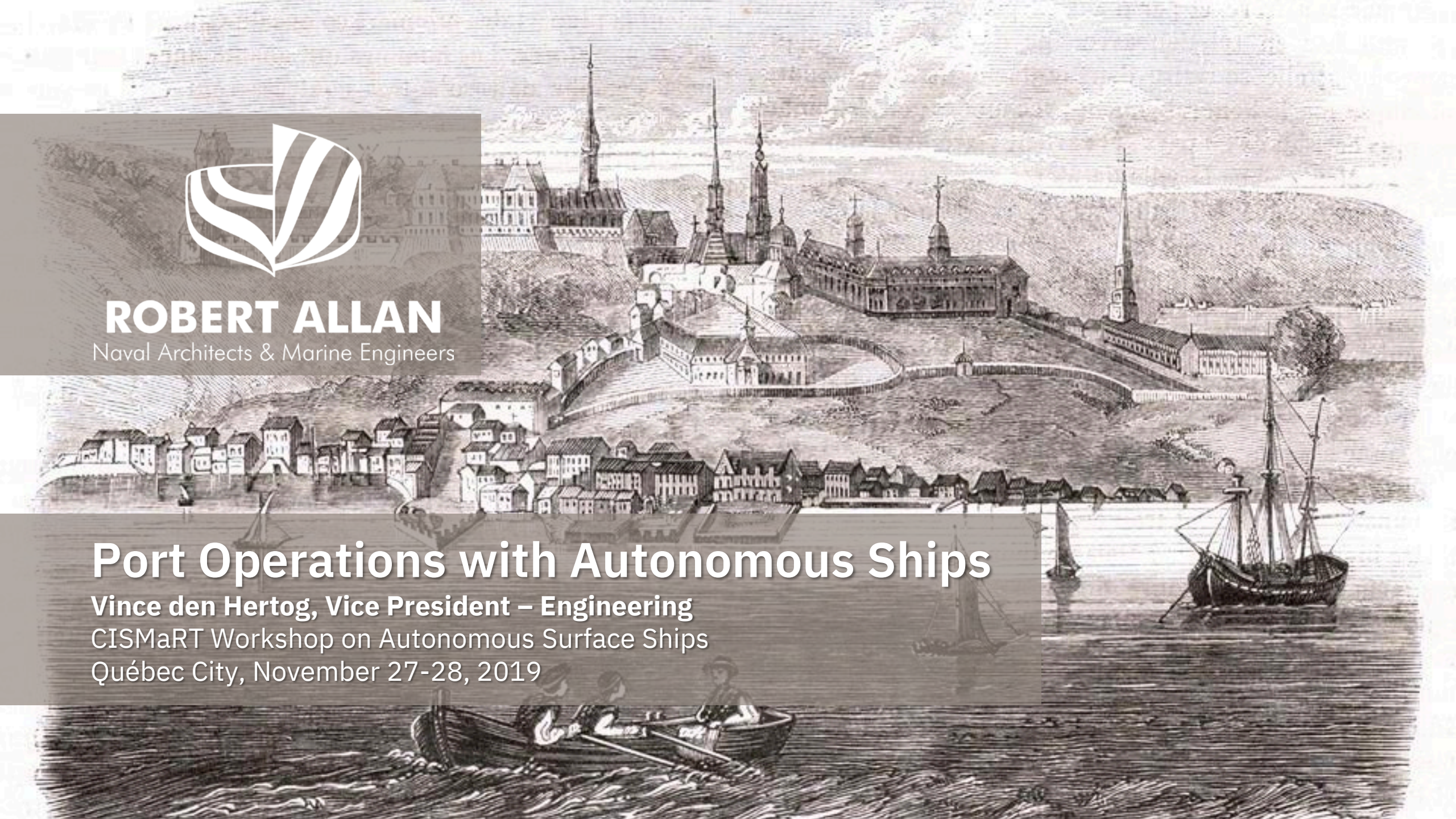


ROBERT ALLAN
Naval Architects & Marine Engineers

# Port Operations with Autonomous Ships

**Vince den Hertog, Vice President – Engineering**

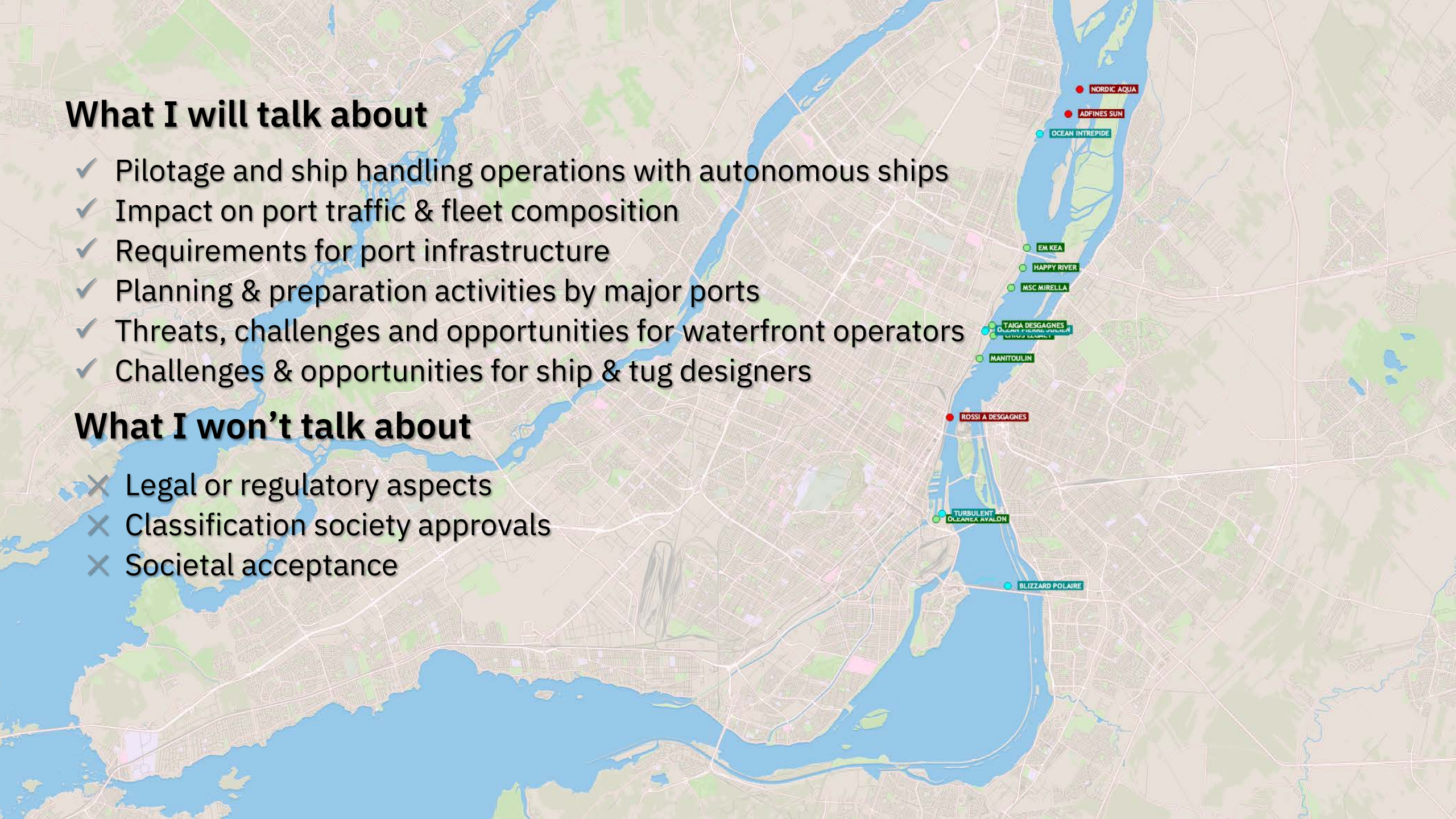
CISMaRT Workshop on Autonomous Surface Ships
Québec City, November 27-28, 2019

## What I will talk about

- ✓ Pilotage and ship handling operations with autonomous ships
- ✓ Impact on port traffic & fleet composition
- ✓ Requirements for port infrastructure
- ✓ Planning & preparation activities by major ports
- ✓ Threats, challenges and opportunities for waterfront operators
- ✓ Challenges & opportunities for ship & tug designers

## What I won't talk about

- ✗ Legal or regulatory aspects
- ✗ Classification society approvals
- ✗ Societal acceptance



