Life cycle risk dynamics for marine systems: A description of a bio-inspired framework for risk fluctuations throughout the life cycle

4th MSSS Conference 2020

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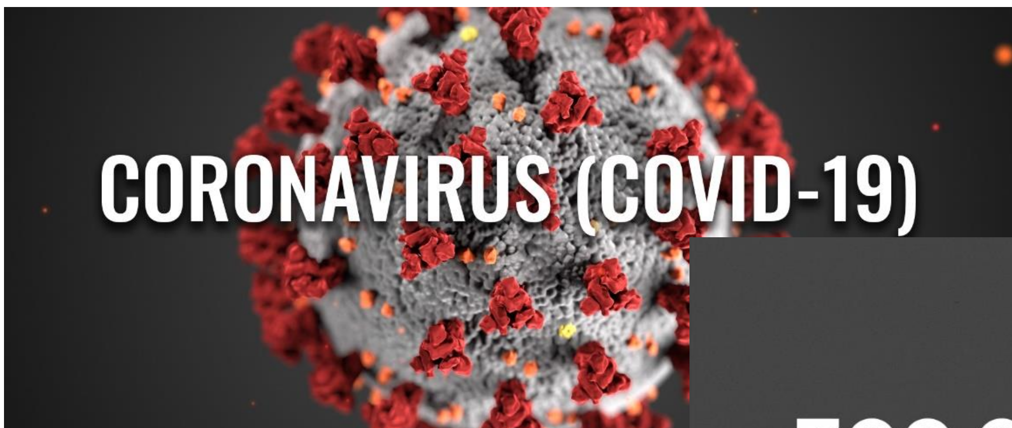
The world is experiencing change

- 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**



Source: ITF Seafarers

The world is experiencing change

- Start rethinking what is **the best way for “doing business”**?
- Maybe autonomous ship concepts will be a **viable/sustainable way forward**…

In this context of uncertainty, we would like to share our thoughts on how we believe risks should be managed in the future!

What is this presentation about?

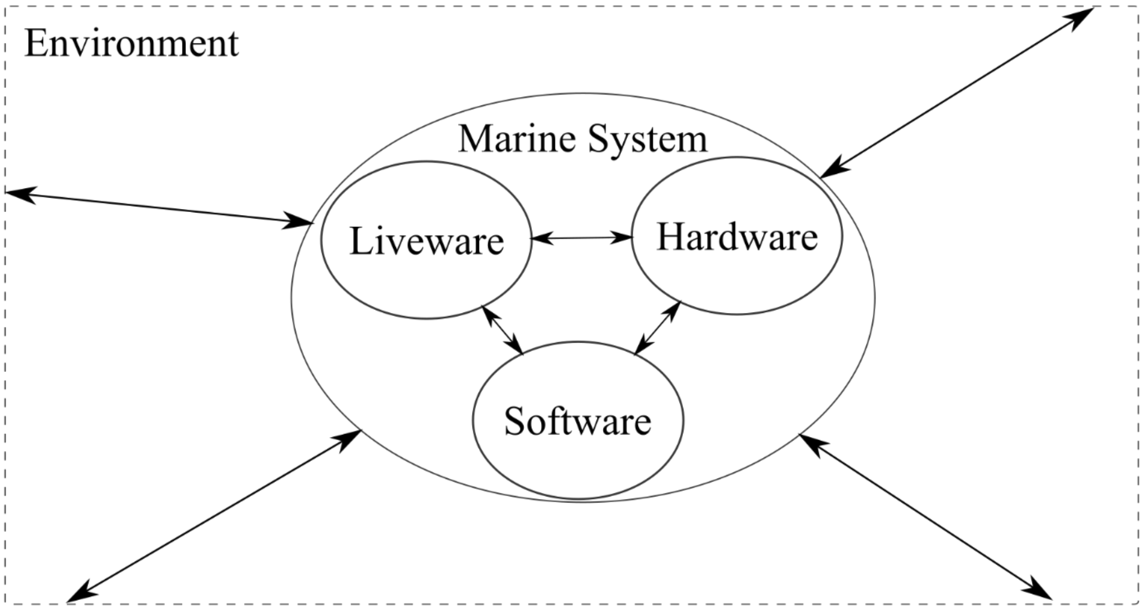
A descriptive framework for risk fluctuations throughout the life cycle of marine systems

