Aalto-yliopisto
Insinööritieteiden
korkeakoulu

Marine Technology at Aalto University

Orientation week 2023

Importance of seas on earth and society

UN environment programme

- We live on a blue planet, with oceans and seas covering more than 70 percent of the Earth's surface.
- Oceans feed us, regulate our climate, and generate most of the oxygen we breathe.
- Ocean serves as the foundation for much of the world's economy, supporting sectors from international shipping to fisheries to tourism
- We must ensure a sustainable consumption and production patterns to fulfill the SDGs

Goal 12 Sustainable Consumption and Production

Goal 13 Climate Action

Goal 14 Life Below Water

Aalto-yliopisto
Aalto-universitetet
Aalto University

M.Sc. Programme in Mechanical Engineering

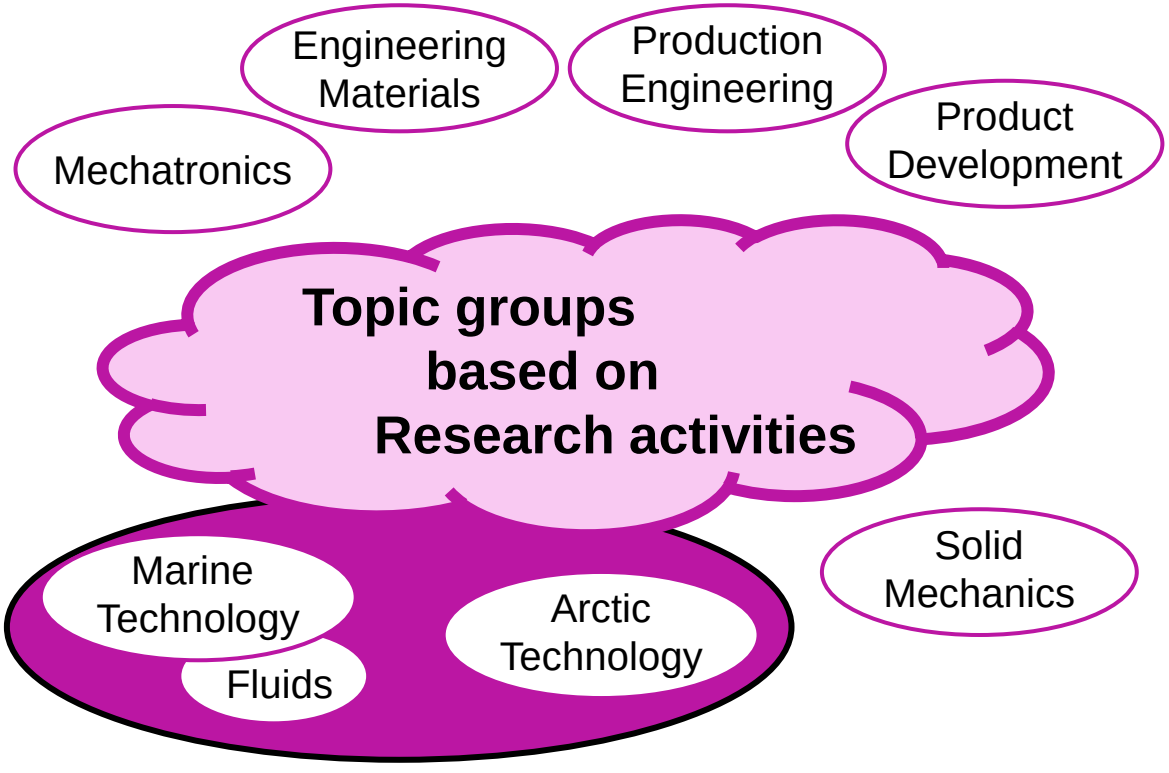
Different topic groups

Common studies
(30 cr.)

Advanced studies
(30cr.)

Electives
(30cr.)

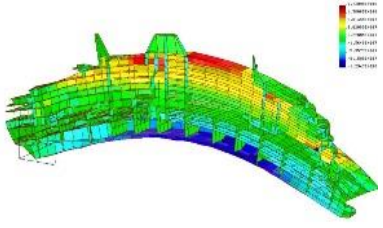
M.Sc. Thesis
(30 cr.)

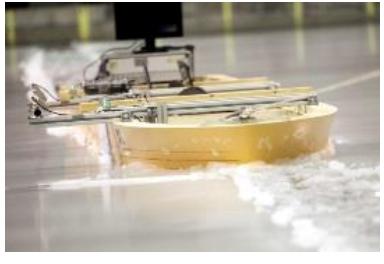


Marine Technology Education focus

- **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 Operation

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





Teaching in Marine Technology

Marine Major

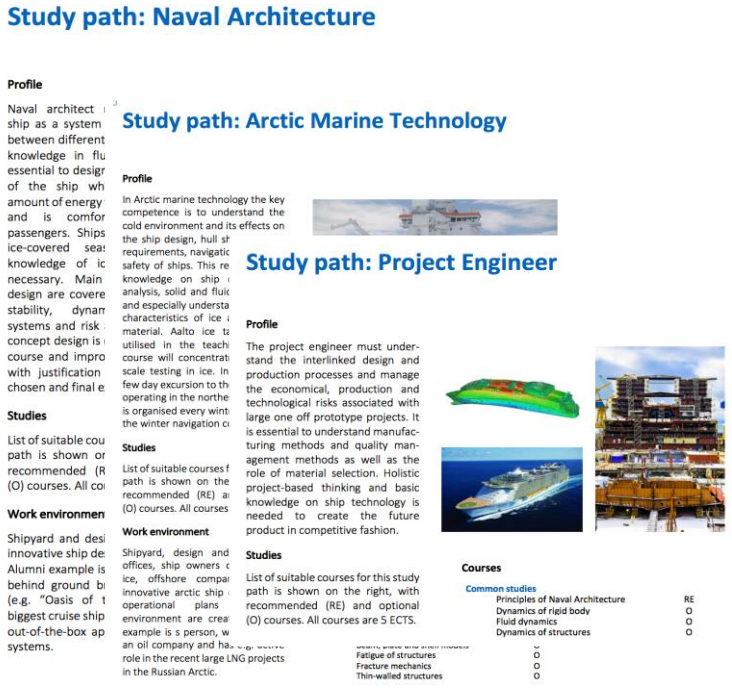
Target Group and Learning Objectives: Naval architects and focus related sub-fields of engineering with focus on first-principles.