# Pilotage & Ship Handling Today

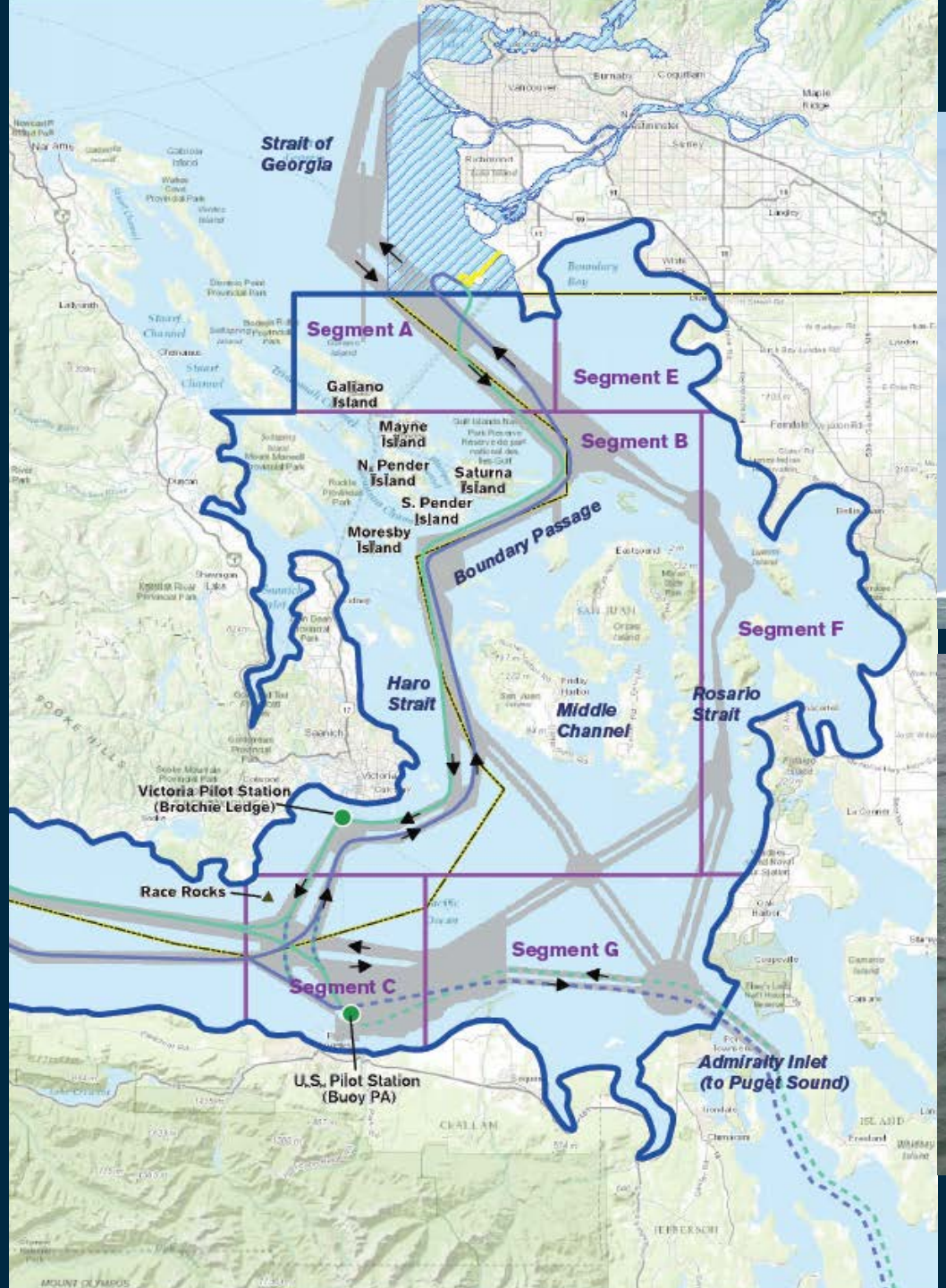




Photo: Pacific Pilotage Authority

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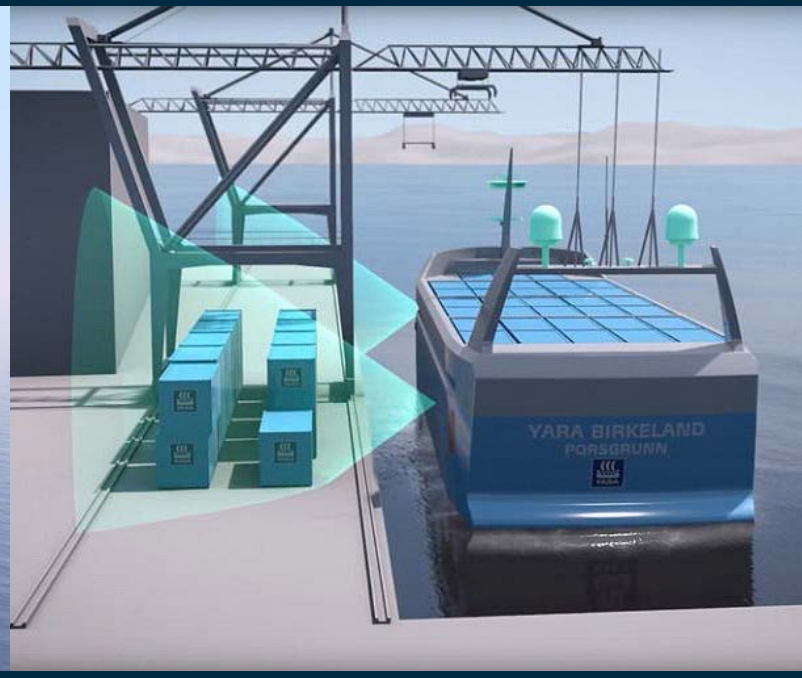
# Pilotage & Ship Handling Operations with Autonomous Ships


Will pilots need to board autonomous ships?

Could pilots operate the tugs directly?

Would they want to?

Will the tugs themselves be uncrewed?

What about autodocking systems?

What ships will be autonomous?

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# Impact on Port Traffic & Fleet Composition

