



# Fouling control solutions for slow steaming vessels

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# Outline

- Project set-up
- Slow steaming and fouling challenge
- What we intend to do
- The consortium
- Success criteria



# Slow steaming paint

- Blue innoship and DMF
- Project partners
  - DTU
  - Hempel
  - Maersk
- Total budget: 6,7 mio DKK
- Bridging between lab-scale and real-life



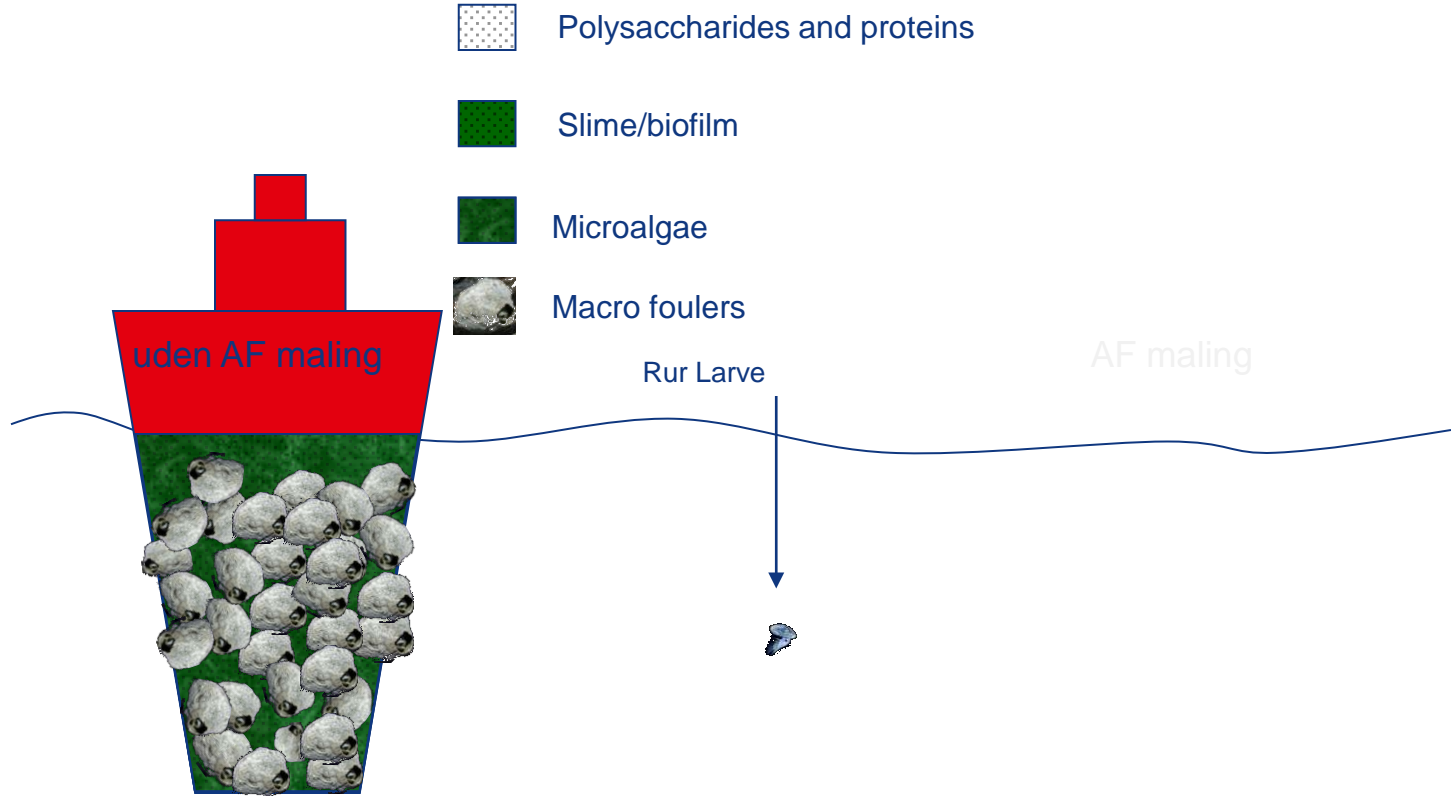


# Slow steaming

- Fuel consumption is proportional to speed<sup>3</sup>
- Slow steaming is the most effective way to cut costs
- Container vessel trading
  - Slow steaming ~ 15 knots (full speed for a bulk carrier!)
  - Near shore trading



