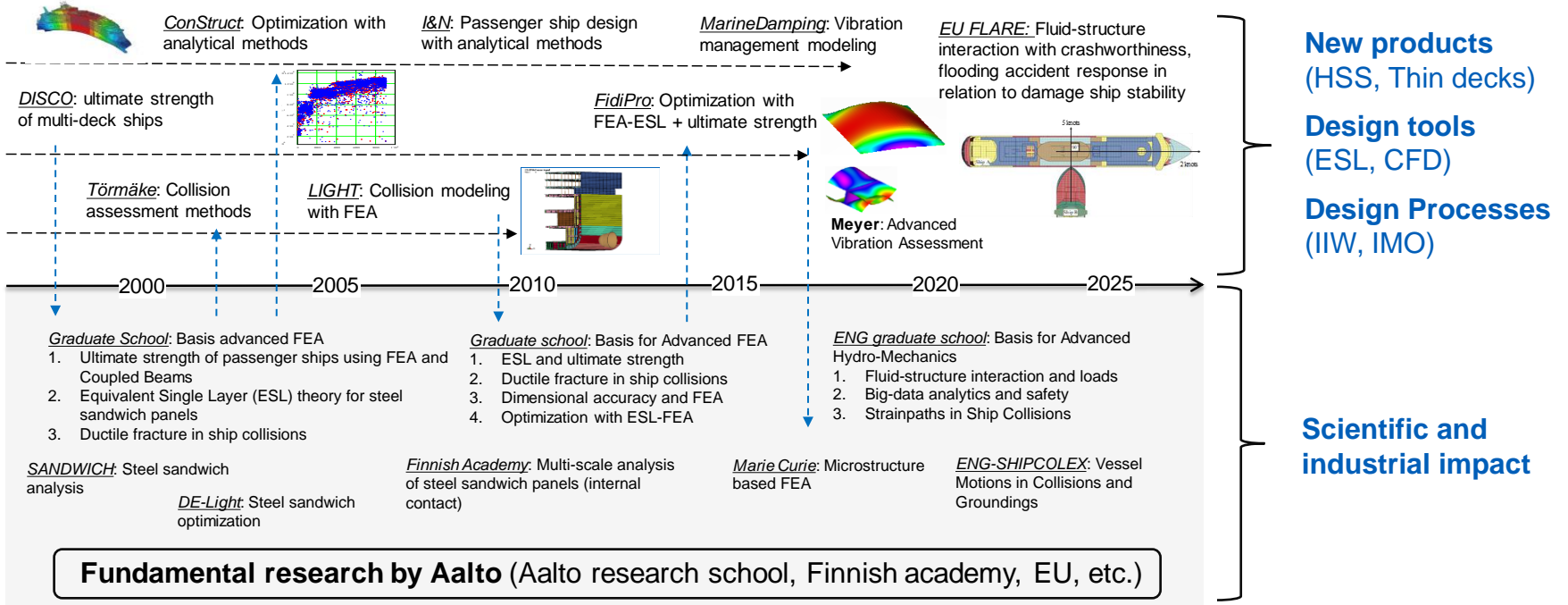


Tim Meyer, CEO of Meyer Turku Oy, and President Ilkka Niemelä in the opening of the Meyer hall on Friday, 9 September 2022.

Example of a long-term research roadmap

Applied research (With Meyer-Turku-Aalto cooperation, TEKES and/or EU funding)

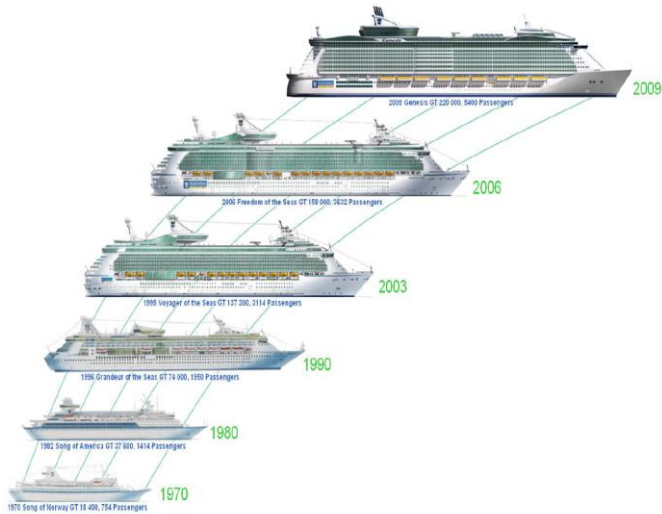
Example of R&D Roadmap: Numerical Analysis of Advanced Ship Structures