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

Marine Minor

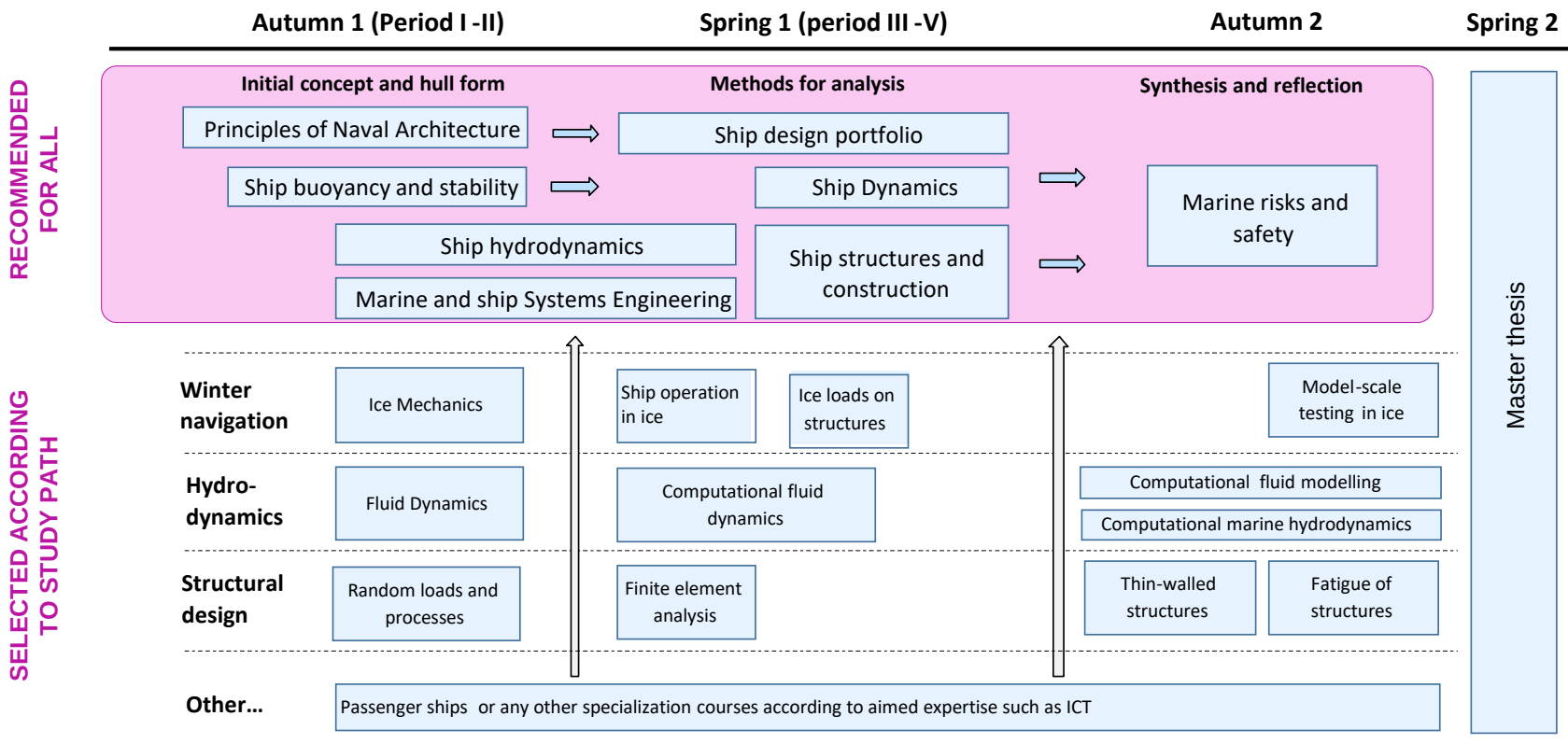
Target Group and Learning Objectives: Engineers, Economist, Architects, Industrial Designers, Natural Sciences. People who can utilize their expertise in maritime.

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



Major study path examples ...

Marine Major study paths



Common studies and other supportive courses are selected based on the study path and student's interest

Aalto-yliopisto
Insinööritieteiden korkeakoulu

Teaching staff at Marine Technology

Professors

Heikki Remes

Jani Romanoff

Spyros Hirdaris

Osiris Valdez Banda

Mashrura Musharraf

Marjo Keiramo
(POP)

Pekka Ruponen
(POP)

