Exploiting automation and autonomy in the maritime domain: Challenges and benefits

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How will the maritime industry prove and assure adequate safety

04 Towards the future of EU Short Sea Shipping

What solutions are being developed - The MOSES project
Snapshots from the future
Developments in Maritime Autonomy (EU)

- **2012**: MUNIN - Critical design factors
- **2013**: DNVGL - ReVolt - Concept Study
- **2017**: Svitzer Hermod - Remote Control
- **2018**: AUTOSHIP - > TRL7 remote and autonomous vessels
- **2019**: Yara Birkeland Falco Demo - Aim at large-scale operation
- **2020**: MOSES, AEGIS - Autonomous Short Sea Shipping
- **> 2025**: Autonomous Ships - Large scale operation
Developments in Maritime Autonomy

Maritime Autonomous Surface Ship “MASS” is defined as a ship which, to a varying degree, can operate independent of human interaction. (MSC. 100/5)

Degrees of automation and human presence (MSC 101/5/4)

1: Ship with automated processes and decision support
2: Remotely controlled ship with seafarers on board
3: Remotely controlled ship without seafarers on board
4: Fully autonomous ship

Automation:
the implementation of processes by automatic means, under specified conditions can function without human intervention

Autonomous ship:
uses automation to operate without human intervention (on one or more ship processes), for the full duration or in limited periods of the ship's operations or voyage

Crewless ship:
a ship with no crew on board

- MSC 102/5/18 (2020)
Problems addressed

MASS is an entirely new design, not just a conventional ship without a crew!

58% (EMSA, 2018) to 75% (Allianz, 2017) of marine accidents are caused by human error.
The necessary measures for dealing with the COVID-19 pandemic has disrupted many “normal” functionalities.

The maritime industry is faced with the related Crew Change Crisis.

Autonomous ship concepts may be a viable/sustainable way forward...
Challenges – Emerging risks

- Increased complexity
- Differentiated role for the human element

\[ \text{Safety Assurance?} \]

- Automation bias, over-reliance on automation
- Information overload, reduction of vigilance
- Communication latency
- Erroneous prediction of the behaviour of ships with varying levels of autonomy (Ahvenjärvi, 2016)

Source: Porathe et al. (2018)
Challenges – Emerging risks

• Operational risk **not managed** by crew

• New interactions may result in **new hazards**
  - (unmanned ship in relation to Shore Control – imagine what could happen with a ship with advanced AI!)

• New interactions between manned and unmanned ships (**mixed traffic**)

• Human in the loop (HITL)

<table>
<thead>
<tr>
<th>AL3</th>
<th>‘Active’ Human in the loop</th>
<th>Decisions and actions are performed with human supervision. Data may be provided by systems on or off-board.</th>
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<tbody>
<tr>
<td>AL4</td>
<td>Human in the loop, Operator/Supervisory</td>
<td>Decisions and actions are performed autonomously with human supervision. High impact decisions are implemented in a way to give human Operators the opportunity to intercede and over-ride.</td>
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Autonomy Levels (AL) proposed by Lloyds Register (IMO MSC 99/55/6)
New era for safety

Beyond traditional safety assessment

• Simulation-based safety
• Digital twin
New era for safety

Life Cycle Safety Management

• Risk management conducted in design and throughout operational phases

• Are new approaches needed to address emerging risks?

Bio-inspired


The future of MASS

• Safety assurance affects the public’s perception of risk
• Adoption from ship owners and operators will depend on the strength of the business cases, to justify making such investments
• Development of international regulatory framework
• New FSAs?

**IMO Regulatory Scoping Exercise**

**Target:** consider whether international conventions require amendments to enable the safe and secure use of MASS
The future of MASS

**Strengths**
- Optimized route by default
- Improved logistics
- Safer
- Seafarers can go home after their shift
- Can be more reliable with less errors
- No costly crew exchanges, no wasted crew time onboard
- More sustainable, increasing longevity

**Weaknesses**
- Fully autonomous ships cannot assist other ships in emergencies
- Lack of tripartite social-economic dialogue
- Lack of global-scale, international coordination
- Very little advertising of such projects
- Significantly reduced possibility for machinery failure mitigation
- Poor business case