2000 — 2005 — 2010 — 2015 — 2020 — 2025 →

Research impact example

New generation?
Value: >1000 M€ / ship

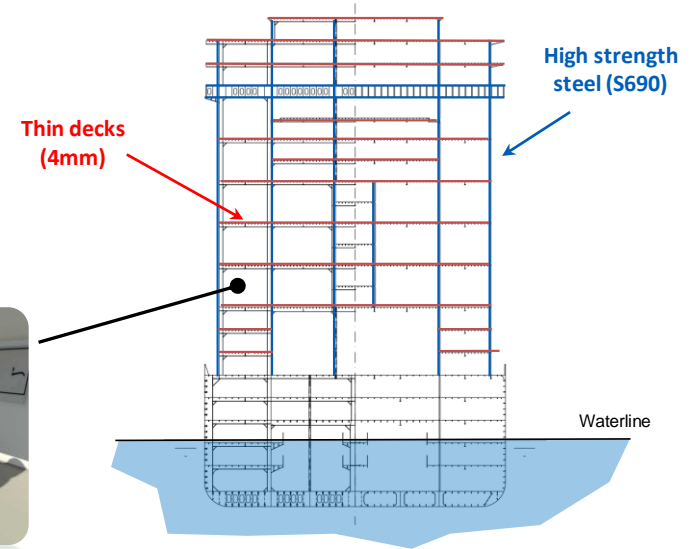


Competitive cruise ship concepts

- Two additional decks
- Passenger capacity increased 19%



YLE News, May 2018



A cross-section of next generation Cruise Liner

Kivelä et al. Marine Tech Gala, May 2018

Future research areas and co-operation

- Decarbonization

- New fuels, new engines, new propulsion systems, ...

- Sustainability

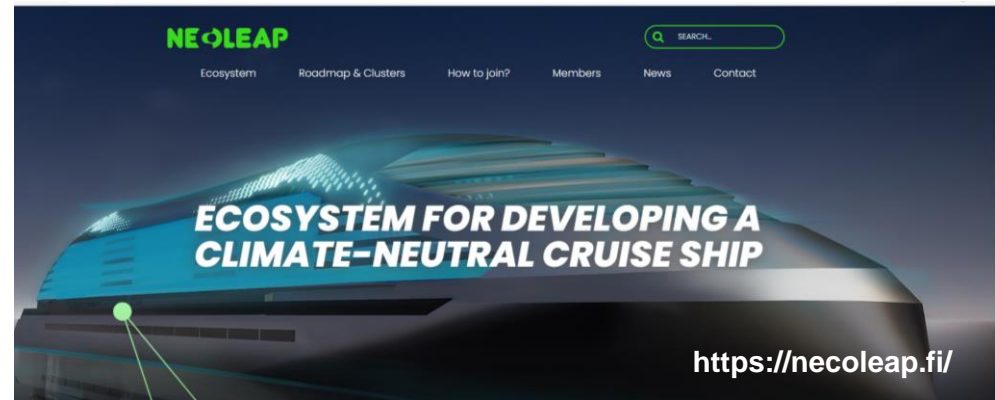
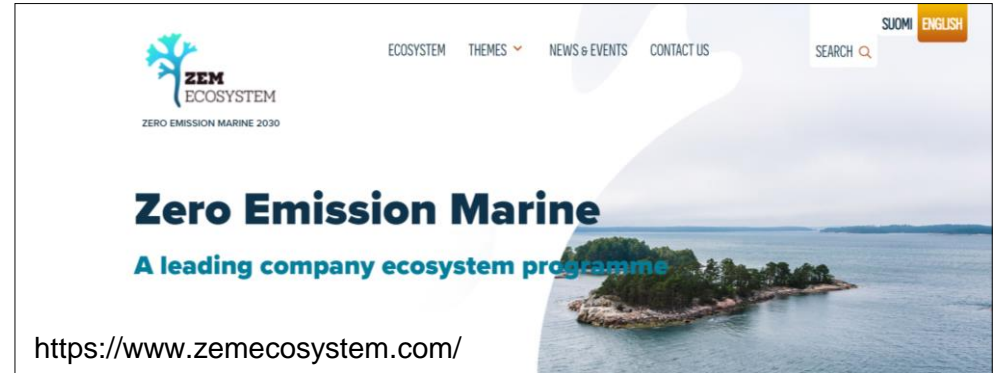
- Energy efficiency, advanced hull form design, light structures, ...

- Digitalization

- Data-driven ship design and operation, AI in marine technology, optimized and safe operations, safety-based design, ...

- Creative design

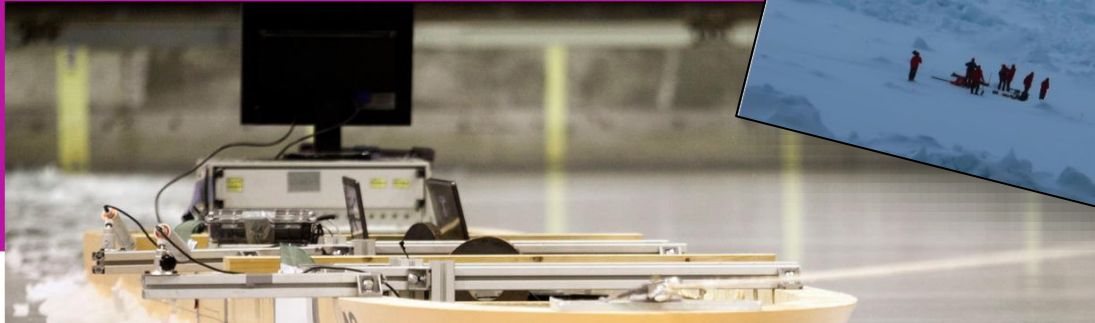
- Innovative concepts, outstanding architecture, user experience, ...



Department of Mechanical Engineering

Study marine technology at Aalto University

Future marine technologies can solve environmental challenges for shipping and improve operational efficiency and assist in the sustainable exploitation of ocean space – in the face of a shortage of challenges and opportunities in the maritime sector.



<https://www.aalto.fi/en/department-of-mechanical-engineering/study-marine-technology-at-aalto-university>

Thank you for your kind attention!