# Biofouling on ships





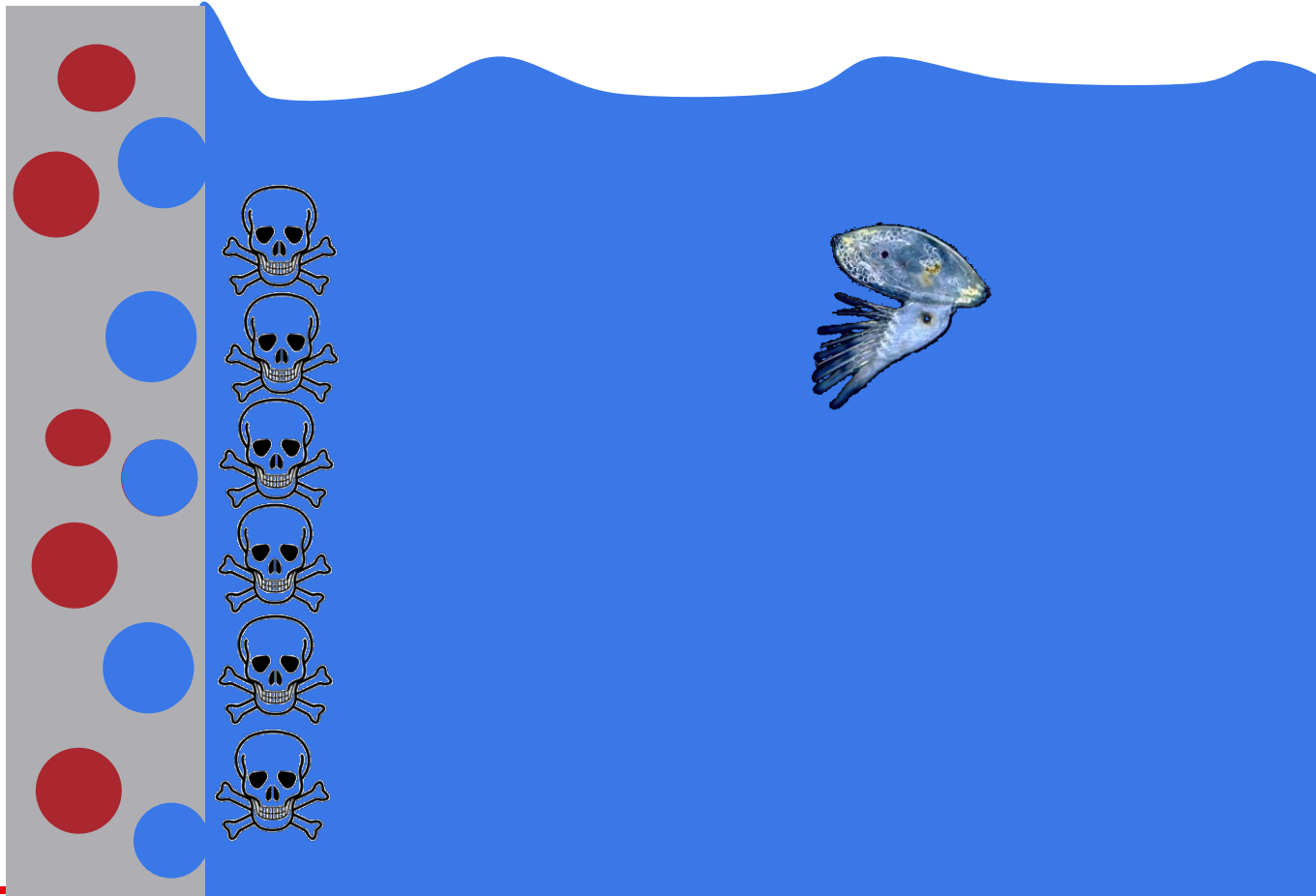
# Paint

- Continuous phase
  - Binder
  - Additives
  - Adhesion
  - Film forming
- Discontinuous phase
  - Pigments
  - Colour
  - Opacity
  - Fillers
  - Biocides





