Will the seas of the future be dominated by autonomous ships?

Konstantinos Louzis
PhD Candidate, Researcher, NTUA
Maritime industry and automation

“ [...] the more advanced a control system is, so the more crucial may be the contribution of the human operator”

(Bainbridge, 1983)

“Automation changes the task it was meant to support; it creates new error pathways, shifts consequences of error further into the future and delays opportunities for error detection and recovery.”

(Lützhöft and Dekker, 2002)
What is an autonomous ship anyway?

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)
Where are we with autonomous ships?

- **DNVGL - ReVolt Concept Study**
- **Svitzer Hermod Remote Control**
- **Falco Demo** Aim at large-scale operation
- **Autonomous Short Sea Shipping**
- **Yara Birkeland** Starts manned operation
- **Zhi fei** Autonomous container feeder
- **Mayflower** Completes trans-Atlantic crossing
- **Sunflower Shiretoko** 750 km autonomous sailing

Critical design factors
Why do we need autonomous ships?

58% (EMSA, 2018) to 75% (Allianz, 2017) of marine accidents are caused by human error.

Initially, autonomous ships would be meant to reduce these accidents.
Should all ships be autonomous?

- **Payload type**
  - Containers, Oil and chemicals, Bulk, People
  - Liner shipping
  - Tramp shipping
- **Trading pattern**
  - Predictability
  - Public acceptance
- **Size**
  - Waterway safety
- **Area of operation**
  - Need for human mitigation
  - Open sea, Short Sea
  - Shipping, Coastal, Inland
  - Large ships
  - Small ships
Should all ships be autonomous?

- Short Sea Shipping
- Port tugboat ops.
- Inland Waterways
- Maritime Drones
- Urban Transport
Risk and autonomous ships

Perceived safety is one of the most significant concerns and is inversely proportional to autonomy levels!

Survey for autonomous urban ferries (Goerlandt and Pulsifer, 2022)

Identifying (credible) accident scenarios

Causes ➔ Hazardous events ➔ Accident ➔ Loss

Risk as the expected consequences

\[ R = \langle s_i, p_i, x_i \rangle \]

Where \( s_i \): scenario description, \( p_i \): scenario probability, \( x_i \): consequence of scenario

(Kaplan and Garrick, 1981)
Risk and autonomous ships

Conventional and autonomous ships may not be exposed to the same risks!

*(Ventikos and Louzis, 2019)*

### Known-Knowns

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<thead>
<tr>
<th>Known-Knowns</th>
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<tbody>
<tr>
<td>How fires on ships develop</td>
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<td>Factors that affect grounding accidents</td>
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### Unknown-Knowns

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<td>Mixed traffic interactions</td>
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<td>Response capacity of remote operators (complacency)</td>
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### Known-Unknowns

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<td>How routine maintenance will be conducted without crew onboard</td>
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### Unknown-Unknowns

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<td>Risks we cannot yet imagine!</td>
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Experience from other industries (e.g. automotive, aviation, nuclear)
We cannot only rely on trying to identify scenarios for accidents that have not yet happened!

**Complexity**
Affects how failures develop into accidents

**Environment**
An autonomous ship is part of a system with which it interacts

**Human Involvement**
Autonomous ships will have to collaborate with humans and share risk awareness

**Data and knowledge**
- Assess risk based on how the system works, not only by how it fails
- Go beyond calculating accident probabilities
Will the seas of the future be dominated by autonomous ships?

Most likely no...the consensus is that autonomy will be application-specific, but in any case it needs to be safe!
Thank you very much for your attention!

Konstantinos Louzis
PhD Candidate, Researcher, NTUA
klouzis@mail.ntua.gr
Thank you for your attention!

If you have any questions or require further information, please contact us:

Prof. Nikolaos P. Ventikos  
National and Technical University of Athens-NTUA  
National Technical University Campus  
School of Naval Architecture and Marine Engineering, Office Γ.304  
9, Iroon Politechniou Str.  
GR-15773, Zografou Athens. GREECE  
Tel: +30 2107723563  
email: niven@deslab.ntua.gr, mosesproject20@gmail.com.