AUTONOMOUS SHIPS IN NORWAY
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SINTEF: Scandinavia's largest independent not-for-profit research organization

- 2000 Employees
- 75 Nationalities
- 4000 Customers
- NOK 3.1 billion Revenues
- NOK 450 MILL International sales
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
Cooperation also in autonomous ship technology

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From January 2017, a merger of:

- MARINTEK
- SINTEF Fisheries and Aquaculture
- SINTEF Environmental Chemistry

Not-for-profit, independent
Contract research
360 employees
World leading ship laboratories

Ocean laboratory  Towing tank  Hybrid energy laboratory  Trondheim test area
SINTEF services within smart shipping

International cooperation and investigations

Maritime communication technology

Operational analysis and system design

Information models and management

Advanced automatic control

Laboratory tests
Some history, NFAS and INAS
Remote controlled ships are not new!

Nikola Tesla 1898

Japan 1982-1988: Highly reliable intelligent ship project
LP Odyssey (SeaLaunch)

In operation: 1999-2014
Unmanned and remote control during launch: Dynamic Positioning
Class: DNV-GL
Flag: Liberia

Photo: Frank Leuband/Wikimedia
The fourth shipping revolution is on

1. Mechanized Power
2. Mass Production
3. Computerized Control
4. Shipping 4.0
Development goals create new external forces
Ship transport: The life-blood of world trade

- 90% of world trade
- 90% of EU's external trade
- 90% of liquid fuel to EU
Increase automation of processes and data: Improved integration in supply chains
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
International Network for Autonomous Ships

- Agreed on at meeting in Oslo Oct. 30th 2017
- Hosted by NFAS and SINTEF Ocean
- 22 participants at meeting
- 12 countries now
- 3 organizations

http://www.autonomous-ship.org/
Why Norway?

Coast: 100 000 km
Mainland: 85 000 km
Sea border: 2650 km

A complete maritime cluster.

14% of value creation from businesses
38% of export (ex HC)

Still a big role in inland cargo transport – that needs to be increased
Autonomous or unmanned
Unmanned gives the most interesting benefits

- No accommodation
- Less power
- More cargo

- No safety equipment
- No voluntary speed loss
- New constructions

Enables completely new transport system concepts

- No crew
- No crew related costs
But higher automation also has value

1. Energy consumption – optimal transit and berthing
2. Less accidents and damage on infrastructure and ships
3. Operational costs for small vessels: Sleeping watch, generally reduced manning
4. Better working conditions
Unmanned and Smart ships

"The smart ship"

Periodically unmanned bridge

More automation & decision support

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

Small unmanned transport vessels

Larger, dedicated transport chains

The ships of the future

"The unmanned ship"

Today's ships
Normally not fully autonomous

1. **Operator controlled**: Decision support and advice to operator. Operator on controls.

2. **Automatic**: Automated operation – stop at deviation, continuous supervision.

3. **Constrained autonomous**: Autonomous, but defined limits on capabilities, supervision.

4. **Partly autonomous**: Autonomous to system's capabilities, (continuous?) supervision.

5. **Fully autonomous**: Autonomous and without supervision.
Human in the loop 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
Why unmanned and autonomous ships?
Unmanned ships come at a cost ...

- More expensive sensors and control system – cyber security
- Continuously manned shore control centre
- More and automated shore infrastructure
- Long time until international legislation is in place.
- No crew onboard: No HFO, more redundancy, more costly maintenance
- Unclear risk picture and higher safety requirements
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 sound business case!

- New logistics
- Improved operations
- Some reduced costs

More complex ship systems

Reliability: No maintenance on board

Shore Infrastructure
Can defeat economy of scale

Enables completely new transport system concepts
Create new 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
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 ~ 40 kg oil

6 liter $H_2$ (700 bar) ~ 1 liter oil
Further improve efficiency of ship transport

- Lower weight: 700 – 1000 tons
- Wind resistance: ~ 1% savings
- No hotel load: 200 – 270 kW
- Lower speed?
- Nominal engine effect: ca. 4 MW

20 000 dwt: "Easy" savings: 10-15%
Transfer cargo from road to waterborne

• More flexible transport systems
• Smaller, battery operated daughter vessels
• Higher frequency
• Towards door-to-door transportation
Some cases.
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
New logistics systems – ASKO cargo ferry

• Connects storages at the opposite sides of the Oslo fiord
• Two-three barges
• Parallel loading/unloading of one barge at the opposite sides all the time
Shuttle-ship distributes containers in fjords

Short distances – electric
Sheltered waters
Faster coastal trade
Closer to end users
Autonomous Ship Transport of lumber, gravel and other bulk products

- Low cost: Wait in port, reduce storage and lifts
- Batteries
- Cargo handling TBD
Autonomous highway car ferries
Better transport services in rural areas
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
Deep sea is feasible, but not first mover?

- 10,000 TEU container vessel
- Shanghai – Los Angeles
  - 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.
Efficiency of port call

Calls at large EU terminal 2014/15, n=697
How to rethink pricing at container terminals
By Timo Glave and Steve Saxon
McKinsey&Company
Conclusions

• The time seems to be right for autonomous ships
• They will change transport systems
• Development of autonomous ships is an important strategic area in Norway
• SINTEF aims to be the leading technical R&D institute in this area