(see also Ventikos and Louzis, 2018; 2019)

Objective	Describe **risk fluctuations** under the influence of human-organizational and technical issues
Inspiratio n	**Biological immune system** mechanisms for adaptive identification and response to threats in a dynamic environment with varying capacity for response (i.e., immune deficiencies/degradation)

- Risk assessment for conventional/ autonomous ships
- Bio-inspired Life Cycle Risk Assessment
- Towards a descriptive framework
- Instead of conclusions
- Sneak preview…

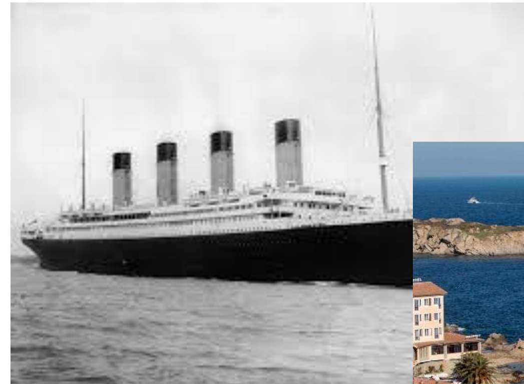
How does risk, related to a marine system, fluctuate throughout its life cycle phases?



Adapted from Leveson (2015)

Risk assessment for conventional/autonomous ships

- We have a large "**knowledge library**" of what can go wrong with conventional ships and what are the consequences → We can **prescribe recipes** for averting disasters



- Autonomous ship concepts have only been tested in **small scale**
- We don't know what will happen exactly
  - New interactions that may result in new hazards (unmanned ship in relation to RCS – **imagine what could happen with a ship with advanced AI!**)
  - New interactions between manned and unmanned ships (**mixed traffic**)

We must **guess, and produce ways to prove** these complex systems will be at least as safe as the existing systems!

Bio-inspired Life Cycle Risk Assessment

Adapted Life-Cycle Model for marine systems

The relationship between self and nonself is different during each phase of the life cycle

Risk control effectiveness varies

The operational envelope may change

DESIGN	SHIPBUILD.	OPERATION & MAINTENANCE		LIFE EXTENSION		End of Life (EoL)
		Growth	Maturity	Adaptation	Aging	
Designed ability to control risks	Testing & Verification of designed ability	Susceptibility to unknown risks	Gradual learning, improved efficiency of response	Change in system components and goal	Deterioration of system	
		EMERGENCY (**change of system goal – e.g. from delivering cargo to saving pax**)				

DESIGN	SHIPBUILDING	OPERATION & MAINTENANCE	LIFE EXTENSION	DISPOSAL

Typical Life-Cycle Model (see also Ayyub, 2000)

Towards a descriptive framework

Assessing risk fluctuations – Example from the navigation system

- **Scenario**: Newbuilt ship with inexperienced crew operates in heavy traffic and visibility conditions they had never experienced before
- **Life Cycle Phase**: Operation & Maintenance → Growth

SELF

$$R_{t_n} = \left\{ \begin{matrix} Speed = Service \\ Nav.Eq.status = Operational \\ Situation\ awareness = High \\ Competence = Adequate \end{matrix}, Low\ probability\ of\ nav.accident \right\}$$

Market pressure
Visibility conditions
Heavy traffic

+

NONSELF

$$R_{t_{n+1}} = \left\{ \begin{matrix} Speed > Service \\ Nav.Eq.status = Operational \\ Situation\ awareness = Low \\ Competence = Adequate \end{matrix}, High\ probability\ of\ nav.accident \right\}$$

