

# Hello, anybody on board ?

## KIVI MARTEC November 12<sup>th</sup> 2015

Ørnulf Jan Rødseth, Senior Scientist - MARINTEK

[OrnulfJan.Rodseth@marintek.sintef.no](mailto:OrnulfJan.Rodseth@marintek.sintef.no)

**MARINTEK**

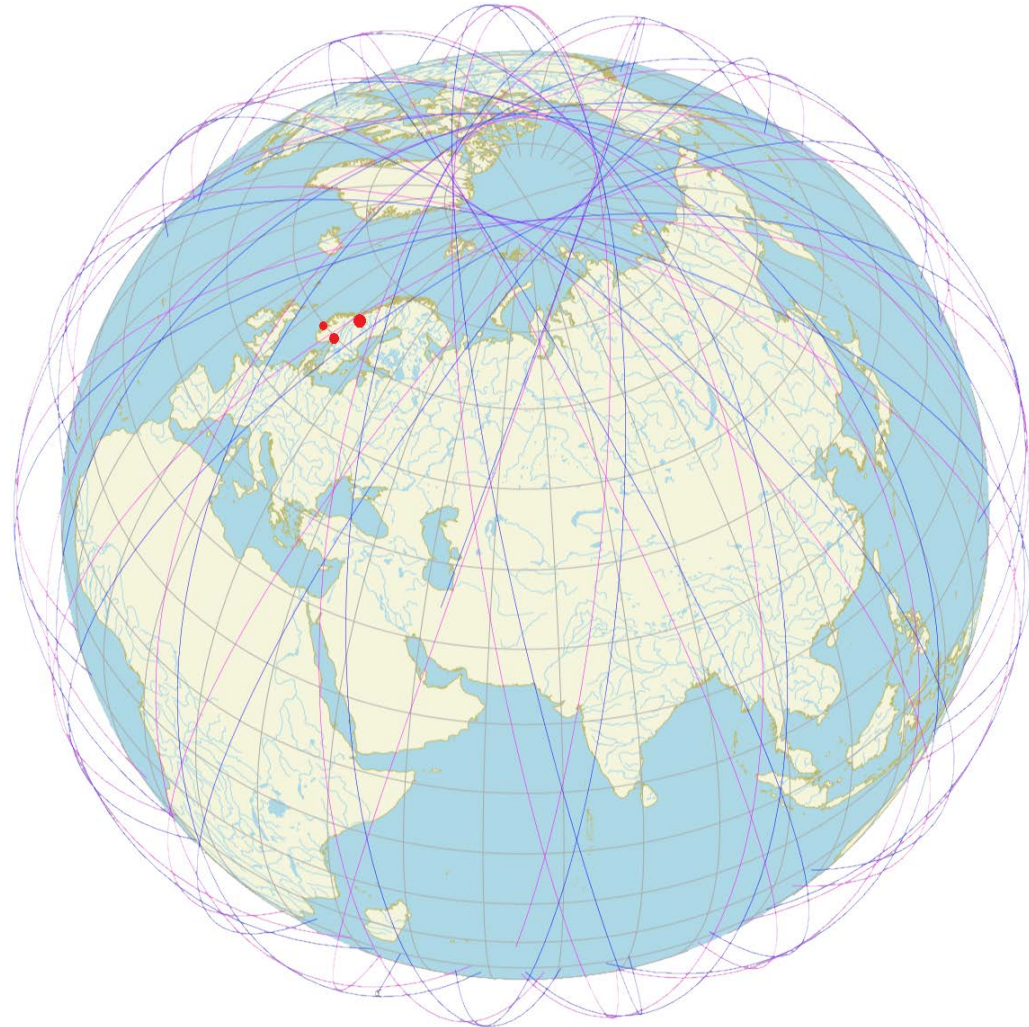
Norsk Marinteknisk Forskningsinstitut

 **SINTEF**

# MARINTEK



History from 1939  
150 scientists  
Close cooperation with NTNU  
Independent, not for profit institute  
Limited Company