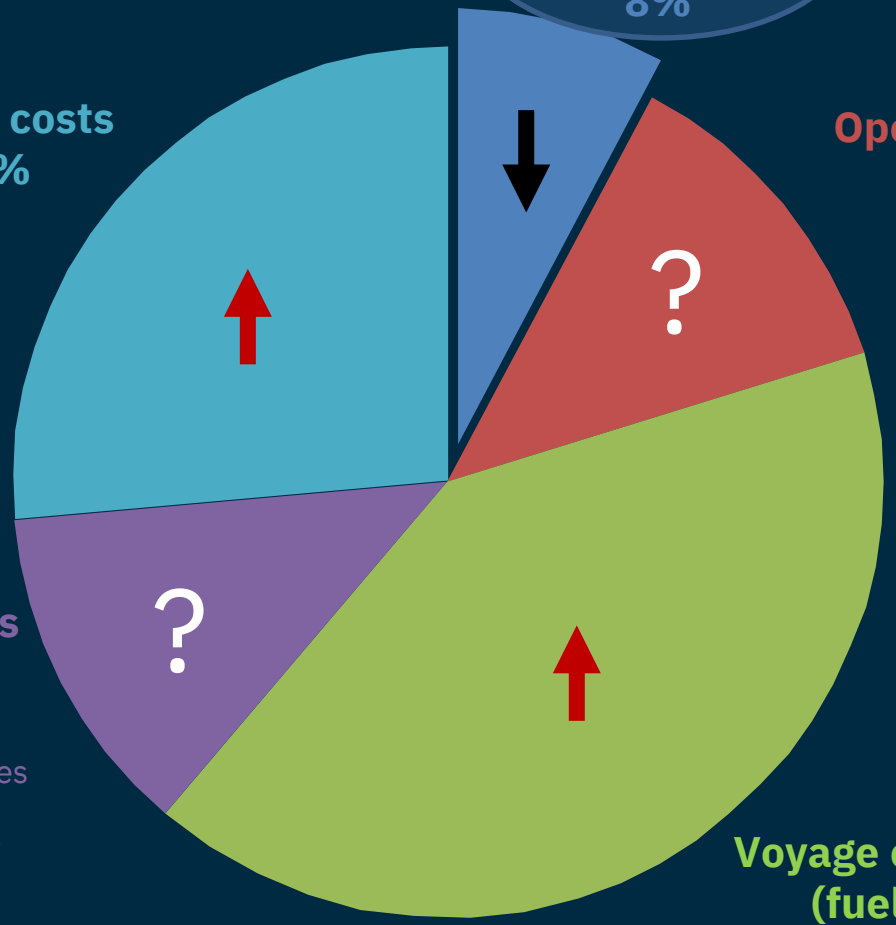


At this stage, autonomous shipping is being promoted mainly by technology providers.

The business case is not always clear.

# Lifetime Costs for a Panamax Bulker

| | |
|---|---|
| LOA: | 230m |
| Service Speed: | 15.5 kts |
| Displacement: | 90,600 t |
| Fuel: | HFO |
| | |
| Ship at berth/waiting: | 120 days/yr |
| Ship maneuvering: | 29 days/yr |
| Ship in sea passage: | 216 days/yr |




- General stores and lubricants
- Maintenance & repair
- Insurance
- Administration & management costs
- Dry dockings

- Fees and charges for services received in port

Kretschmann, L, et al. (2017), *Analyzing the economic benefit of unmanned autonomous ships: An exploratory cost-comparison between an autonomous and a conventional bulk carrier.* Research in Transportation & Business Management

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# Which Ships?

| Ship Type | | Service | Autonomous? |
|---|---|---|---|
| Container ship |   | Liner service<br>Deep sea | ★★★☆☆<br>Increasing automation over all aspects of containerized supply chain |
| Container feeder |  | Liner service<br>Coastal / inland SSS | ★★★★☆<br>Savings from crew costs and shorter service times |
| Oil tankers (large) |  | Liner service<br>Deep sea | ★★☆☆☆<br>Acceptance hurdles |
| Oil/chemical tankers (small) |  | Liner service<br>Coastal / inland SSS | ★★☆☆☆<br>Acceptance hurdles |
| Bulk/general cargo (large) |  | Tramper or liner service<br>Deep sea | ★★☆☆☆<br>Business case unclear |
| Bulk/general cargo (small) |  | Liner service<br>Coastal / inland SSS | ★★★★☆<br>e.g. Yara Birkeland |
| Ro-ro |   | Liner service<br>Deep sea | ★★☆☆☆<br>Business case unclear |

# Which ships?


Container ships on regular liner service

- ~16.7% of global tonnes loaded or ~1720 million tonnes annually [4]

Small bulk carriers & container feeders on regular liner service – Short Sea Shipping (SSS)

- EU ports: ~ 60 % of the total sea transport of goods to and from the main ports [1]
- Vancouver: 26% or ~37 million tonnes annually [2]
- Great Lakes St. Lawrence Seaway System: Intra-lakes traffic ~150 million tonnes annually [3]

*"Autonomous vehicles are mission-driven."*

Dr. James McFarlane, founder and president of International Submarine Engineering and ROV / AUV pioneer

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# ‘Real’ project - Yara Birkeland

- World’s first autonomous and electric container vessel
- YARA, Kongsberg, VARD
- NOK 133.6 million from Norwegian Government
- Delivery Q1 of 2020, Vard Brailia in Romania
- Fertilizer transport
  - Herøya – Brevik (approx. 7 nm)
  - Herøya – Larvik (approx. 30 nm)

| | |
|---|---|
| LOA: | 80 m |
| Max speed: | 13 knots |
| Cargo capacity: | 120 TEU |
| Deadweight: | 3200 mt |
| Azipull pods: | 2 x 1200 KW |
| Tunnel thrusters: | 2 x 700 KW |
| Battery Capacity: | 7 MWh |