# Antifouling paint mechanisms



**IPEL**



# Fouling release



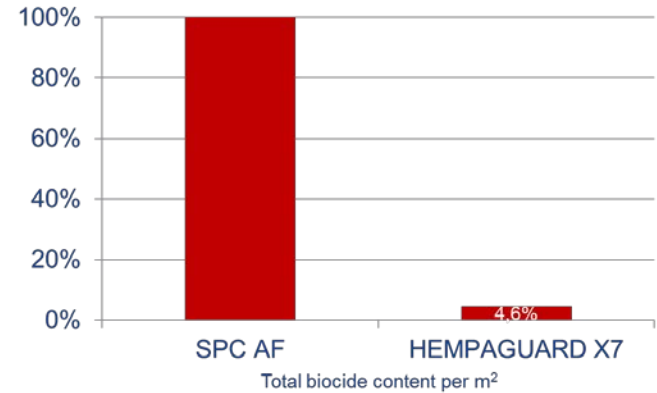
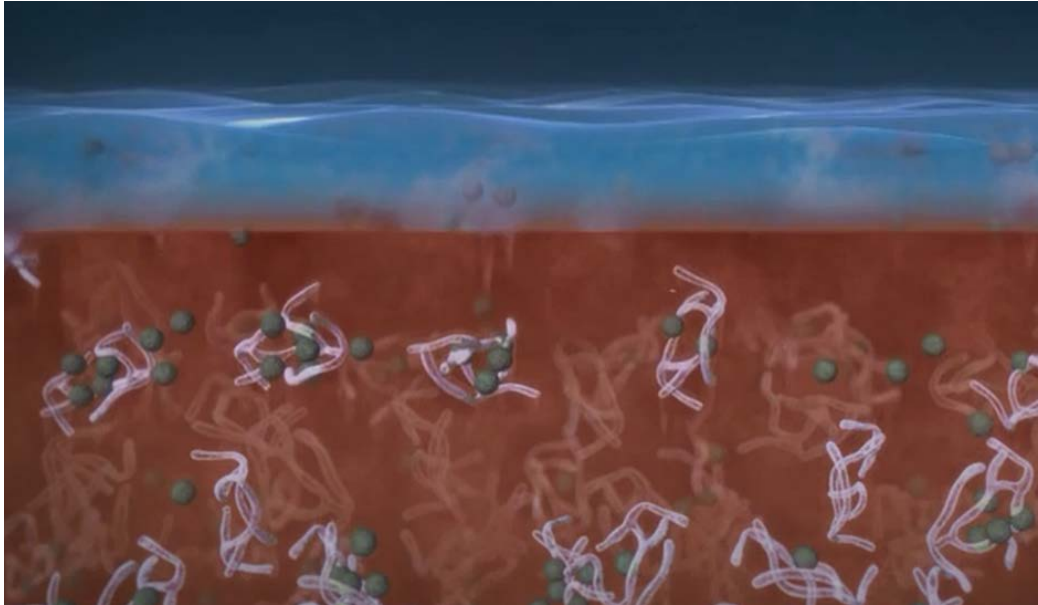
**IPEL**





# Fouling defence

Actiguard superior controlled release gives best performance out of minor biocide content.



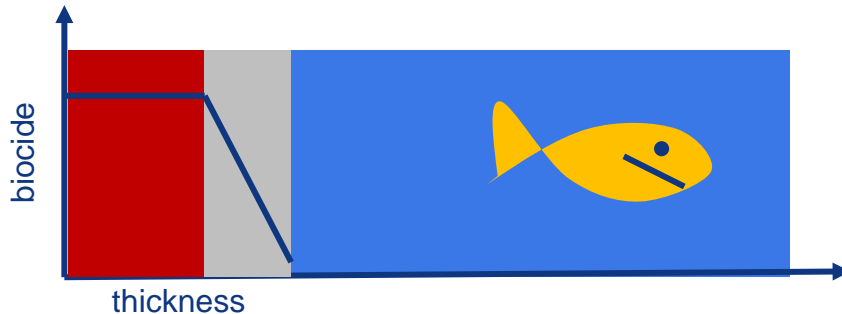
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# Why focus on slow steaming vessels?

Slow steaming adds to the fouling pressure of ocean going vessels.