# The Maritime Technology Center - Trondheim



Integrated operations laboratory



**MARINTEK**  
Norwegian Marine  
Technology Research  
Institute

**NTNU**  
Norwegian University  
of Science and  
Technology



Energy and engine laboratory



Towing tank



Ocean basin



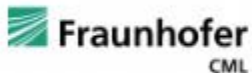
Cavitation tunnel



Structural testing

# A concept study for a fully unmanned handymax dry bulk carrier on an intercontinental voyage.

- Duration: 01.09-2012 – 31.08.2015
- Funding: 2.9 million EUR of budget 3.8 million EUR
- Activity code: SST.2012.5.2-5: E-guided vessels - the 'autonomous' ship



**MARINTEK**



aptomar  
safety in your fingertips

**CHALMERS**  
UNIVERSITY OF TECHNOLOGY



MARORKA



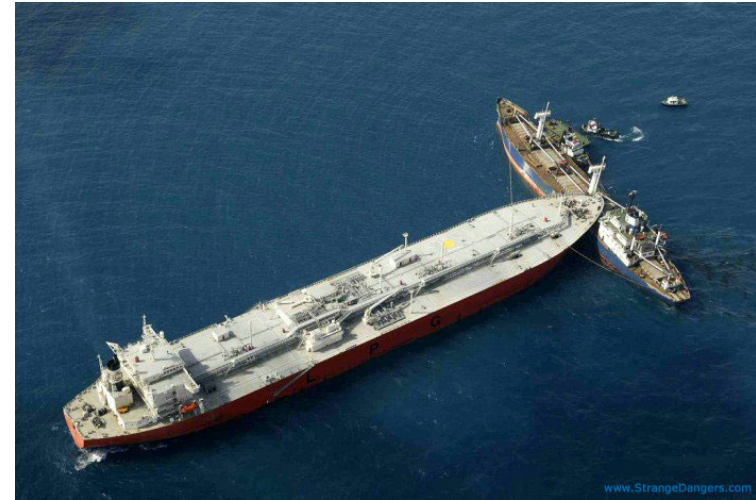
# Contents

- Driving factors and risks
- Required and yet unqualified technology
- 12 Critical design factors
- Some possible examples of unmanned ships
- Conclusions and summary