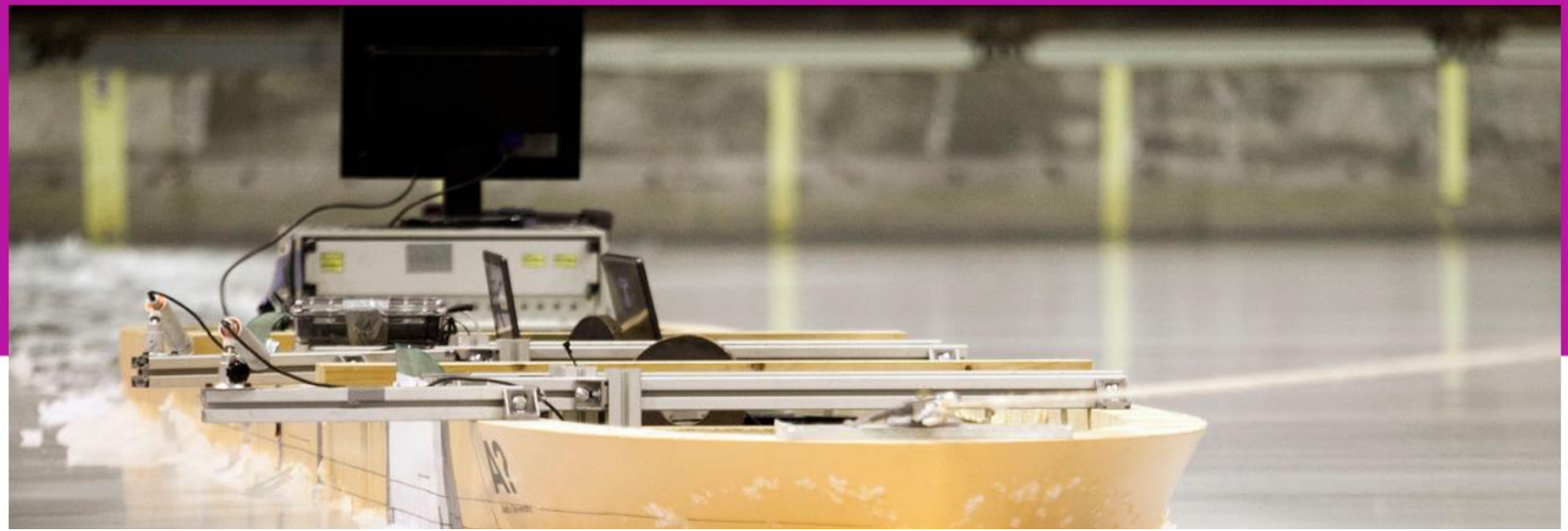
Lecturer

Tommi Mikkola

Department of Mechanical Engineering

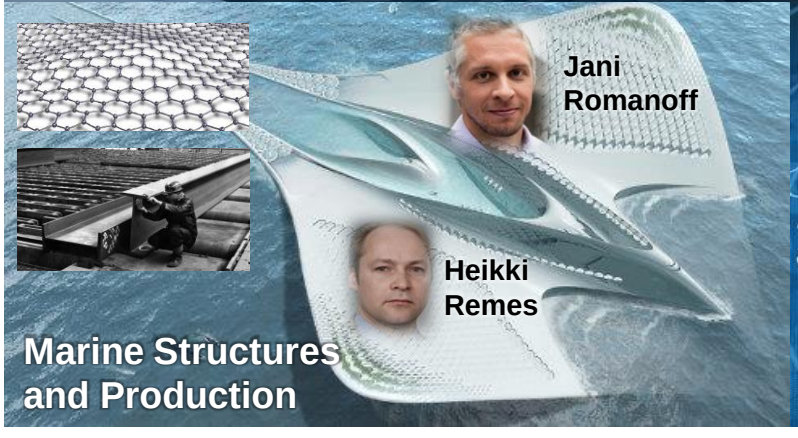
Study marine technology at Aalto University

Future marine technologies can solve environmental challenges for shipping and logistics, improve operational efficiency and assist in the sustainable exploitation of ocean space – there is no shortage of challenges and opportunities in the maritime sector.



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

Research areas



Marjo Keiramo
(POP)
Radical creativity in ship design

NEW! Arctic Ocean Engineering
2024

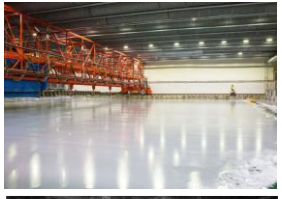
Arctic Marine Engineering (1)

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**.

Full-scale tests

mimic

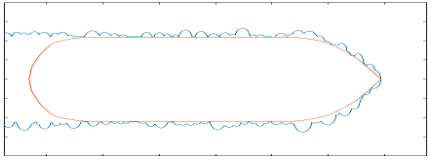
Model-scale tests



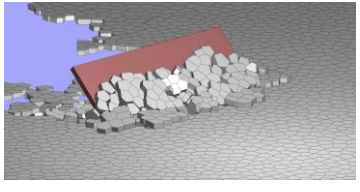
simulate

validate

validate

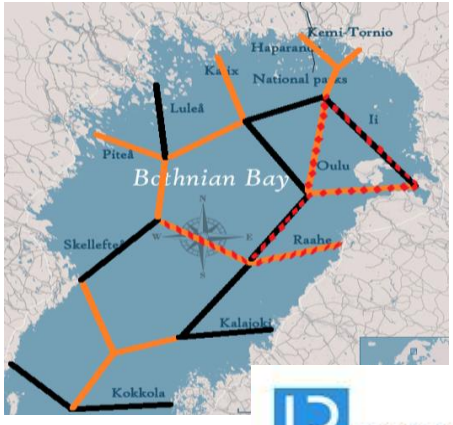


Modeling



Arctic Marine Engineering (2)

- Holistic treatment of the design relevant features of ships and shipping and their identification to ensure safe arctic operations and transport
- Updated definition of the limit states to be used in the structural design of Arctic ships
- Validation of the new Polar Code risk index approach: establishment of the link between the risk index and level of safety of Arctic shipping
- Simulation model for winter navigation system of Finland, funded by LVM, Väylävirasto, TRAFICOM, Research question: How many icebreakers we need on 2030 ?
- INFUTURE , Future potential of Inland Waterways, 2018-2021, The South-eastern Finland – Russia CBC 2014-2020
- SIMREC, Simulators for improving cross-border oil spill response in extreme conditions, 2019-2022. South-East Finland-Russia CBC program.



Lloyd's Register Foundation

Courtesy: Aker Arctic

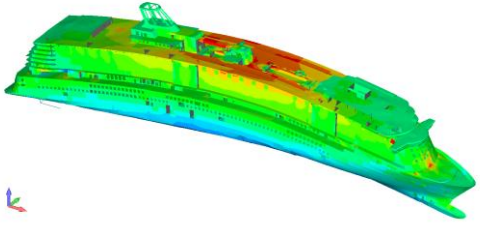
Marine Structures and Production (1)

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.

Full-scale

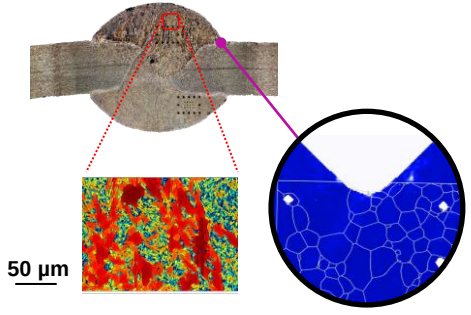
Structural engineering

Macro-scale



Mechanics of structures

Micro-scale



Strength of materials

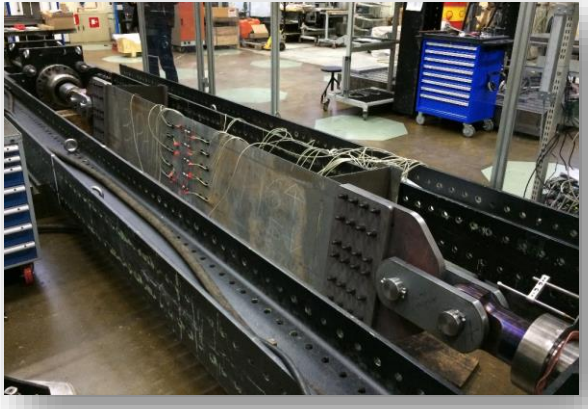
Marine Structures and Production (2)