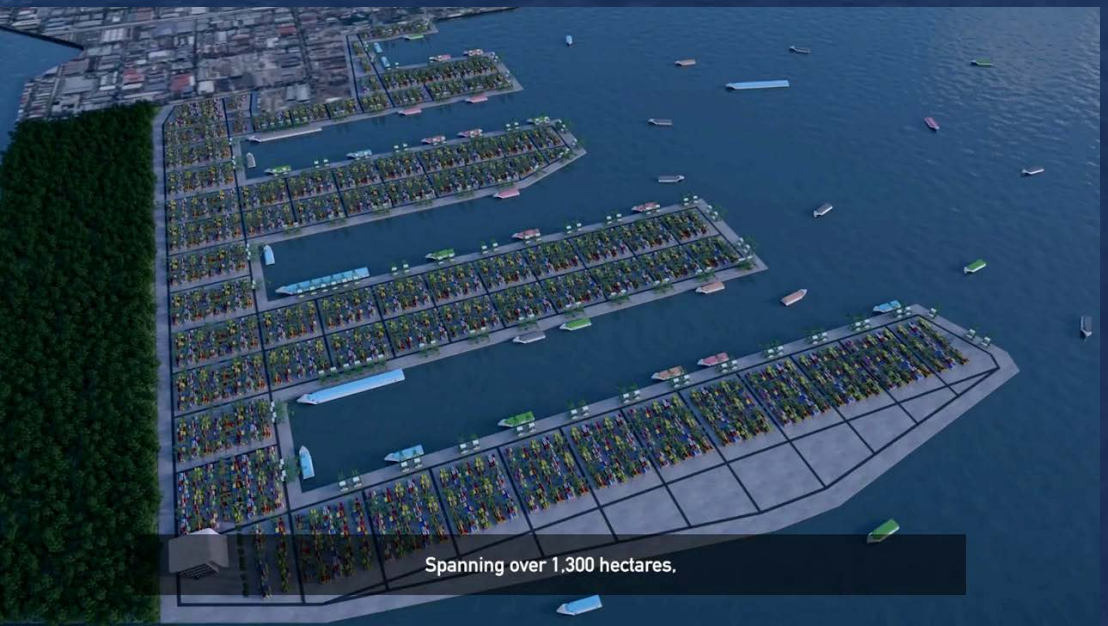

# Demands on Ports

Faster turn-around to reduce service times & costs

- Auto docking
- Auto loading/unloading
- Rapid bunkering (liquid fuels & electric shore charging)


https://www.youtube.com/watch?time_continue=142&v=TvFDHIO3L_w

Wärtsilä SmartDock




https://www.youtube.com/watch?time_continue=16&v=9IHrkx_KRSU

PSA TUAS Mega Port

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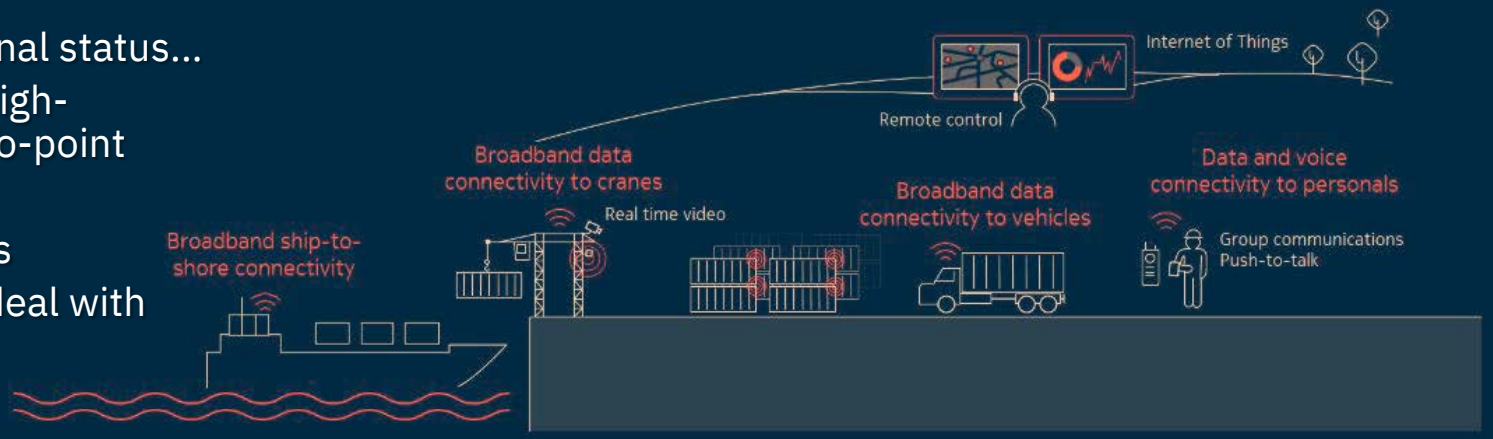
# Demands on Ports

Safe operating environment to comply with regulations and minimize insurance costs

- Data on traffic, weather, currents, terminal status…
- Communications: secure, low latency, high-bandwidth networks (e.g. 5G) or point-to-point
- Control centres
- Line of sight antenna & camera locations
- Emergency towing & repair services to deal with uncrewed vessels




https://www.nokia.com/networks/use-cases/private-lte-based-networks-for-terminal-operators/


# Planning & Preparation Activities by Major Ports – Highlights

Hamburg Port Authority and IAPH Port Planning and Development Committee: *Autonomous Vehicles' Impact on Port Infrastructure Requirements* (Fraunhofer Center for Maritime Logistics and Services CML, April 2019)

Port of Rotterdam: Testing autonomous navigation with a floating lab, a former patrol vessel; Developing a Geographic Information System (GIS) to manage and analyze port data including weather, ship traffic, status of terminals etc for improved real-time situational awareness

British Ports Association: *Automation of Ships in Ports and Harbours* (Setfords, London, December 2018)

Port of Singapore: Maritime and Port Authority of Singapore (MPA) investing $7.2 Million in five projects to build capabilities. Includes collaboration to develop a remote piloting system for guiding movements and berthing from shore.