NOAA Office of Response and Restoration

Own ship: No crew or passengers



Other ships and environment: Less human errors

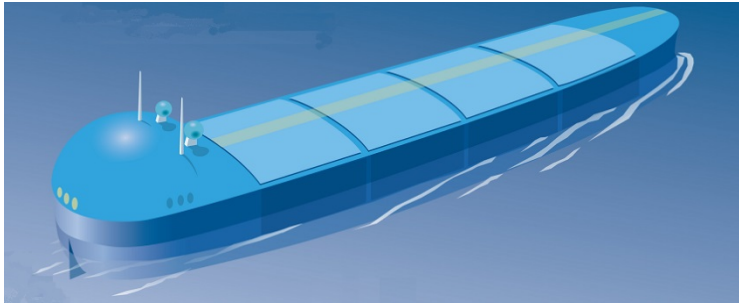


Exxon Valdez Oil Spill Trustee Council

Lookout: Better sensor systems



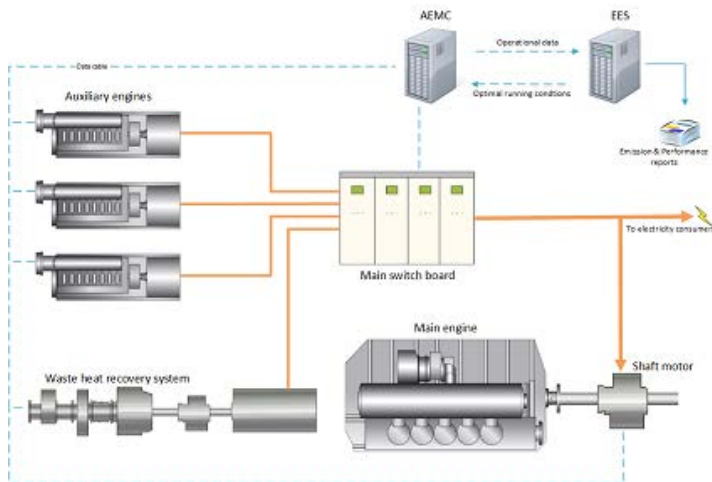
# Driving: Reduced costs



No accommodation  
Less power  
More cargo

No crew

No crew related costs



Improved technical systems  
Less off-hire  
Better efficiency

# Driving: Societal

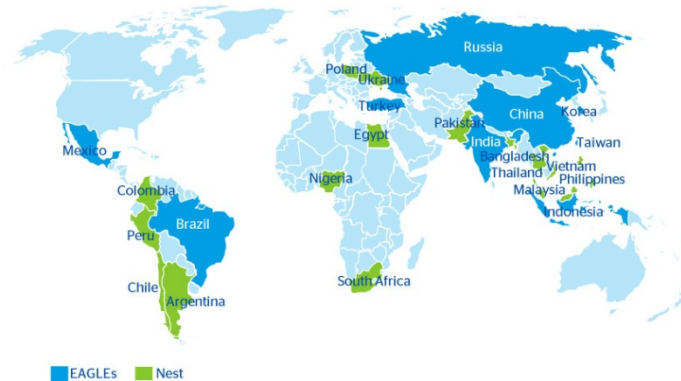


European maritime competitiveness  
Availability of seafarers  
European employer attractiveness  
Improved transport systems

Less dangerous work  
Periodically unmanned bridge  
Shorter stays away from home  
More interesting work



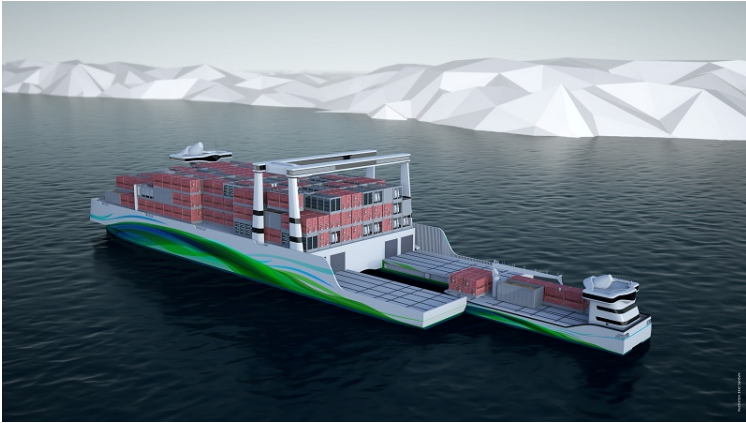
[strangecosmos.com](http://strangecosmos.com)



The world's need for  
low cost transport



# Driving: New business models



NCE Maritime Clean Tech & NCL

Mother ship and unmanned drones

Low operational cost short sea / last mile shipping



godsfergen.no

**Risks?**

# Risk: Cost-benefit

- No hotel
- No crew
- Improved efficiency
- Less off-hire
- New business model



- Dual propulsion, no HFO
- Shore Control Centre
- Longer dockings
- Costlier instruments
- Existing business model

# Risk: Legal and liability issues



- Contracts
- Insurance

- UNCLOS
- SOLAS



- Liability



[wikimedia.org/paolodefalco75](https://commons.wikimedia.org/wiki/File:Paolodefalco75)

