At least as safe as manned shipping?
Autonomous shipping, safety and “human error”

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The first autonomous ship accident
Tarnfjord, Tarnfjord this is Brevik VTS on channel 16. Have you seen the overturned kayak ahead of you?

Brevik VTS, this is Tarnfjord. We are slowing down and holding to port. We should manage to avoid the kayak. But we cannot reverse. And we will have close call with Yara!
Yara remote control, are you following what is happening in the Brevik strait?

Yara remote control, this is Brevik VTS on channel 16. Please respond Yara!!

Brevik VTS, this is Yara. Did you call me? I had a coffee break..
Thank you, Yara!

Stop immediately! can’t you see the kayak in front of you

What the hell is the tanker doing!!

No, the sun is completely blinding both my cameras and on the radar I only see the bridge
Yara Birkeland Operation

Operational area
- Herøya-Brevik – 7 nm
- Herøya-Larvik – 30 nm
- Whitin Brevik VTS area

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

Staged implementation
- Manned the 1st year
- Remote the 2nd year
- Autonomous after 3 year
Shipping 4.0

- Internet of Services at Sea
- Simulation and Optimization
- Augmented reality
- Data Analytics
- Internet of Things at Sea
- Robotics and Autonomy
- Cyber Security
- Open system integration
- Cyber-physical systems
- Computation
- Cyber Security

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What is autonomy?

Dependent on:

- Complexity
- Manning level on ship and shore.
- Automation level (on ship and shore).
- What function(s) are automated.
- Voyage phase.
Maritime safety through time

<table>
<thead>
<tr>
<th>Year</th>
<th>number of ships</th>
<th>totally lost per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>225</td>
<td>225</td>
</tr>
<tr>
<td>1996</td>
<td>12 000</td>
<td>150</td>
</tr>
<tr>
<td>2016</td>
<td>33 000</td>
<td>33</td>
</tr>
</tbody>
</table>

Source: UNCTAD 2017

Source: LMIU, losses as reported in Lloyds List
Maritime safety today

Accident causes 2012-2016 (IUMI 2017)

- 50% weather
- 20% grounded
- 10% fire or explosion
- 10% machine failure
- 5% collision
Maritime safety today

A study of 6091 major accident claims (Dhillon 2007)

• 62% of the claims were attributable to “human error”
• «Human error» contributed
  • 84-88% of tanker accidents
  • 79% of towing vessel groundings

Over 80% of marine accidents are caused or influenced by human and organization factors.

«Human error» contributes to 89–96% of ship collisions.
Example

Source: UK MAIB 2016
What is «human error»?

“human error” is not a cause but a result of other factors such as poor design, poor planning, poor procedures, etc.

• “Human variability”
Can automation increase safety?

Why automation can make ships safer

- Decline in accidents due to more robust and reliable systems:
  - Dynamic positioning, satellite based navigation, autopilot, track pilot and other technologies
- Automation address human shortcomings like:
  - Fatigue, attention span, information overload / underload, normality bias etc.
Can automation increase safety?

Why automation can make ships less safe

– Automation needs to be programmed and can therefore only solve simple or complicated problems → challenging in a complex maritime environment
– Moving «human error» to other parts of the system: design, monitoring, maintenance etc.
– What about «human recoveries», near accidents averted by crew?
Example of near accident averted by crew

M/T Tarnfjord
- 18 crew
- 20,000 tons of gasoline
- GT: 12,926 tons
- 165 m

M/S Wellamo
- 1000 passengers and crew
- GT: 20,581 tons
- 168 m

Source: SHK 1992
Source: www.shipspotting.com
The new risk picture!

Today's incidents in shipping

- Incidents averted by automation
- New incidents caused by technology
- Incidents averted by AI after time

Incidents today averted by crew

Improvements in automatic ship

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Conclusion

Will autonomous shipping be at least as safe as traditional manned shipping?

→ Todays risk picture vs the autonomous risk picture

- Unknown size of the bubbles to the right.
- Will the net result be low enough for societal acceptance of the new ship types?
- Constrained autonomy: remember the human in the loop!
- New types of risk analysis to address the new risk picture:
  - human centred risk analysis, use of dynamic risk assessment, and other real time tools that can be used on the ship or in the shore control centre.