Making Shipping Smarter
- Future Developments in Autonomous Shipping

Room B7.1

10:00 to 12:30
<table>
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<th>Title</th>
<th>Speaker</th>
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<td>1000: Autonomous ship research priorities in SINTEF.</td>
<td>Ørnulf Rødseth, Senior Research Scientist</td>
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<td>1020: Cost and benefits of autonomous ships in short sea transport</td>
<td>Håvard Nordahl, Research Scientist</td>
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<td>1040: Ship design aspects of autonomous and unmanned vessels.</td>
<td>Kourosh Koushan, Senior Adviser</td>
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<td>1100: Break</td>
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<td>1120: The model-simulation-experiment triangle: a new capacity in</td>
<td>Anders Valland, Research Manager</td>
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<td>hybrid marine power systems.</td>
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<td>1140: Development of a future marine energy system: Model centric</td>
<td>Kevin Koosup Yum, Research Scientist</td>
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<td>approach.</td>
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<td>1200: How to use CFD to cost-effectively reduce fuel consumption.</td>
<td>Anders Östman, Senior Research Scientist</td>
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From January 2017, a merger of:

- MARINTEK
- SINTEF Fisheries and Aquaculture
- SINTEF Environmental Technology

Not-for-profit, independent
Contract research
360 employees
Part of SINTEF, 2000 employees
Applied research, technology and innovation

Expertise from ocean space to outer space:

- Renewable energy
- Ocean space
- Industry
- Buildings and infrastructure
- Materials
- Micro-, nano- and biotechnology
- Climate and environment
- Oil and gas
- Health and welfare
- Society
- Digitalization
- Transport
Why autonomous ships?
Unmanned and Smart ships

"The smart ship"

More automation & decision support
Periodically unmanned bridge

Various special ships, like survey, small passenger ferries, military etc.

Small unmanned transport vessels
Larger, dedicated transport chains

Today's ships

"The unmanned ship"

The ships of the future
Unmanned gives the most interesting benefits

- No accommodation
- Less power
- More cargo

- No crew
- No crew related costs
- No safety equipment
- No voluntary speed loss
- New constructions

Enables completely new transport system concepts
Shore Control Centre (SCC) is normally needed

There is normally a human in the loop!
• Simplifies technology, increases safety and security
• Simplifies transitions from today's legislation to unmanned operation
• Keeps high value assets under close control
Defeats economy of scale
They can increase automation of processes and data: Better integration into supply chain

Ship and terminal operations

Connected and Automated Transport (CAT)
Applications being investigated now
Improving logistics systems

Reducing total logistics costs and environment impact:
- More flexible transport, smaller ports – more frequent
- Less storage in port, warehouse on ship, less cargo lifts
- Integrated logistics, ship is only one component
- More automation, less crew, less occupational hazards
New logistics systems – ASKO cargo ferry

• Connects storages at the opposite sides of the Oslo fiord
• Three "push-barges"
• One "push-tug"
• Parallel loading/unloading of one barge at the opposite sides all the time
Transfer cargo from road to waterborne

• More flexible transport systems
• Smaller, battery operated daughter vessels
• Higher frequency
• Towards door-to-door transportation
Yara Birkeland

- Yara fertilizer
- Kongsberg partner
- Replaces 40,000 truck trips a year

Features
- 100-150 TEU, 70 m x 15 m
- Batteries – Fully electrical

Staged implementation
- Manned after 1 year
- Remote after 2 year
- Autonomous after 3 year

Operational area
- Herøya-Brevik – 7 nm
- Herøya-Larvik – 30 nm
- Within Brevik VTS area
Autonomous highway car ferries
Better transport services in rural areas
Better utilization of inland waterways

EFRO: "Autonoom varen in de Westhoek"

Real life demonstration of the state-of-the-art equipment:
- Technical design
- Legal design
- Pilot demonstrations
Better use of urban waterways

• Avoid bridges
  • Blocks other ships
  • Costly

• Flexible and lower cost
  • On-demand operations
  • 24x7 operation without crew

• Environment
  • Battery operation
  • Silent, no congestion
  • Better use of infrastructure
Contributes to non-carbon transport solutions

Green energy generally have low energy density.

High energy efficiency is critical for use of the technology.

Small size ships also helps!

1 ton Li-Ion ~ 30 kg oil
6 liter $\text{H}_2$ (700 bar) ~ 1 liter oil
Further improve efficiency of ship transport

Aim is to make it 50% more effective by 2050
Deep sea is feasible, but not first mover?

- 10 000 TEU container vessel
- Shanghai – Los Angles
  - Two states involved
  - 6000 nm, open sea
  - No channels
  - Short port approach
  - Remote control to port
- Dual propulsion systems
- Two stroke diesels
- Biofuel, methanol ...

... but, autonomous ships are not conventional ships without crew.
Why now?
Remote controlled ships are not new!