# Risk: Hostile (cyber) attacks

- Terrorist hijack e.g. by GPS spoofing



University of Texas at Austin

- Pirate attack



IMO



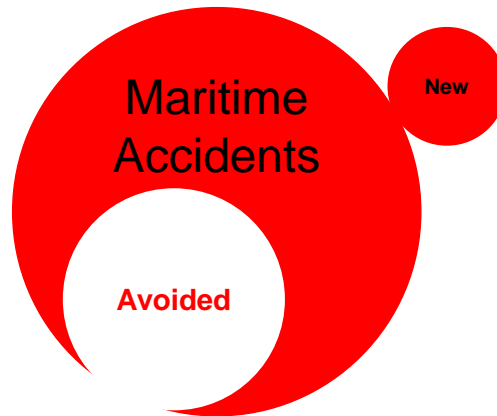
Wikimedia.org/Caricato da Makki98

- Governmental backdoor

# Risk: "Autonomy assisted accidents"



First radar assisted collision: Andrea Doria and Stockholm off Nantucket in 1956

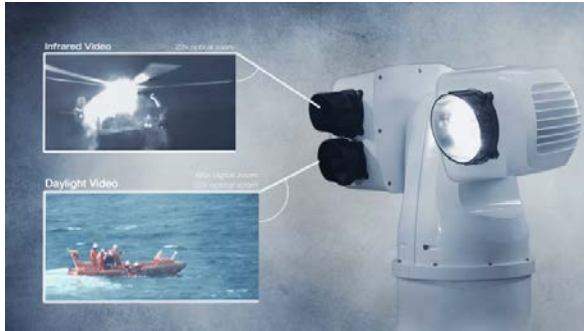


Some new accidents are probably unavoidable. Question is the totality!

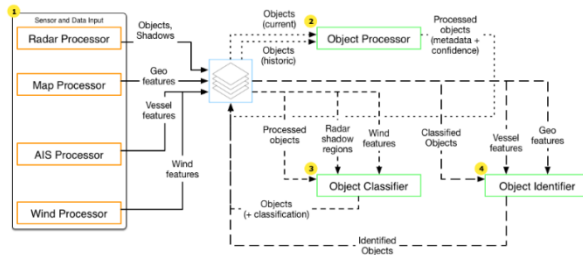
# Contents

- Driving factors and risks
- **Required and yet unqualified technology**
- 12 Critical design factors
- Some possible examples of unmanned ships
- Conclusions and summary

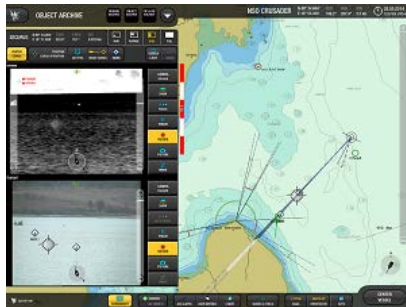
# New sensor functions



New detectors in IR and daylight video.  
Improved radars.



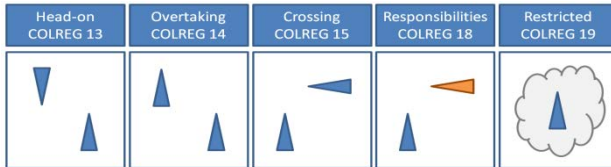
Sensor fusion and classification: AIS, Radar and video.



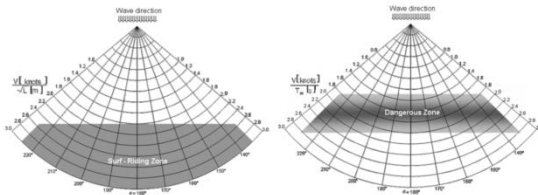
Integrated SCC decision support.



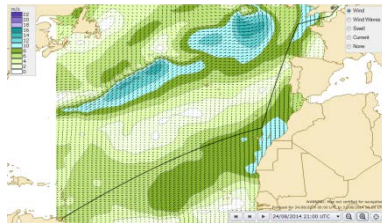
# New navigation functions



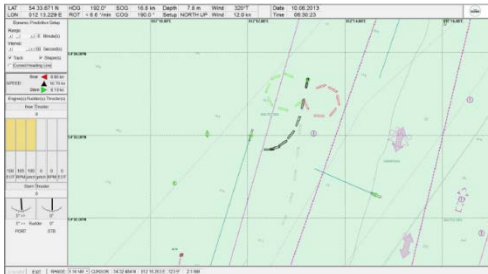
Deep sea collision avoidance: Tactical and last minute.



Avoid dangerous sea conditions: Surf riding, parametric rolling, broaching etc.