$R_{t_{n+1}} > R_{t_n}$ → Risk control needed

Symptom identified by state detector

Instead of conclusions

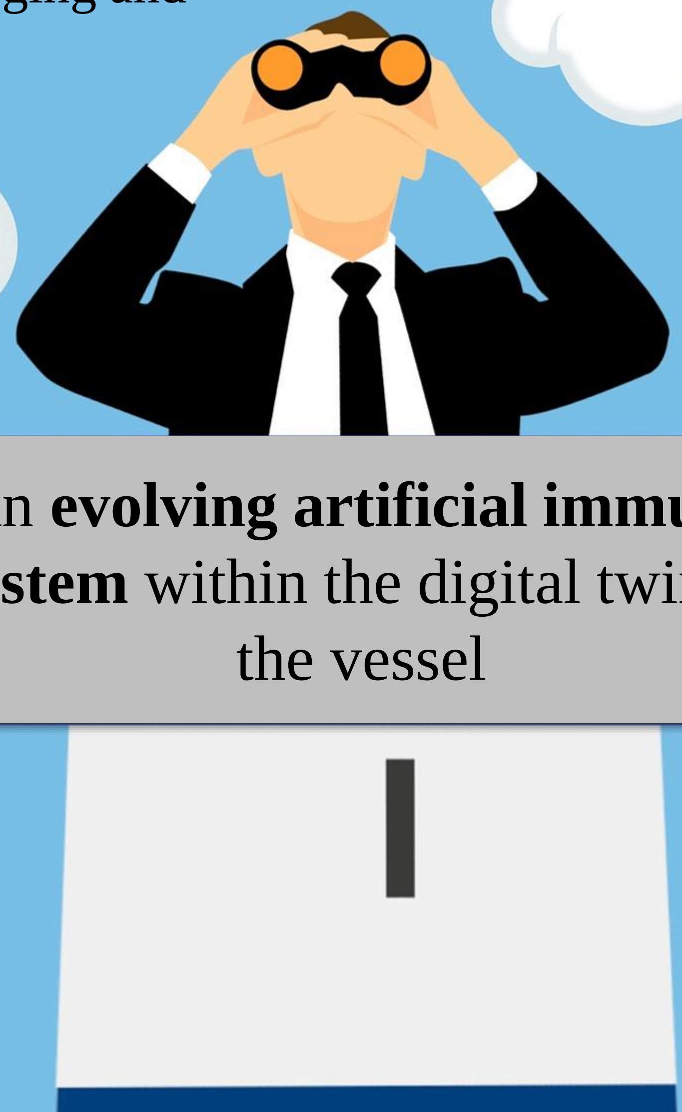
Through this research, we hope to

build a **risk framework** – equally applicable to conventional and autonomous ships - that can thrive on **unknown unknowns**

develop system **antifragility** through controlled exposure to unsafe states - improved recognition, faster response

Sneak Preview…

Benefit from the efficiency of a new immune – like paradigm for dealing with emerging and unknown threats



An **evolving artificial immune system** within the digital twin of the vessel

MOSES Facts

- **Project Title:** AutoMated Vessels and Supply Chain Optimisation for Sustainable Short Sea Shipping
- **Call identifier:** H2020-MG-2.6-2019
- **Topic:** “Moving freight by Water: Sustainable infrastructure and Innovative Vessels”
- **Duration:** 01.07.2020 - 30.06.2023 (36 months)
- **Funding scheme:** RIA – Research and Innovation Action
- **EU contribution:** EUR 8 122 150
- **Coordinated by:** National Technical University of Athens (NTUA), Greece

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

MOSES Project Overview

MOSES Vision

The aim of MOSES project is to **enhance the Short Sea Shipping (SSS) component** of the European supply chain by **addressing the vulnerabilities** and **strains** related to the operation of large containerships.