- Lowers the shear on the surface of the coating
- Fouling organisms find it more easy to attach
- Decreases the rate of polishing of the antifouling layer
  - Thickens the leached layer
  - Lowers the flux of biocide at the outermost surface

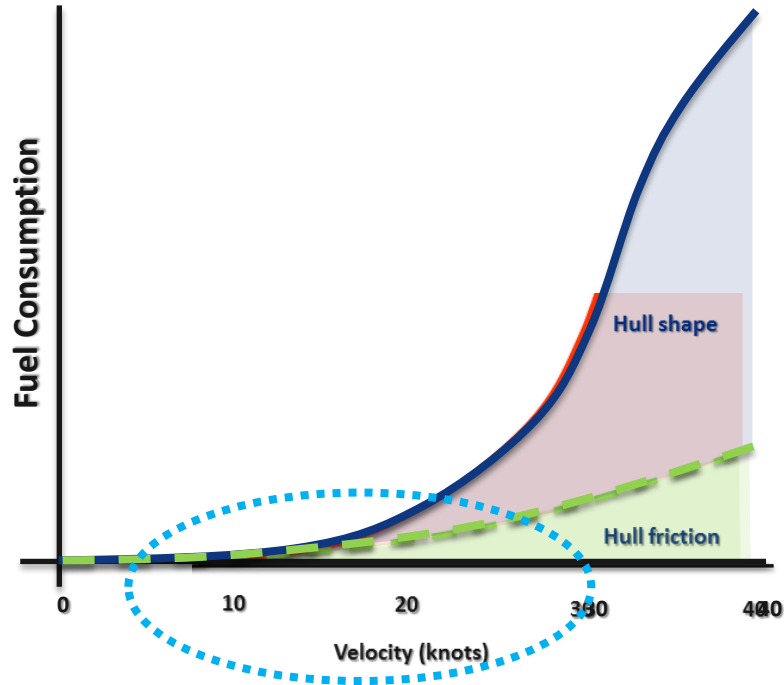


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# Hull paints and fuel consumption

- In commercial shipping, hull coating roughness is responsible for most of the vessel's fuel consumption
- 10  $\mu\text{m}$  increase in roughness increases the fuel consumption 1%