# Existing Automation in Ports

"Almost 40 partly or fully automated ports now do business in various parts of the world, and the best estimates suggest that at least $10 billion has been invested in such projects.[1] The momentum will probably accelerate: an additional $10 billion to $15 billion is expected over the next five years."

[*The future of automated ports*, December 2018 Article, McKinsey & Company https://www.mckinsey.com/industries/travel-transport-and-logistics/our-insights/the-future-of-automated-ports]

Qingdao New Qianwan Container Terminal, Port of Qingdao

Yangshan Deep Water Port, Port of Shanghai

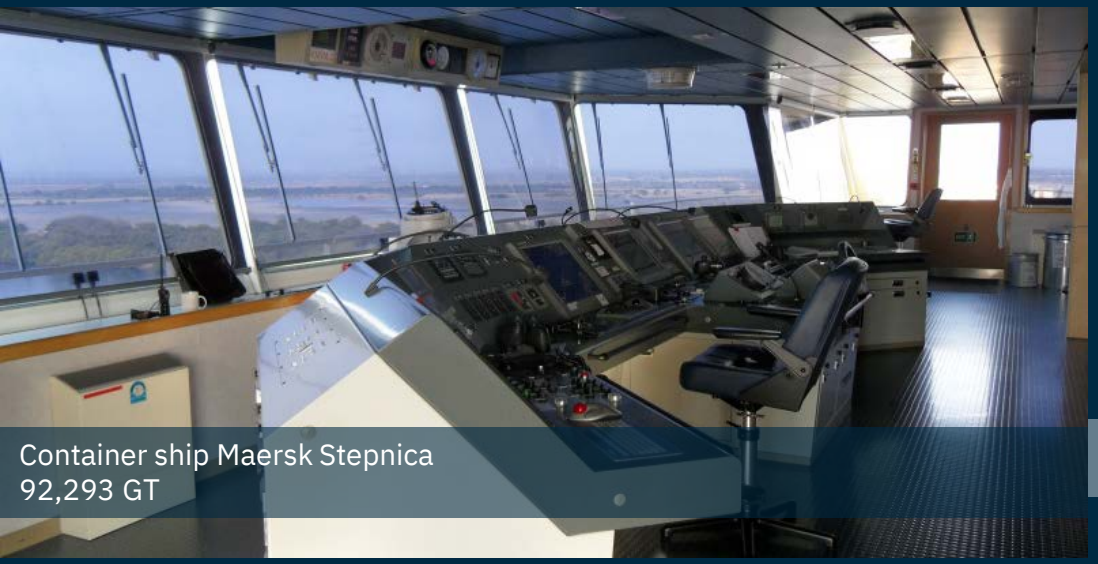
Victoria International Container Terminal, Port of Melbourne

Maasvlakte 2, Port of Rotterdam

# Threats, challenges and opportunities for waterfront operators

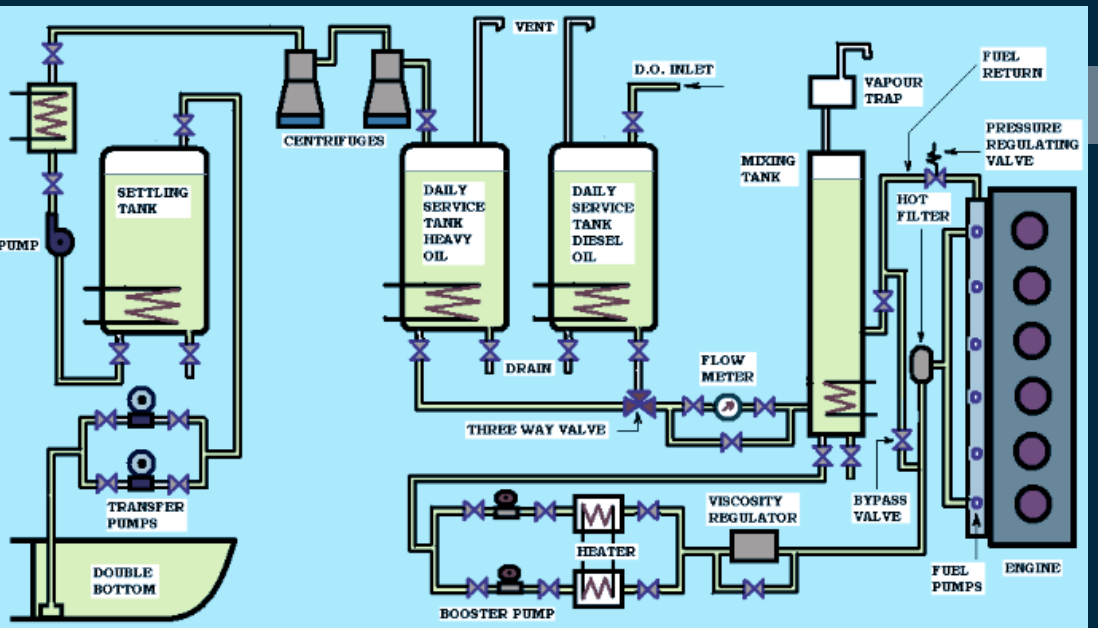
| | Threats | Challenges | Opportunities |
|---|---|---|---|
| Bunkering   | Less demand for traditional marine fuels by greener autonomous ships | Faster turn-around and tighter schedules | New demand for clean 'energy currency' fuels such as $H_2$, methanol;<br>Shore charging (electric bunkering) |
| Chandlering  | Less demand for crew-related supplies | Adapting to different service needs of uncrewed or minimally crewed ships | Supporting control centre personnel requirements |
| Repair and Service  | Minimal | Adapting to new technologies and different equipment & systems, both onboard and ashore | New demand for specialist services for uncrewed vessels in port |