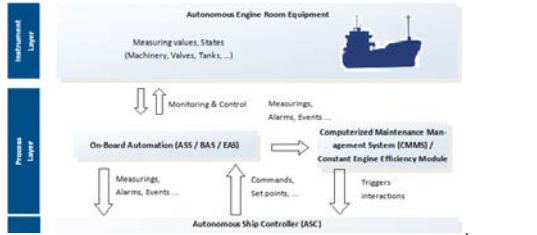


Tactical weather routing.

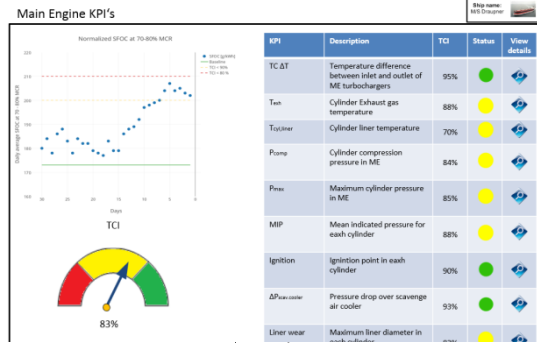


User decision support for remote control.

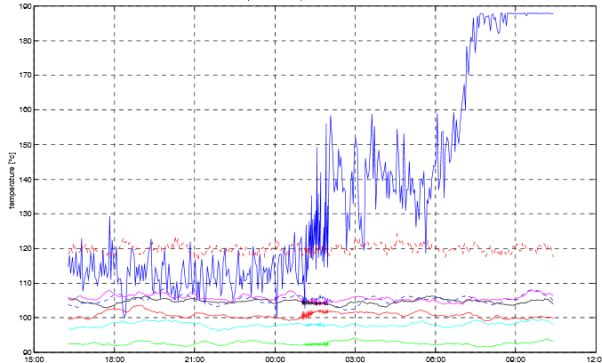
# New machinery and maintenance functions



Prototype operation and maintenance concept for unmanned ship.

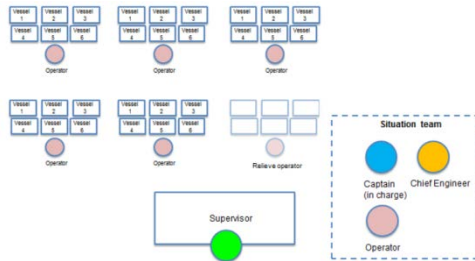


KPI based energy efficiency and maintenance planning system.

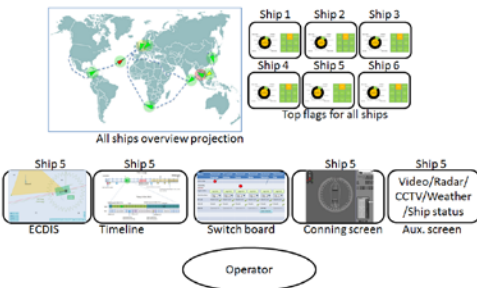


New condition monitoring systems and approaches.

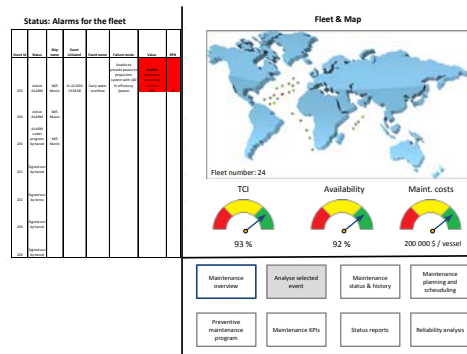
# Shore Control Centre (SCC)



General organizational principles and staffing.