Research impact examples

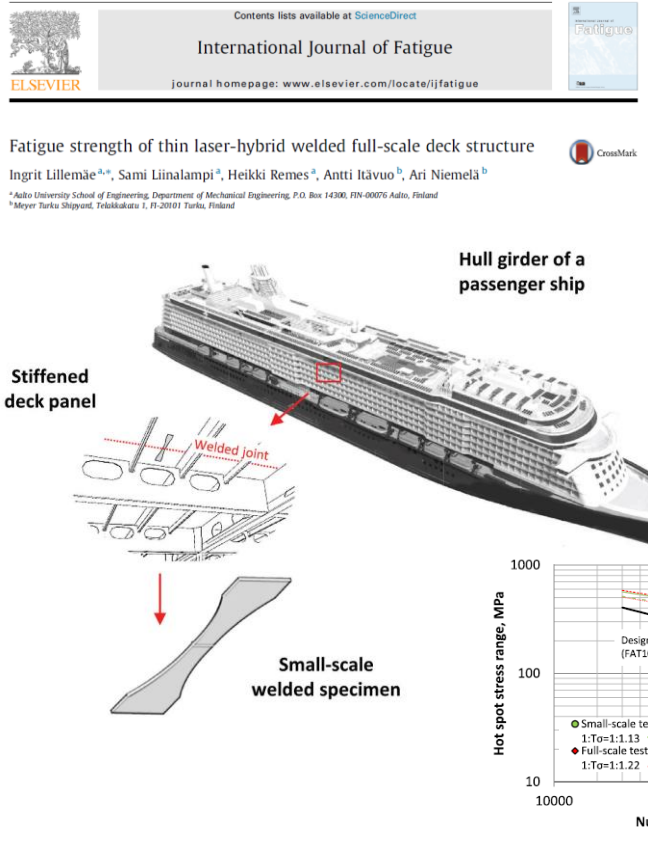
Competitive cruise ships

Thin-deck structure

- **30% thickness reduction**



MEYER TURKU
SHIPYARD 1737



Marine Structures and Production (3)

Research impact examples

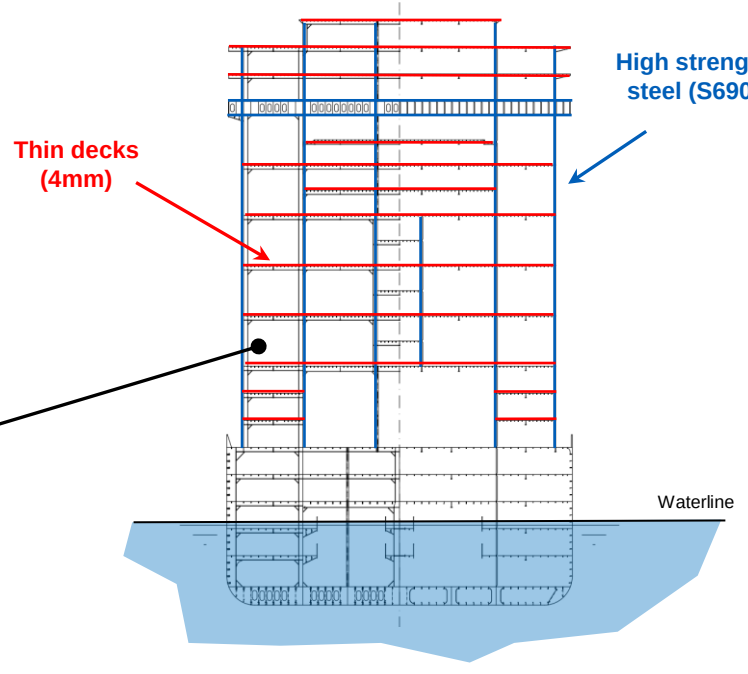
Competitive cruise ship

A concept based on scientific evidence

- New structural topology with two additional decks
- Passenger capacity increase 19%

YLE News, May 2018

Interlock
Cabin
module



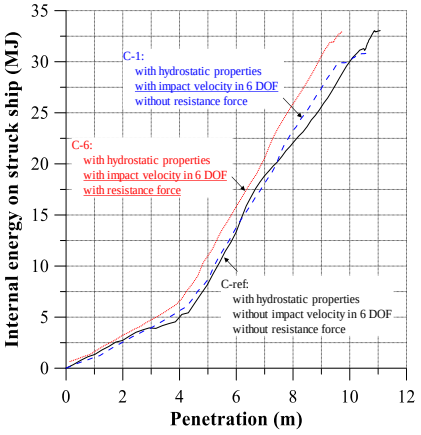
A cross-section of next generation Cruise Liner

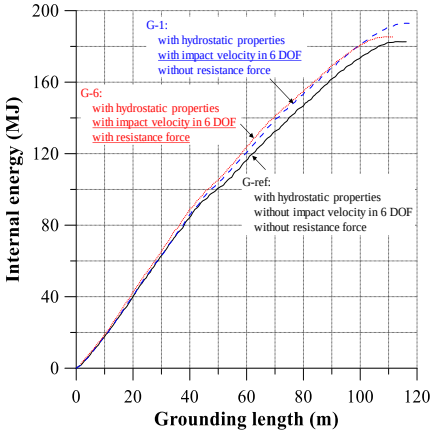
Kivelä et al. Marine Tech Gala, May 2018

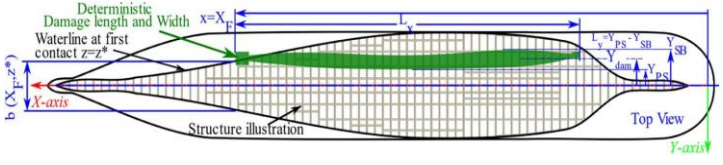
Marine Hydro Mechanics (1)

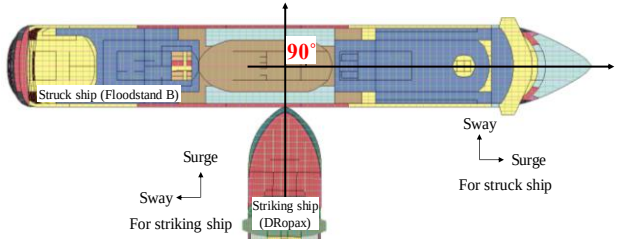
We develop cutting-edge methods to model the influence of accidental loads on ship collisions and groundings and their impact on ship stability.