**Opportunities**
- Other ship designs possible
- Strengthened multimodality
- Creating new maritime career paths
- Parallel revolution in automotive industry leads to knowledge exchange
- Incorporation of tech for greener fuels
- Improve working conditions for seafarers

**Threats**
- Lack of standardization from manufacturers
- Only ports which adapt accept autonomous ships
- Legal implications/ Lack of common framework
- Lack of demand from major ship operators
- Lack of reliability of machinery equipment
- Public trust in automation
- Assure operational safety level

Adapted from 2nd International Ship Autonomy and Sustainability Summit (Nov. 2020)
The case for Short Sea Shipping (SSS):

- Trade between a relatively limited number of ports
- National authorities can approve the use of the technology within national waters and ports
- Infrastructure needs are limited compared to larger vessels
- The market for SSS vessels can justify large scale investments for equipment providers

The most promising candidate for early adoption of autonomous applications is liner shipping operations – SSS.

(Rødseth 2017)
The MOSES Project

Automated Vessels and Supply Chain Optimisation for Sustainable Short Sea Shipping

MOSES aims to significantly enhance the SSS component of the European container supply chain, following a two-fold strategy:

i) reducing the time to berth for deep sea shipping ports,

ii) stimulating the use of SSS feeder services to small ports with limited or no infrastructure.

This project has received funding from the European Union’s horizon 2020 research and innovation programme under grant agreement No. 861678.

• 17 expert partners throughout Europe
• Budget: EUR 8,1m
• 36 months (2020 – 2023)
More containers globally need to be transported. Larger container ships bring more cargo to terminals that need to be transshipped to the hinterland. Island ports with no infrastructure are usually serviced by trucks on Ro-Pax Ferries. This leads to congestion from heavy container truck traffic. Large and more container ships also lead to adverse consequences in terms of safety.
MOSES Challenges

Short Sea Shipping to small ports with no cargo handling infrastructure could provide an alternative to land-based transshipment

This potential is mostly untapped, because
- existing feeders cannot be served by small ports
- there is little incentive for carriers to choose maritime transport instead of road/rail modes.

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The case of a European Archipelago
MOSES will create **new pathways** in the EU container supply chain by **integrating small ports** with no infrastructure into the EU container supply chain.
MOSES wants to take container cargo directly from large container terminals...
The case of a European Archipelago

To small ports via Short Sea Shipping feeders
The MOSES Concept
The MOSES Concept

Innovative Feeder
Concept design, feasibility for autonomous operation

AutoDock
Autonomous Tugboat swarm collaborating with automated mooring

Robotic Container Handling System
Automated infrastructure

Matchmaking Platform
Matching demand and supply of cargo

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A large containership approaches a container terminal
MOSES Impact on sustainable SSS

Autonomous Tugboat swarm collaborating with automated mooring

Safety
- Minimize human error in towing
- Reduce accident during berthing

Environment
- Reduce air emissions, tugs will use electric propulsion

Efficiency
- Reduced time to berth
- More reliable towing services
- Increase service availability

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MOSES Impact on sustainable SSS

**Innovative feeder with robotic container-handling system**

**Safety**
- Minimize risk in cargo handling

**Environment**
- Green propulsion technologies
- Reduce total emissions/TEU
- Reduce road congestion in port areas

**Efficiency**
- Delivering cargo where no infrastructure is available
MOSES Impact on sustainable SSS

Matchmaking platform

Environment
Promote environmentally-friendlier alternative to land-based transshipment

Efficiency
Ensure viability of SSS services based on innovative feeder
Increase freight using SSS
## MOSES Stakeholder Needs (ind.)

### Environment
- Investigate deeper into zero-emissions possibilities, including any market-related aspects.
- Other environmental aspects should be considered, such as noise footprint.

### Automation
- Clear terminology about the level of automation/autonomy.
- Determine which functions will be automated.
- Impact of automation on existing port operations and competencies of port workers.
Innovative feeder / Sea passage (autonomous navigation)
MOSES – Towards the future of SSS

Automated technologies/processes
Autonomous operation

Safety + Efficiency

Sustainable SSS feeder services to small (and remote) ports without infrastructure
Special thanks to my student
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Thank you very much for your attention!

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