SINTEF Ocean

From January 2017, a merger of:
- MARINTEK
- SINTEF Fisheries and Aquaculture
- SINTEF Environmental Chemistry

Not-for-profit, independent
Contract research
360 employees
Scandinavia's largest independent research organization

- 2000 Employees
- 75 Nationalities
- 4000 Customers
- USD 390 million Revenues
- USD 60 million 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
The fourth shipping revolution is on

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

Possible **game changers** in Shipping 4.0:

- Digitalization of commercial shipping processes
- Autonomous and unmanned ships
Autonomous ships in Norway
Why autonomous ships?

- Less dangerous exposure for crew
- Less damage related costs
- Fewer large oil spills
- Lower costs?
- Lower emissions
- New ship types
# Types of autonomous ships – manning levels

## Autonomy Assisted
- **Bridge**: AAB

## Periodically Unmanned
- **Bridge**: PUB
- **Ship**: PUS

## Continuously Unmanned
- **Ship**: CUS

### Maritime Autonomous Surface Ship
- **Ship**: MASS

### Autonomous Surface Vehicles
- **Vehicle**: USV (Small)

## Table: Ship types

<table>
<thead>
<tr>
<th>Ship type</th>
<th>Always on Bridge</th>
<th>Available on Ship</th>
<th>Never on Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAB</td>
<td>✗</td>
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<tr>
<td>PUB</td>
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</table>
Completely unmanned gives largest benefits!

- No accommodation
- Less power
- More cargo

- No crew
- No crew related costs

Enables completely new ship concepts

- No safety equipment
- New constructions

NCE Maritime Clean Tech & NCL
A Shore Control Centre (SCC) is normally needed
Operational autonomy levels

- Decision support
- Automatic
- Constrained autonomy
- Full autonomy (X)
Why Norway?

- Coast: 100,000 km
- Mainland: 85,000 km
- Sea border: 2,650 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.
Why not unmanned ships?
More advanced and expensive control systems

New detectors in IR and daylight video.
Improved radars.

Sensor fusion and classification: AIS, Radar and video.

General ship system redundancy and communication systems integration.
Hostile (cyber) attacks

- Terrorist hijack e.g. by GPS spoofing

Pirate attack

- Communication system attacks

Governmental backdoor

No one to ransom, difficult to steal
Stowaways is a problem!
Legal and liability issues

- UNCLOS
- SOLAS
- Contracts
- Insurance
- Liability

Easier to do this in national waters.
"Autonomy assisted accidents"

First radar assisted collision: Andrea Doria and Stockholm off Nantucket in 1956

Some new accidents are probably unavoidable. Question is the totality!
No maintenance on board

Minimize systems onboard

Redundancy

No heavy fuel oil
New infrastructure on shore

- Shore control, VTS interface
- Tugs, docking, mooring
- Loading and discharge of cargo
Cost-benefit

- No hotel
- No crew
- Improved efficiency
- Less off-hire
- New business model

- Dual propulsion, no HFO
- Shore Control Centre
- Longer dockings
- Costlier instruments
- Existing business model
So, what is going on?
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/
NTNU AMOS

• Supported by Norwegian Research Council
• Norwegian "Centre of Excellence"
• Established 2013
• Planned for 10 years
• Total budget approx. EUR 80 million

https://www.ntnu.edu/amos
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.
- 40 Institutional Members
  - Including Industry, authorities, class, insurance research, universities, ports ...
  - 2 other institutions as personal members

http://nfas.autonomous-ship.org
Norwegian authorities are positive
Some ongoing projects
Yara Birkeland

- Yara fertilizer
- Kongsberg partner
- Replaces 40,000 truck trips a year
Autonomous Ship Transport at Trondheimsfjorden (ASTAT)

- Short voyages
- 12-50 TEU
- Inland, fjords/sheltered
- Low cost: Wait in port
- Legs 4-12 hours
- Port cranes
- Automated berthing
- Batteries
Milli-Ampere

- On-demand passenger ferry
- Max 12 persons + bicycles
- Electrical propulsion, battery
- Inductive charging at quay

Linking center of Trondheim to seaside and rail station
GREEN COASTAL SHIPPING PROGRAMME
Pilot 8: AUTONOMOUS COASTAL CONTAINER FEEDER

Operational area

Vessel
Plug in hybrid.
Battery powered during normal operation.
Speed: 12 kts
Operational range: 100nm
Capacity: 100 TEU
1300 DWT
LOA: 60 m
Hrónn: Unmanned offshore vessel

- Light-duty, offshore utility ship
- Commissioned in 2017, in operation 2018
- Initially for man in the loop applications
- Tested in Trondjemsfjorden test area
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.
External factors may help!

Subsidies: NOx-fund

Public infrastructure investments

International legislation

Regional restrictions: HFO in Arctic

Green businesses

Black swans: Cost of new energy carriers
International activities
National and international strategy
International Forum for Autonomous Ships

- Agreed on at meeting in Oslo Oct. 30th 2017
- Hosted by NFAS and SINTEF Ocean
- 22 participants at meeting
- Two more correspondents
Bilateral agreements

Research project on test area development
• April 1st 2017 to December 31st 2019
• SINTEF Ocean + KMOU + ETRI
• Funded by Korea

Memorandum of Understanding signed 21st October 2017:
• Conference Of Great Lakes And St. Lawrence Governors And Premiers
• The Marine Autonomy Coalition
• NFAS
Conclusions

• Shipping 4.0 is possible game changer in autonomy and digitalization.
• Autonomous ships is an important strategic area in Norway and SINTEF Ocean.
• Unmanned ships are “constrained autonomous”
• International cooperation is required and ongoing!
Technology for a better society