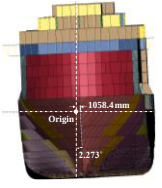
Our new methods bring together structural dynamics, ship dynamics and marine hydrodynamics.











Ghalib Taimuri, Pekka Ruponen, Spyros Hirdaris (2023), A novel method for the probabilistic assessment of ship grounding damages and their impact on damage stability, *Structural Safety*, 100, 102281, doi : 10.1016/j.strusafe.2022.102281.

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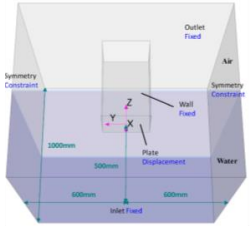
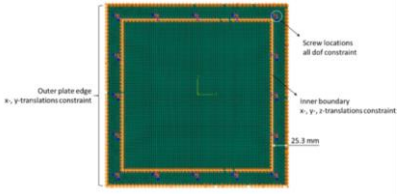
Marine Hydro Mechanics (2)

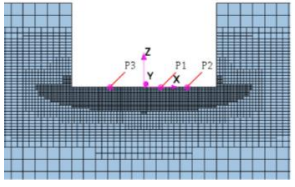
We develop hydroelastic methods for the prediction of wave loads including ship slamming.

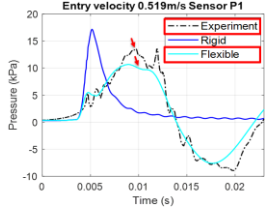
Our research brings together structural dynamics with CFD based marine hydrodynamics

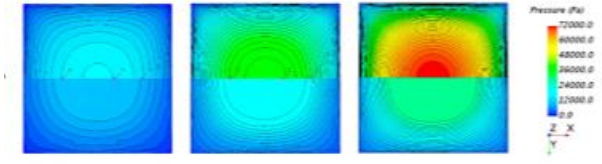
© printerest.com







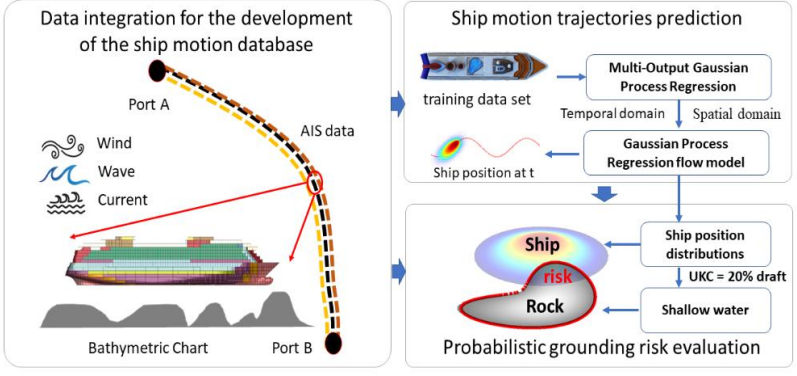


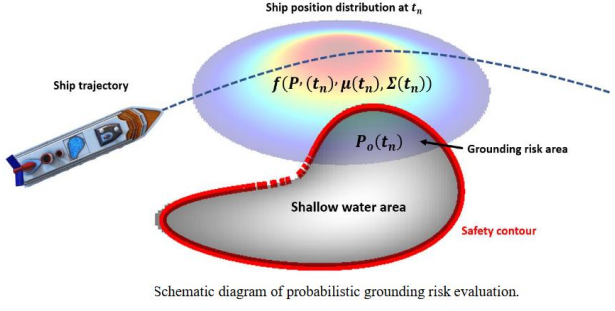


D. Yan, T. Mikkola, P. Kujala & S. Hirdaris (2023) Hydroelastic analysis of slamming induced impact on stiff and flexible structures by two-way CFD-FEA coupling, Ships and Offshore Structures, 18:9, 1300-1312, doi: 10.1080/17445302.2022.2116231

Marine Hydro Mechanics (3)

We predict ship motions by AI methods. Our research brings together principles of ship theory, safety and predictive big data science and may help with ship safety and environmental sustainability assessment in real operational conditions.





Schematic diagram of probabilistic grounding risk evaluation.

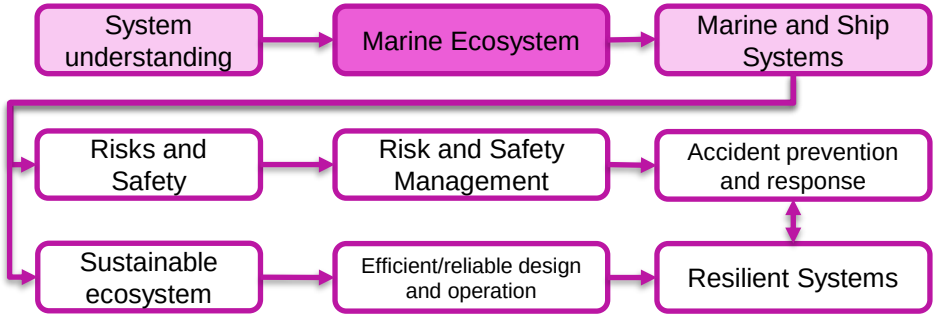
Zhang, M., Kujala, P., Musharraf, M., Zhang, J., Hirdaris, S. (2023). A machine learning method for the prediction of ship motion trajectories in real operational conditions, Ocean Engineering, 283, 114905, doi : 10.1016/j.oceaneng.2023.114905.

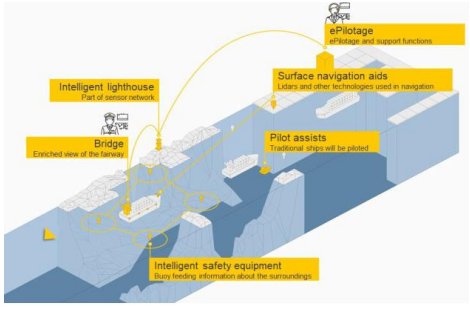
Risks and intelligence in marine systems (1)

SEMSS Research group:

Our research focuses on risk and reliability analysis and safety science principles with application to ship design and marine and ship systems.