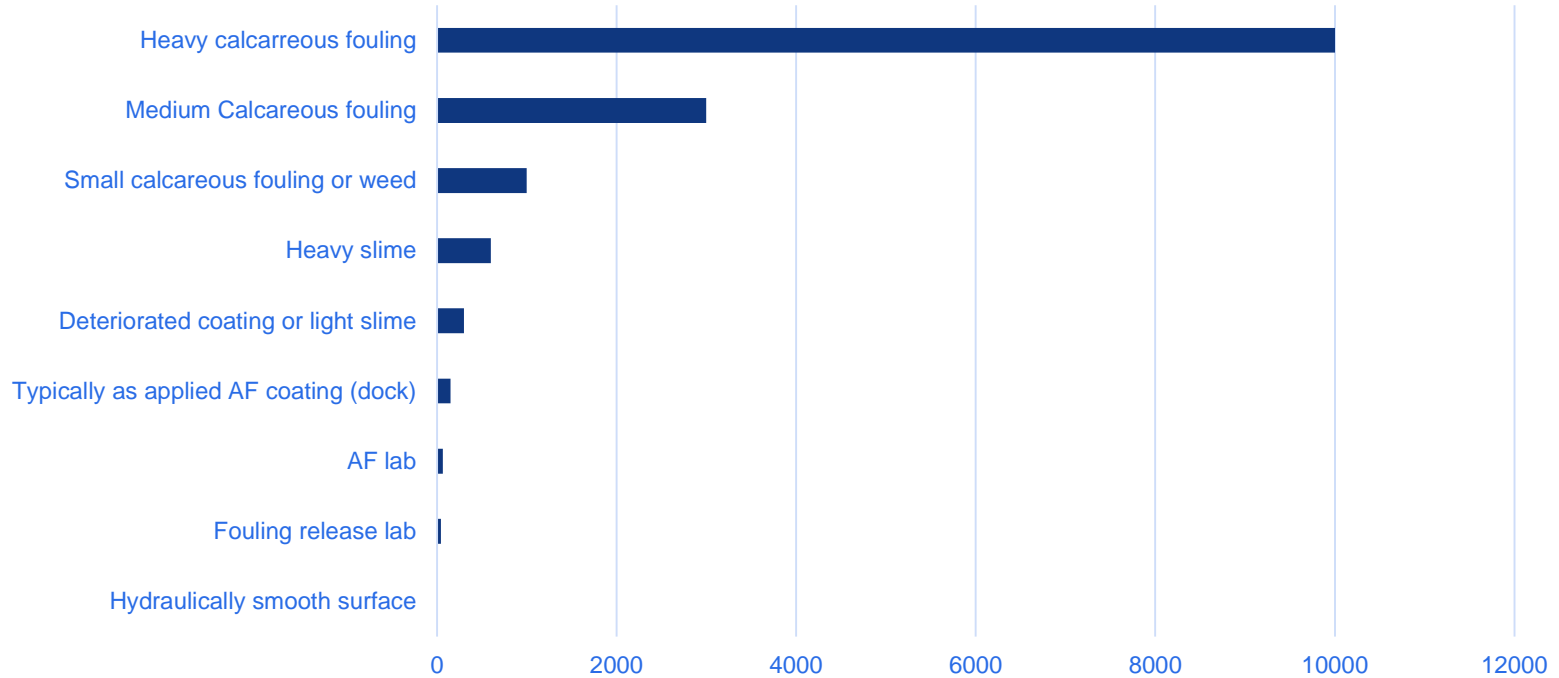
# Hull roughness

	Micro	Macro
Physical	<ul style="list-style-type: none"><li>• Steel profile</li><li>• Minor corrosion</li><li>• Coating condition</li></ul>	<ul style="list-style-type: none"><li>• Plate laps</li><li>• Weld seams</li><li>• Mechanical damage</li><li>• Severe corrosion</li></ul>
Biological	Slime	Algae fouling Animal fouling



# Hull roughness

Rt 50 ( $\mu\text{m}$ )



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# How is this translated into fuel?

**TABLE 1**

**Hull condition effects**

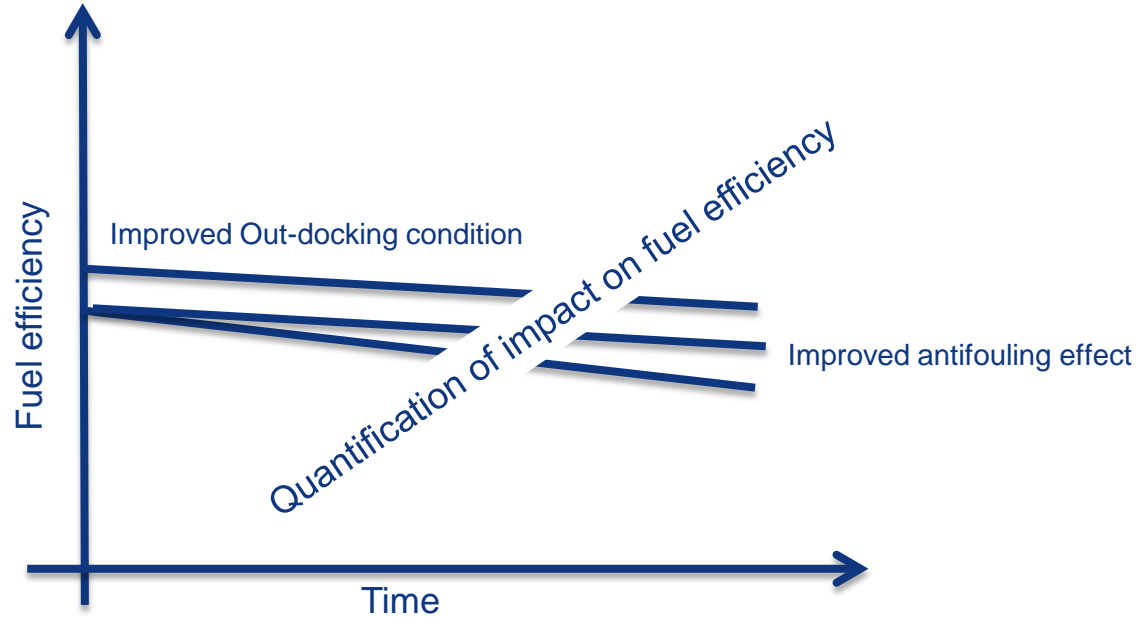
Hull Condition	% $\Delta$ ST
Newly applied applied AF coating	—
Old system or thin slime	9.4
Thick slime	26.8
Algae and small-size shell fouling	50.7
Medium-size shell fouling	82.3

Estimated effect of different hull conditions on the total shaft power (ST) for the case of a 7,000 TEU container ship.