A two-fold strategy

SSS feeder services

Ship design for sustainable services – no infrastructure required

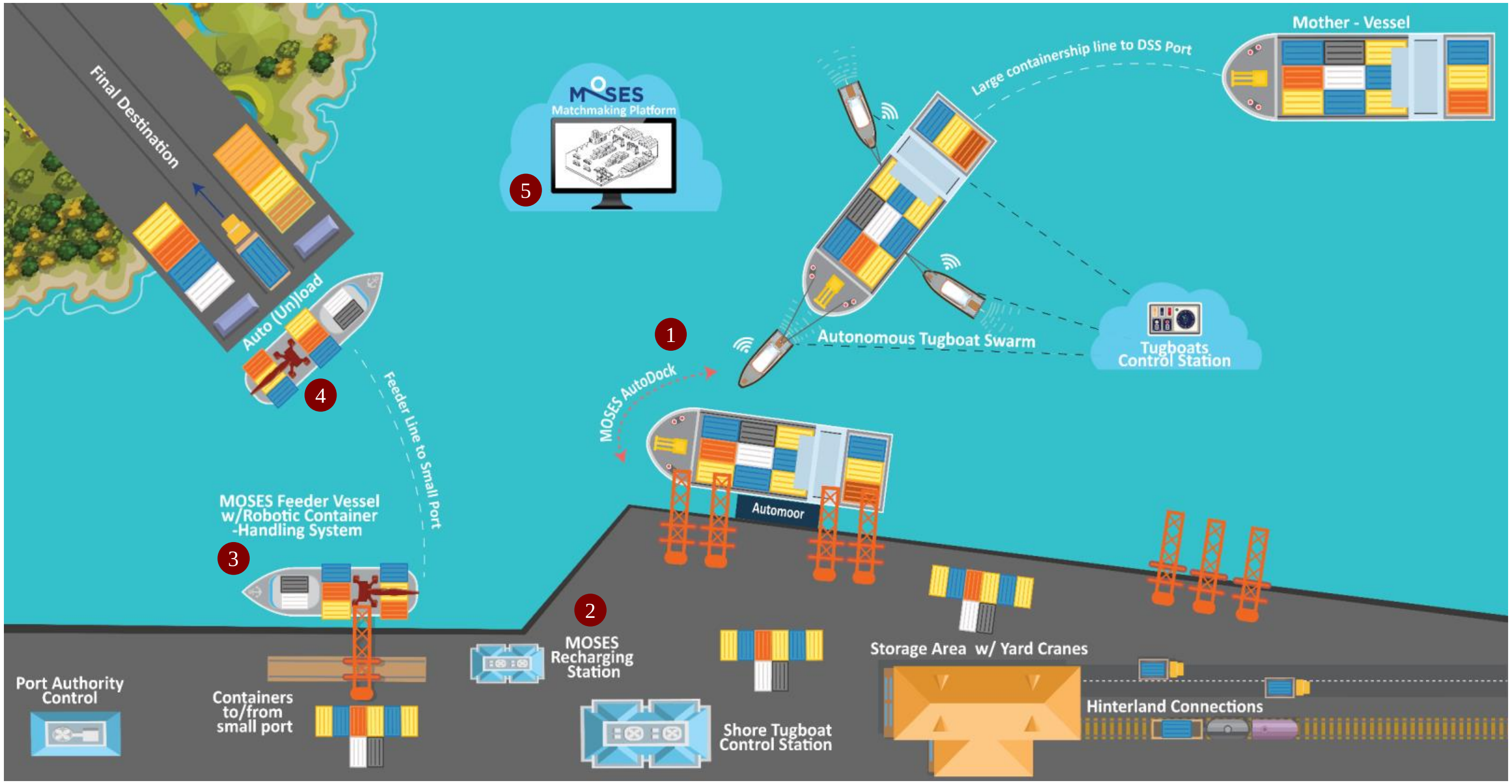
Logistics solution for balancing demand-supply

DSS ports efficiency

Technological solutions for improving DSS ports inefficiencies – reduce berthing time, improve safety

MOSES Project Overview

MOSES Concept & Innovations



MOSES Innovations:

1. **MOSES AutoDock (MOSES Autonomous tugboats + AutoMoor)**
2. **MOSES Recharging Station**
3. **Innovative Feeder Vessel**
4. **Robotic container-handling system**
5. **MOSES matchmaking platform**

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MOSES Project

MOSES

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Thank you for your kind attention!