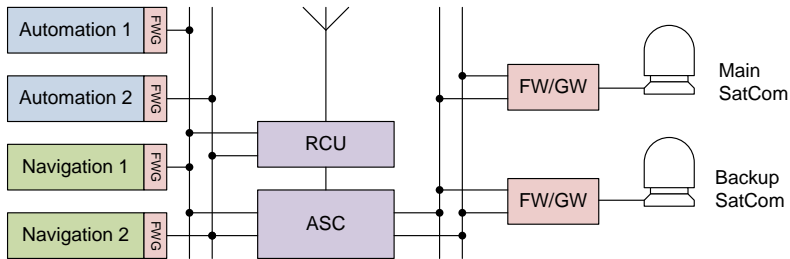


Ship status monitoring.



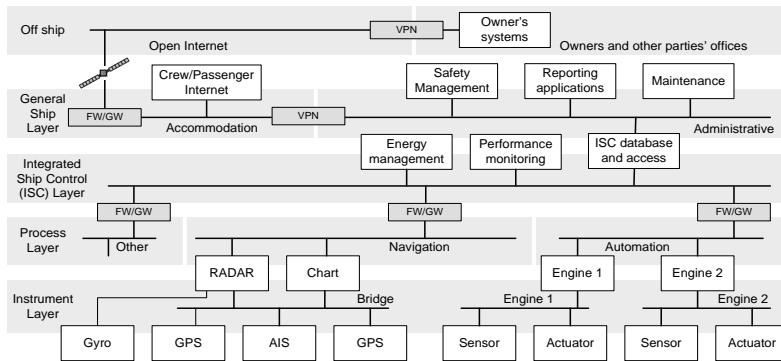
Ship intervention on different levels: Monitoring, new instructions, detailed analysis and support – all ship systems.

# A more integrated ICT architecture



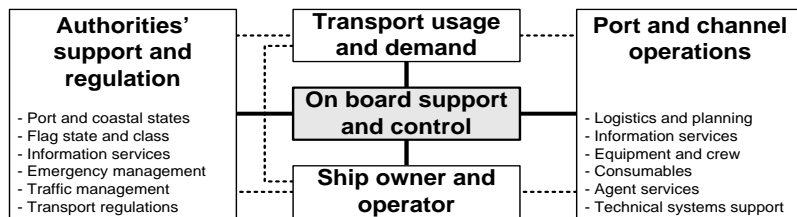
General ship system redundancy and communication systems integration.

IEC 62940



Network architecture for safety and security.

IEC 61162 series

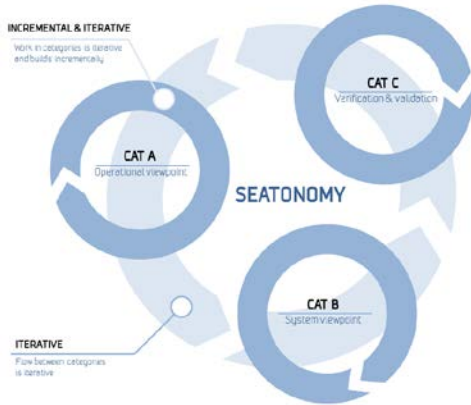


Data structures and semantics.

ISO 28005 series



# An integrated design methodology



Iteratively look at the operational issues in the context of the system design and vice versa.

# SEATONOMY

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain 5	5	10	15	20	25
Likely 4	4	8	12	16	20
Possible 3	3	6	9	12	15
Unlikely 2	2	4	6	8	10
Rare 1	1	2	3	4	5

Risk reduction principle covering both operation and design.

**MUNIN's hypothesis:** Unmanned ship systems can autonomously sail on intercontinental voyages at least as safe and efficient as manned ships.



The Autonomous Sensor Module can sense sufficient weather and traffic data to ensure navigation and planning function on autonomous ships and enable situation awareness in an operation room.



A Deep-Sea Navigation System can autonomously navigate a ship safely and efficiently along a predefined voyage plan with respect to weather and traffic conditions.



A ship engine can reliably operate for 500hrs without physical interference from a human in the ship's engine room.