# What is the challenge





# Improved out-docking condition

## Smoothness of paint job

- Sprayability
  - Under difficult conditions
    - Visibility
    - Wind
  - By non-educated spray painters
- Self-levelling properties

## Levelling of substrate roughness

- Grinding of welding seems
- A/C substrate





# Improved smoothness of different coating systems

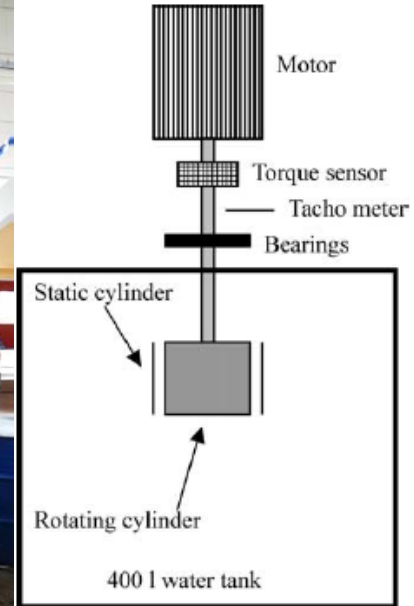
Average Hull Roughness (AHR) values expected immediately after the application of different Fouling Control coating systems under different application scenarios

Product	Lab conditions (ideal)	DD – Good substrate and application	DD – Poor substrate and application
HEMPAGUARD X7	49 $\mu\text{m}$	up to 100 $\mu\text{m}$	up to 125 $\mu\text{m}$
HEMPASIL X3	45 $\mu\text{m}$	up to 110 $\mu\text{m}$	up to 135 $\mu\text{m}$
GLOBIC 9000	62 $\mu\text{m}$	up to 125 $\mu\text{m}$	up to 175 $\mu\text{m}$
High silyl AF	67 $\mu\text{m}$	up to 150 $\mu\text{m}$	up to 200 $\mu\text{m}$



# Improved out-docking conditions

- Hempel
  - Develop paint systems
- DTU
  - Lab-scale testing
- Maersk
  - Access to real-life roughness-data



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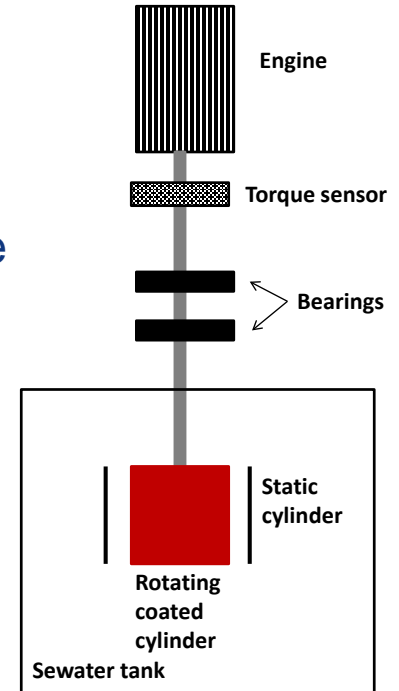
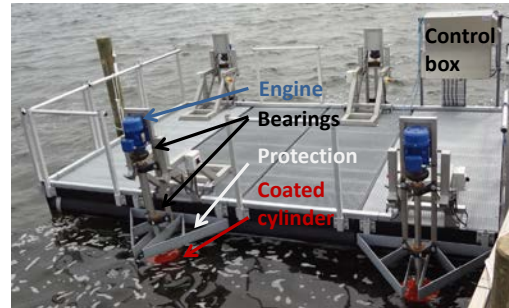


# Improved long-term AF

- Improved biocide delivery
  - Leached layer-thickness
  - Improved control of polishing-rate
- Hempel
  - Development of paint
  - Bridging of lab-based testing to real-life examples
- DTU
  - Testing and quantification of paint performance
- Maersk
  - Real-life testing

# Quantification of performance

- DTU
  - Built/expand a rotor set-up to mimic real-life trading
  - Quantification of development of frictional resistance
  - CFD modelling
- Maersk
  - ROI on dock investments
    - Xtra day
    - Skilled painters
    - Grinding of welding seams





# Success criteria

- Improved fuel efficiency for slow steaming (container) vessels
- Out-docking conditions
- Antifouling performance – long term
  - Effective biocide delivery
  - Continuous smoothness
- Quantification of ROI on maintenance investments