Nikola Tesla 1898

Japan 1982-1988: Highly reliable intelligent ship project

Various papers in "Bulletin of the Society of Naval Architects of Japan", Vol 721-729
The fourth shipping revolution is on

1. Mechanized Power
2. Mass Production
3. Computerized Control
4. Shipping 4.0
Shipping 4.0 and game changers

Enabling technology

Technology with impact

Game changers
MUNIN: A concept study for a fully unmanned handymax dry bulk carrier on intercontinental voyage.

• Duration: 01.09-2012 – 31.08.2015
• Funding: 2.9 million EUR of budget 3.8 million EUR
• Activity code: SST.2012.5.2-5: E-guided vessels - the 'autonomous' ship

http://www.unmanned-ship.org/munin/
Followed by high interest and new concepts
Test area Trondheimsfjorden

• Established September 30th 2016
  • Industry, university, research
  • Port of Trondheim
  • Norwegian Maritime Administration
  • Norwegian Coastal Administration

• Area covers Trondheimsfjorden
  • Permits
  • Instrumentation and communication
  • Exchange of experience

http://navtar.no/
Norwegian Forum for Autonomous Ships

- Established October 4th 2016
- Operated as a joint industry project at SINTEF Ocean.
- General Manager is Mr. Ørnulf Jan Rødseth.
- A board of governors overseeing operations. General assembly approves budgets and strategies.
- 45 Institutional Members
  - Including Industry, authorities, class, insurance research, universities, ports ...
  - 2 other institutions as personal members

http://nfas.autonomous-ship.org
What are the limitations?
Unmanned ships come at a cost …

- More expensive sensors and control system – cyber security
- Unclear risk picture and higher safety requirements
- No crew onboard: No HFO, more redundancy, more costly maintenance

- Continuously manned shore control centre
- More and automated shore infrastructure
- Long time until international legislation is in place.
It rules out tramp/voyage charters!

Because:
- Needs special infrastructure in port
- Needs trained personnel
- Needs agreement with port state and port
- Modifying this type of ship is too expensive

However, these factors will change with time!
We need a good business case!

New logistics

Improved operations

Some reduced costs

More complex ship systems

Reliability: No maintenance on board

Shore Infrastructure
SINTEF Ocean's priorities
International networks

- International Network for Autonomous Ships (INAS)
- Norsk Forum for Autonome Skip (NFAS)

- UK Marine Industries Alliance
- OZT Study Group Japan
- ONE SEA (AUTONOMOUS MARITIME ECOSYSTEM)
- Korea Autonomous and Unmanned Ship Forum
- Systems and Components for Autonomous Ships - SCAS
- "Smart Ship Coalition" in the Great Lakes region in USA and Canada
- IMO scoping exercise correspondence group
- Strategic Transport Research and Innovation Agenda - STRIA

- ISO: Concepts and terminology for MASS
Participate in international developments

NFAS Norsk Forum for Autonome Skip

Consultancy, technical foresight, standards ...
International projects and networks

National projects
EU projects
International alliances
Technology development

Integrated ship control

Information modelling

Satellite communication
QoS

Technical and operational safety

Connected and Automated Transport

Digital Class and Administration

Cyber security

Together with other institutes in SINTEF.
Advanced automatic control

Exact ship control

Prediction of other ship behavior

Ship-ship and ship-port interaction
Concept analysis and early design

Iteratively look at the operational issues in the context of the system design and vice versa.

Risk reduction methods covering both operation and design.

Provide good quality estimates of feasibility and general system design.

Combined with operational simulations and CBA.
What's next?
International Network for Autonomous Ships

- Agreed on at meeting in Oslo Oct. 30th 2017
- Hosted by NFAS and SINTEF Ocean
- 22 participants at meeting
- 2 correspondent countries
- First inland meeting in Trondheim November 6-7

http://www.autonomous-ship.org/
The 1st International Conference on Maritime Autonomous Surface Ship (ICMASS 2018)

IMPORTANT DATES

September 1, 2018: are required to send an abstract (≤ 200 words, excluding author's name, affiliation, address, telephone number, email address, title of paper, and 5 key words) by this date. The abstract shall be submitted to leeki@kmou.ac.kr.

September 10: Acceptance notifications will be emailed by this date. If your paper is accepted, you have the opportunity to deliver a 20-minute presentation or prepare a poster.

September 30, 2018: Camera ready final papers (≤ 2 pages excluding references) must be submitted by this date.

November 8-9, 2018: ICMASS 2018 at Busan Exhibition and Convention Center (BEXCO), Busan, Republic of Korea.

www.icmass2018.org
SAVE THE DATE
THE INTERNATIONAL AUTONOMOUS SHIPPING SUMMIT
03 June 2019 | 10:00 - 18:00 | Clarion Hotel | The Hub | Oslo, Norway
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