# Ship Design Challenges



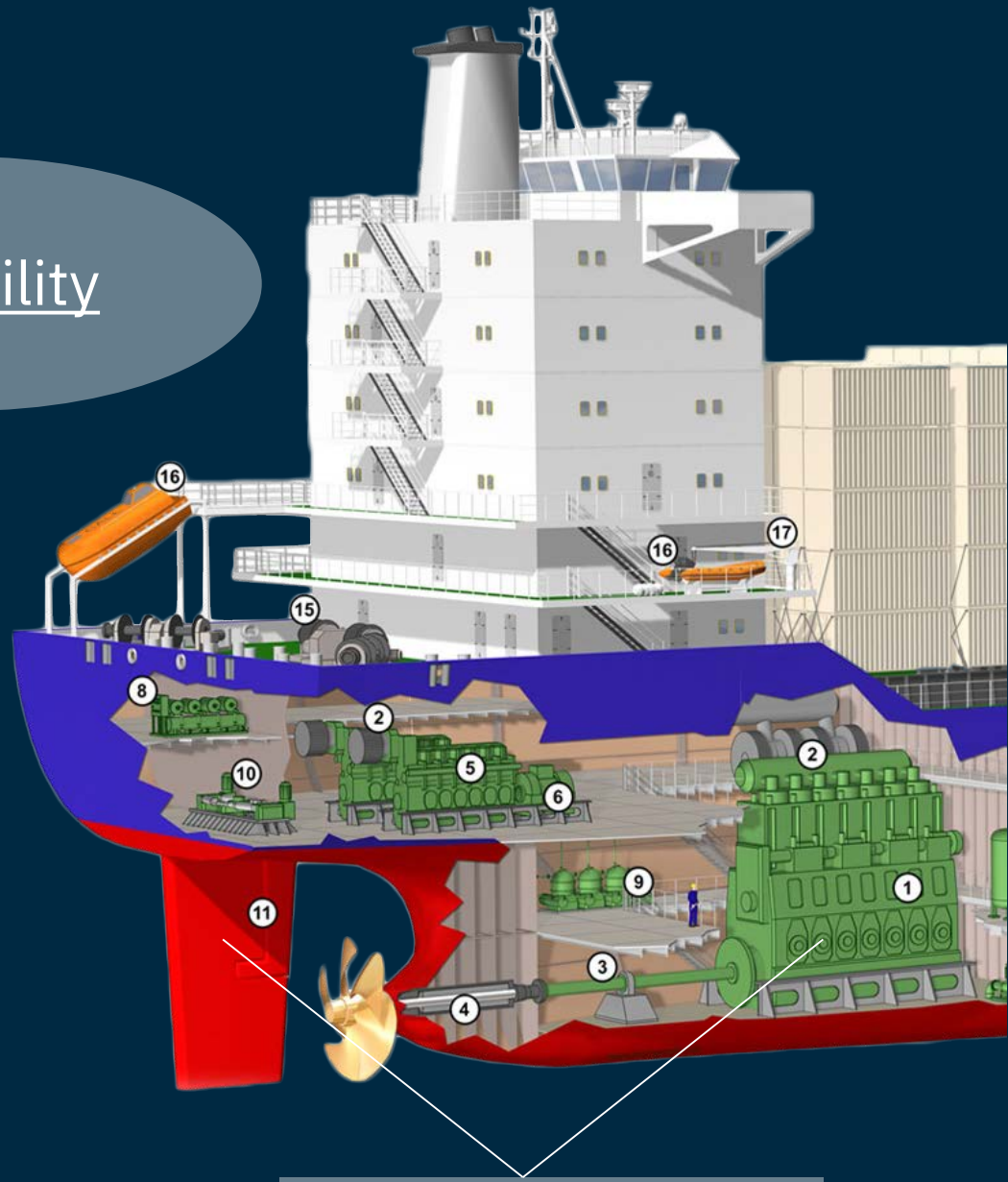
Container ship Maersk Stepnica
92,293 GT