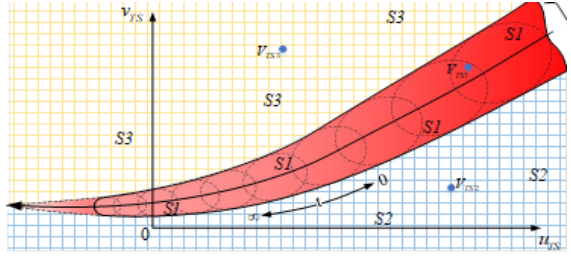
Context: Ship collisions, autonomous maritime technologies, smart shipping, accidental oil spills, and winter navigation.





Risk analysis of Finnish fairways and smart fairway concept

Autonomous Ship Scale Model



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

DIMECC Program SEA4VALUE – Fairway

GYROSCOPE

SMART CITY FERRIES

ECAMARIS
Enablers and Concepts for Automated Maritime Solutions

Risks and intelligence in marine systems (2)

Human-centered intelligent ships for winter navigation

Multipurpose winter navigation database

Expert Knowledge

AIS Data	Vessel Info
Ice Data	Abnormal Events

Human centered intelligent ships for winter navigation

ML for intelligent & transparent decision making

Reality check and crossing the gap

- Measure gap bw simulation and reality
- Propose measures to cross the gap

Human-in-the-loop Testing using the winter navigation simulator

Funded by

SUOMEN AKATEMIA

Aalto University

Collaborators

MEMORIAL UNIVERSITY

University of South-Eastern Norway

Aalto University
School of Engineering

Risks and intelligence in marine systems (3)

JÄÄSIMU & DECoding Icebreaker DEcision (DECIDE)

Continuation of:
MERLOG,
WinterSim, SIMNAV

Funded by

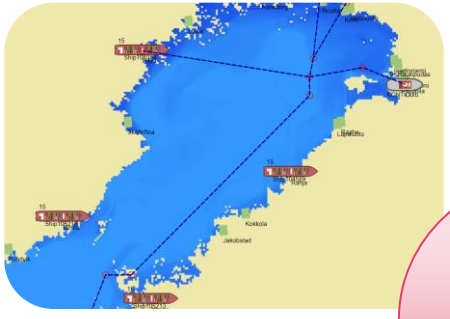
Aalto University · VÄYLÄ · SUOMEN AKATEMIA

Merenkulun säätiö · WNRB

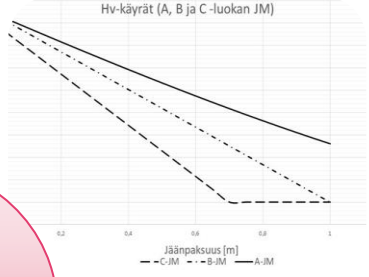
Collaborators

CHALMERS UNIVERSITY OF TECHNOLOGY · FMI · TALLINN UNIVERSITY OF TECHNOLOGY

Visualizing traffic



Ship ice interaction



Finnish Swedish Winter navigation system

Investigating Naturalistic Decision making

Operational optimization & decarbonization

Aalto University
School of Engineering

Our facilities

Main Research Facilities

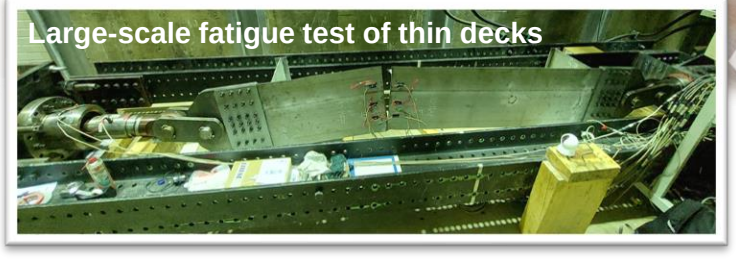
Aalto Ice and Wave Tank

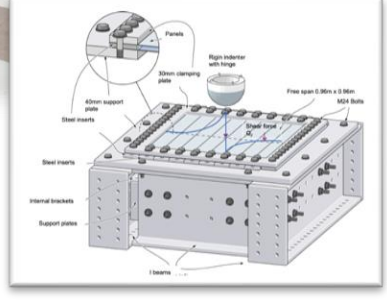
- Size: 40m x 40m x 2.8m
- Ice, wave, and open water test
- Reduced-scale tests with ships, marine and offshore structures

Autonomous Ship Scale Model

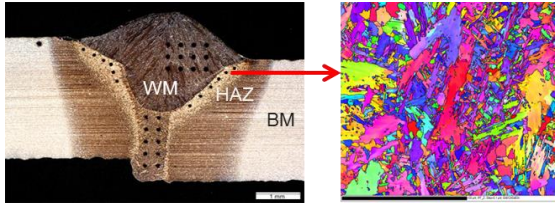
Main Research Facilities

Solid Mechanics laboratory

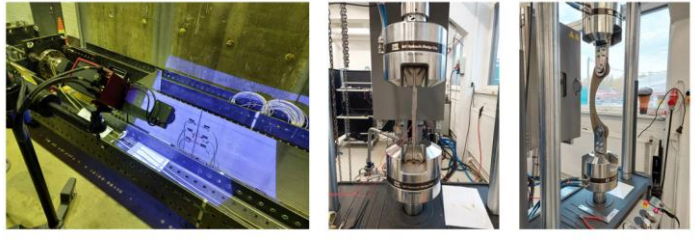


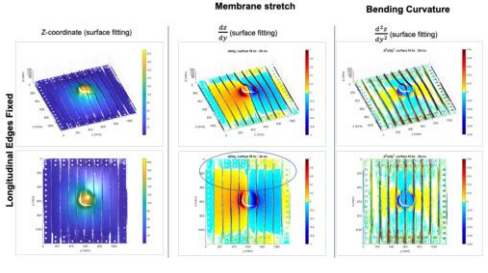


Material characterisation



Material, component and structural testing





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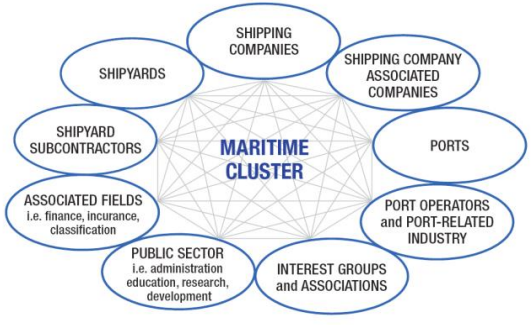
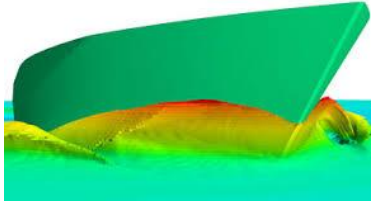
Impact

