AUTONOMOUS SHIPPING PROJECTS IN NORWAY
UNECE, FEBRUARY 12TH 2018

Ørnulf Jan Rødseth, Senior Scientist
What is an autonomous and unmanned ship?
**Autonomy**: Operational Design Domain – ODD, Dynamic Navigation Task – DNT

- Operator Exclusive DNT
- Control System DNT
- Operational Design Domain - ODD
- DNT Fallback

Derived from SAE J3016
Main autonomy levels

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

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

3. **Partly autonomous**: Autonomous for certain operations, supervision.

4. **Constrained autonomous**: Autonomous, but limit on response, continuous supervision.

4. **Fully autonomous**: Autonomous and without supervision.
Unmanned ships

<table>
<thead>
<tr>
<th>Ship type / Crew</th>
<th>Always on Bridge</th>
<th>Available on Ship</th>
<th>Never on Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAB</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PUB</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>PUS</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>CUB</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>CUS</td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
Shore Control Centre (SCC) is normally used

- There is normally a human in the loop!
  - Simplifies technology, increases safety and security
  - Simplifies transitions from today's legislation to unmanned operation
# Autonomy vs. unmanned

<table>
<thead>
<tr>
<th></th>
<th>Operator controlled</th>
<th>Automatic</th>
<th>Partly autonomous</th>
<th>Constrained autonomy</th>
<th>Fully autonomous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crew at bridge at all times</td>
<td>Χ</td>
<td>Χ</td>
<td>Χ</td>
<td>Χ</td>
<td>Χ</td>
</tr>
<tr>
<td>Unmanned bridge, crew on ship, shore control</td>
<td>Χ</td>
<td>Χ</td>
<td>Χ</td>
<td>Χ</td>
<td>Χ</td>
</tr>
<tr>
<td>Unmanned bridge, crew on ship, no shore control</td>
<td></td>
<td></td>
<td>Χ</td>
<td></td>
<td>Χ</td>
</tr>
<tr>
<td>Unmanned, shore control</td>
<td>Χ</td>
<td>Χ</td>
<td>Χ</td>
<td>Χ</td>
<td>Χ</td>
</tr>
<tr>
<td>Fully unmanned, no shore control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>?</td>
</tr>
</tbody>
</table>
Why autonomous ships in Norway
Technical benefits

Automate operations that computers do better: 3D

Lower emissions
Defeat economy of scale

Cost in [EUR/cubic] as a function of ship freight capacity

Illustration: soerfm@wikimedia.commons
Completely unmanned gives largest benefits!

No accommodation
Less power
More cargo

No crew
No crew related costs

Enables completely new **transport system** concepts

No safety equipment
New constructions

---

*Source: SINTEF*
Why Norway?

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

A complete maritime cluster.

Still a big role in inland cargo transport – that needs to be increased

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

- More expensive sensor and ICT
- Extensive cyber security
- Legal and liability
- Stricter safety
- No intervention onboard
- Shore infrastructure
We need a sound business case!

New logistics

Improved operations

Some reduced costs

More complex ship systems

Reliability: No maintenance on board

Shore Infrastructure
Main application areas
Yara Birkeland

- Yara fertilizer
- Kongsberg partner
- Replaces 40,000 truck trips a year
Milli-Ampere – urban waterway

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

Linking center of Trondheim to seaside and rail station
Hrönn: Unmanned offshore service vessel

- Light-duty, offshore utility ship
- Commissioned in 2017, in operation 2018
- Initially for man in the loop applications
- Will be tested in Trondjemsfjorden test area
Automated highway ferries
High interest in Norway
Norwegian authorities are very supportive
Supported by research council

MAROFF-2: 19 new projects
NOK 157,8 million has been allocated as a result of the call for proposals with deadline 11.10.2017.

Title of call for proposals: Innvil 120 millioner til Innovasjonsprosjekter i næringslivet, for maritim sektor

MAROFF-2: 3 new projects
NOK 29,7 million has been allocated as a result of the call for proposals with deadline 6.9.2017.

Title of call for proposals: Innvil 50 millioner til Forskerprosjekter for utvikling av autonome og fjerntyrte fartøy

MAROFF-2: 3 new projects
NOK 42,9 million has been allocated as a result of the call for proposals with deadline 6.9.2017.

Title of call for proposals: Innvil 70 millioner til forskning i maritim sektor - kompetanseprosjekter for næringslivet
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.
- 43 Institutional Members
  - Including Industry, authorities, class, insurance research, universities, ports ...
  - 2 other institutions as personal members

NFAS  Norsk Forum for Autonome Skip

http://nfas.autonomous-ship.org
Test area developments

- Trondheimfjorden, Storfjorden and Horten are established
- Grenland to be announced 2018
- Tromsø possible 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
Conclusions

- Unmanned ships will mostly be “constrained autonomous”
- Autonomous ships is an important strategic area in Norway.
- Autonomous ships will be a game changer and create new business models.
- International cooperation is needed.
Technology for a better society