Low cost




Complexity

Reliability




Single points of failure

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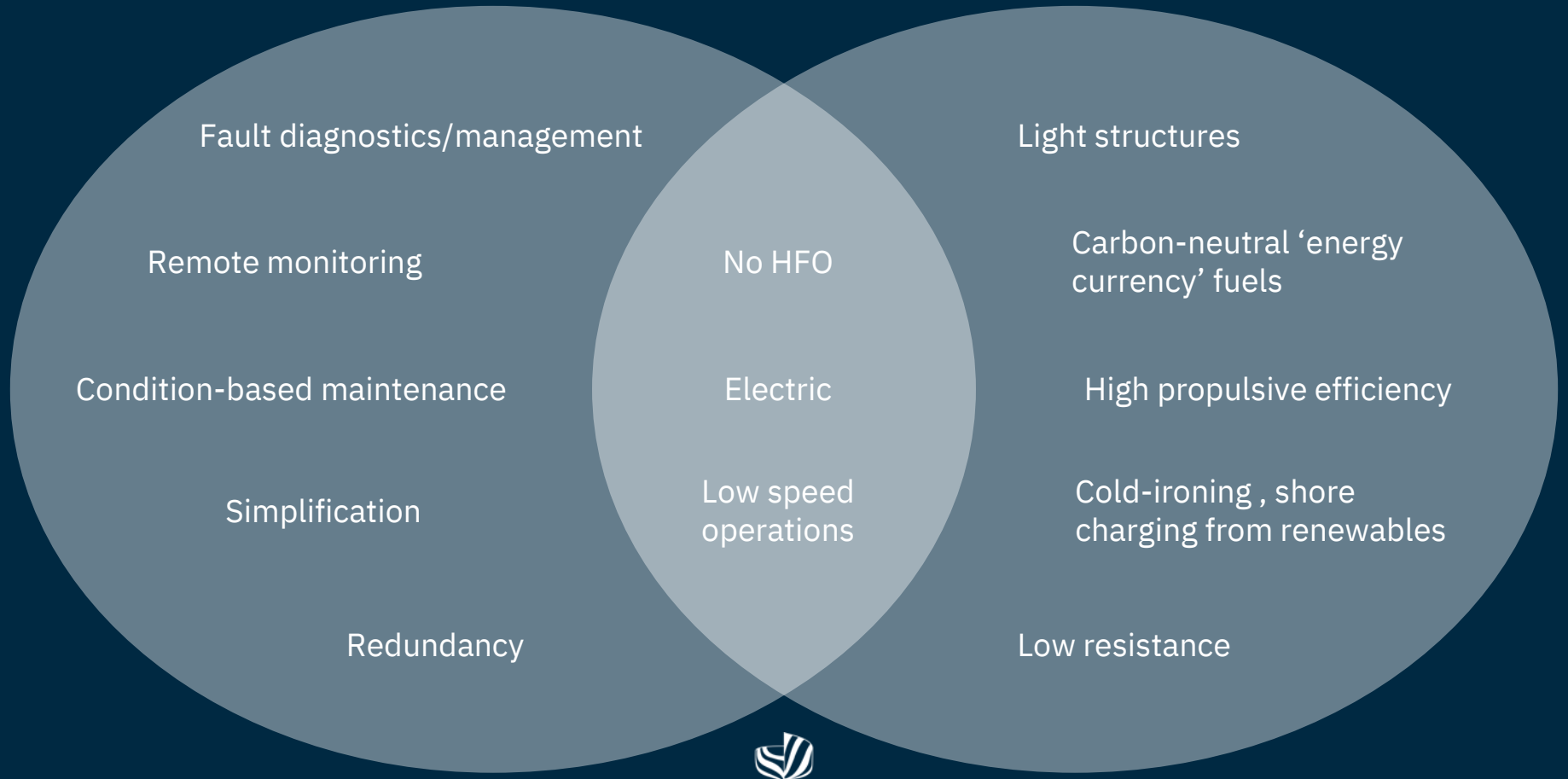
# Ship Design Opportunities

Autonomous Shipping → **Higher Reliability**

**Lower Carbon** ← Global Warming

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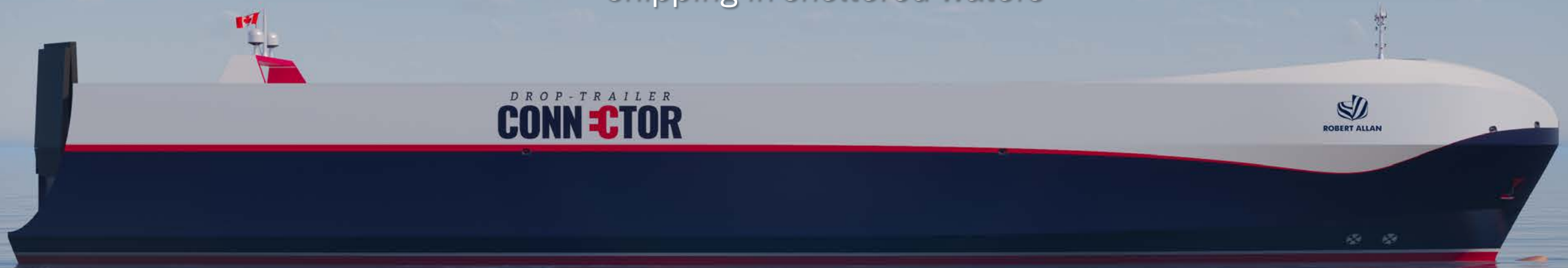
## Key Points

- Impact on pilotage & ship handling will depend on ship types
- Solutions will be ‘mission driven’. First autonomous ships are likely for short sea shipping in sheltered waters




- Ports will need to provide real-time data, communication/control infrastructure and automation in docking, cargo handling, bunkering & shore charging
- Planning by major ports is underway
- Challenge for uncrewed ships: Reliability There may be commonalities from reducing carbon

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# References & Further Reading


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5. DNV-GL Maritime (2017): Low Carbon Shipping Towards 2050. https://www.dnvgl.com/publications/low-carbon-shipping-towards-2050-93579

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