Finnish Maritime Cluster

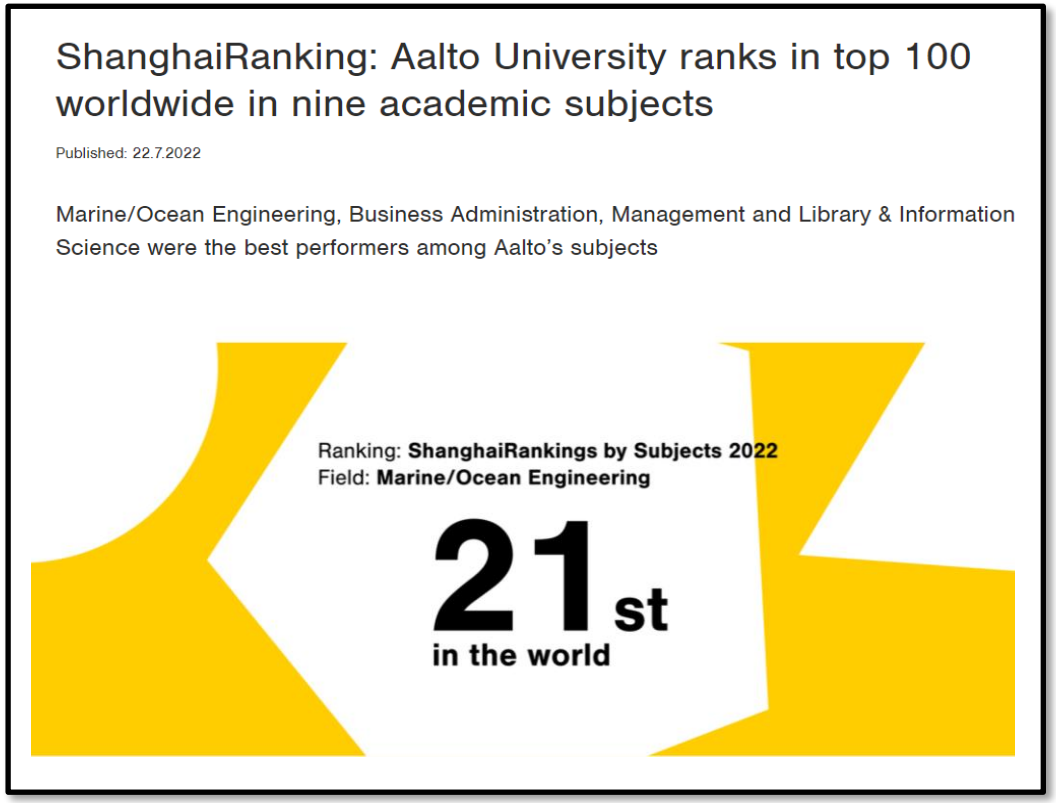
Competitiveness through Competence





Marine Technology Research at Aalto University

Shanghai ranking[1] in subject fields 2022



Top 50 research subject Fields in Finnish Universities in Shanghai Ranking 2022

Subject	University	Ranking
Marine/Ocean Engineering	Aalto	21
Business Administration	Aalto	24
Ecology	Helsinki	26
Dentistry & Oral Sciences	Helsinki	31
Geography	Helsinki	35
Athmospheric 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

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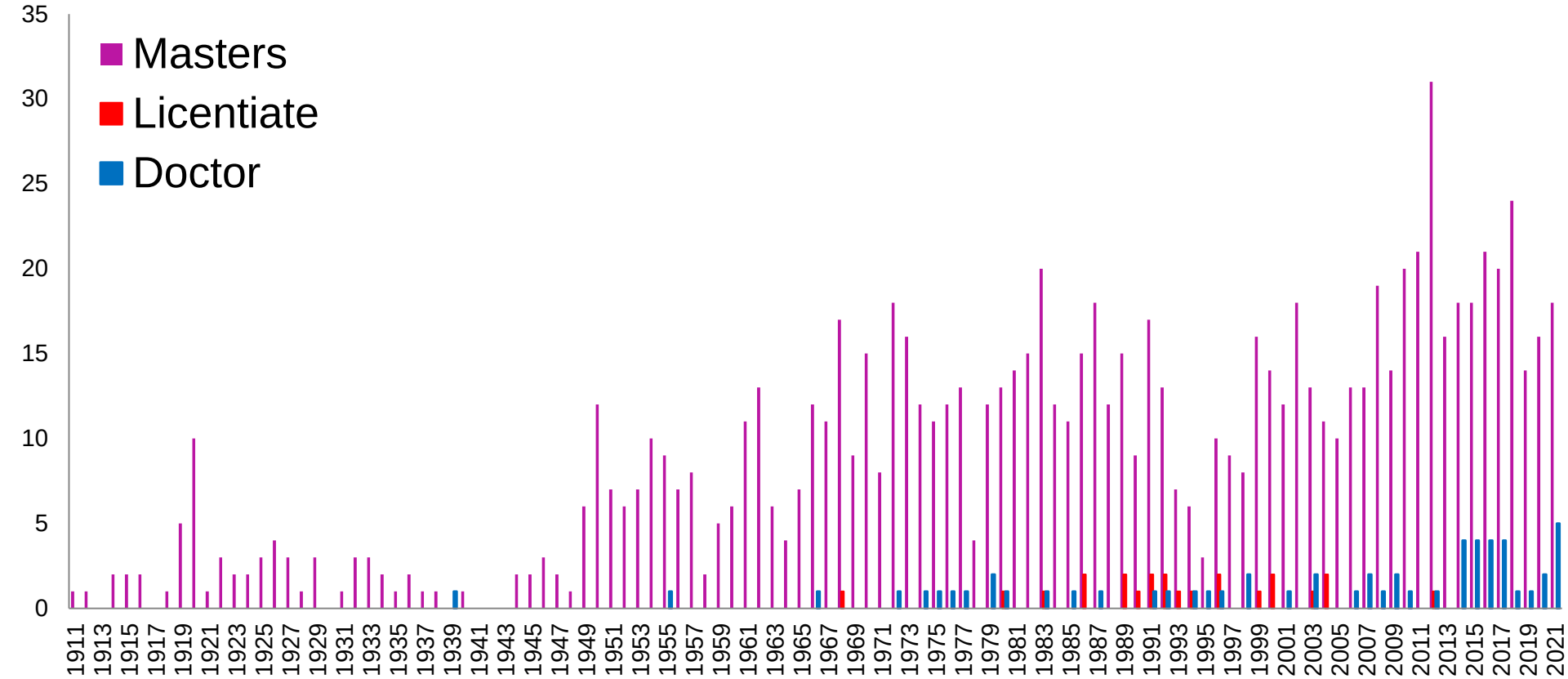
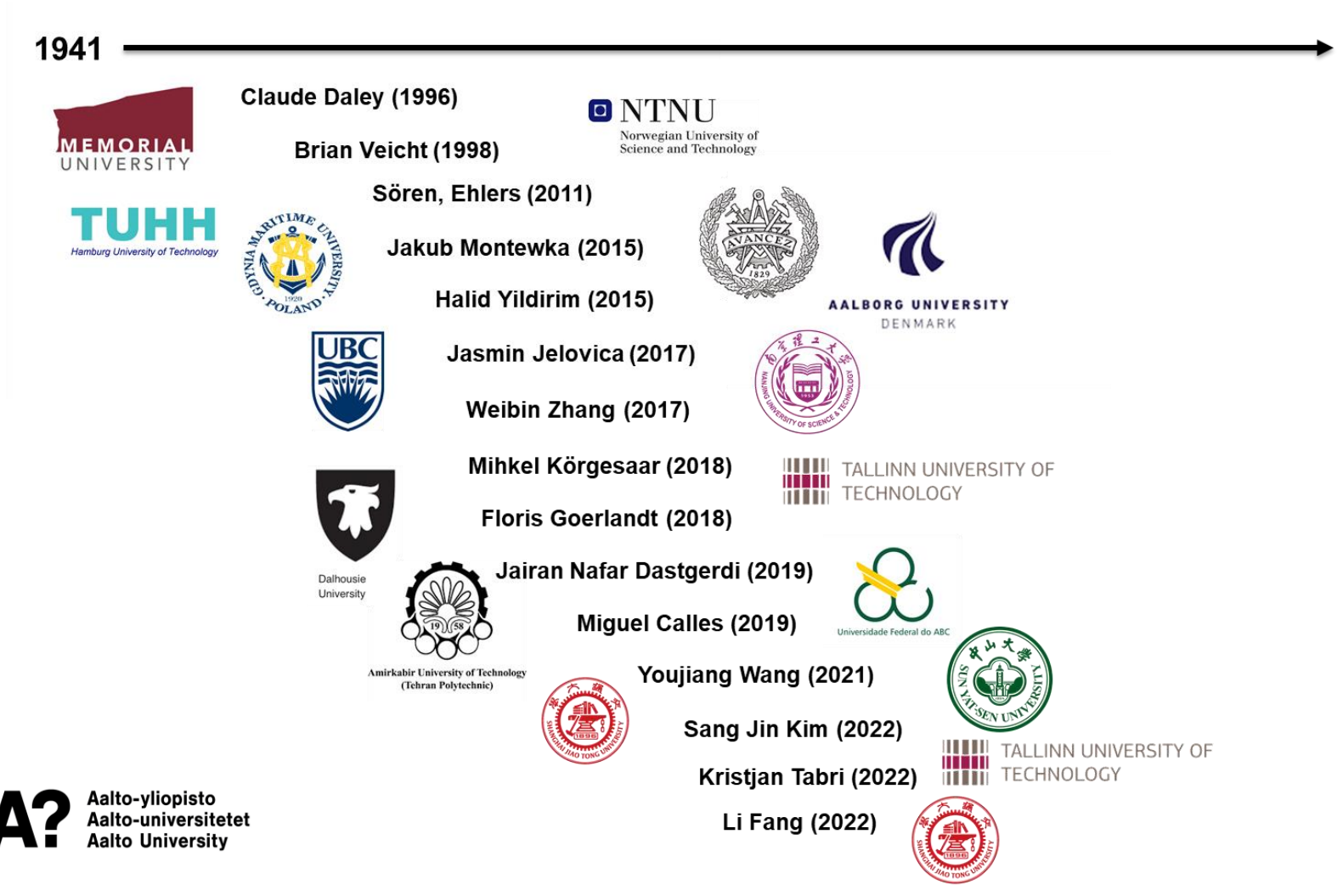
Aalto University

[1] *Shanghai ranking is one of the most appreciated academic rankings of world universities.*



Graduated Students

Professors to other universities



Alumni Excellences, Examples of Industry Leaders

Harri Kulovaara
Executive Vice President

Royal Caribbean International

Mika Heiskanen
VP, Newbuildings

Janne Lietzen
AVP, Newbuilding

MEYER WERFT PAPENBURG 1795

Ari Niemelä,
Dr,H.,C., Head of Department

Carnival

Bo-Erik Blomgvist
Senior Vice President

Helsinki Shipyard

Kim Salmi
Managing director

NAPA

Mikko Kuosa
President

ELOMATIC CONSULTING & ENGINEERING

Patrik Rautaheimo
Head of the Board

ABB

Sakari Sorsimo
Director of ABB Marine

Aker Arctic

Reko-Antti Suojanen
Managing director

FORESHIP AT THE SHARP END

Markus Aarnio
SVP

bluetech FINLAND

Anti Metsä
Managing director

ESL Shipping

Mikki Koskinen
Managing director

RMC

Timo Suistio
VP; Senior Advisor

Aalto-yliopisto
Aalto-universitetet
Aalto University

Aalto-yliopisto
Insinööritieteiden
korkeakoulu

Thanks for your kind attention!