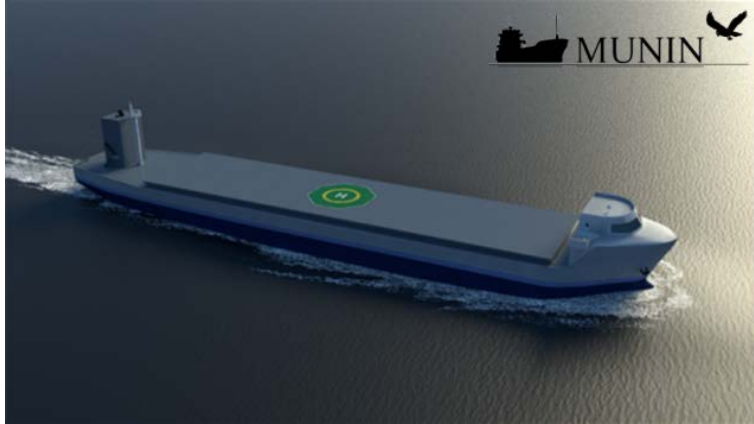
The Shore Control Centre operator will be capable to monitor and control six unmanned ships at the same time.

Validation through hypothesis testing.

# Contents

- Driving factors and risks
- Required and yet unqualified technology
- **12 Critical design factors**
- Some possible examples of unmanned ships
- Conclusions and summary

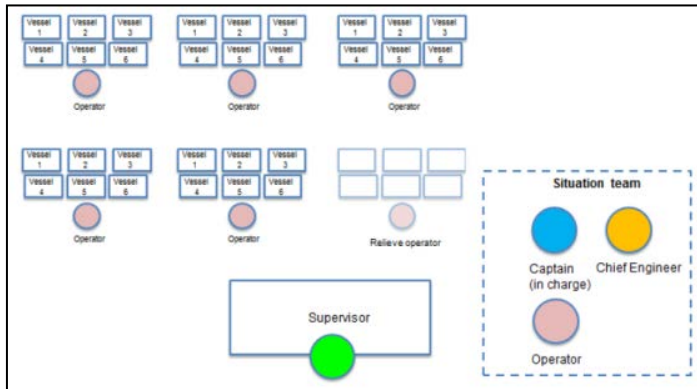
# Critical Design Factor 1 - 4



**No crew or accommodation**



**No passengers**



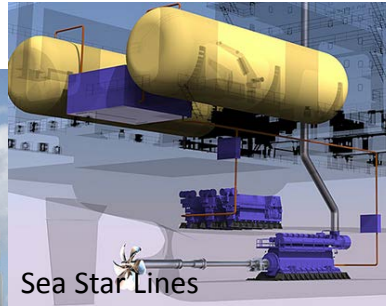
**High quality shore control center**



**Manageable traffic conditions**

# Critical Design Factor 4 - 8

Minimize maintenance



Automated cargo handling systems



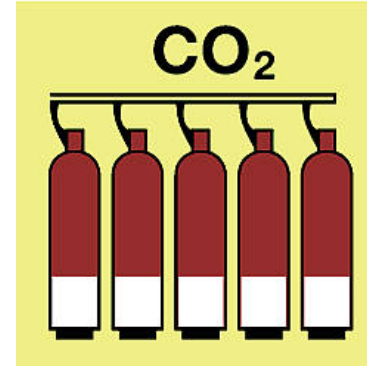
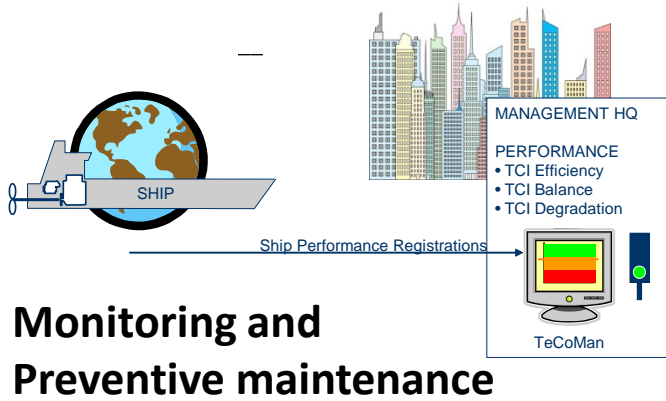
Redundancy



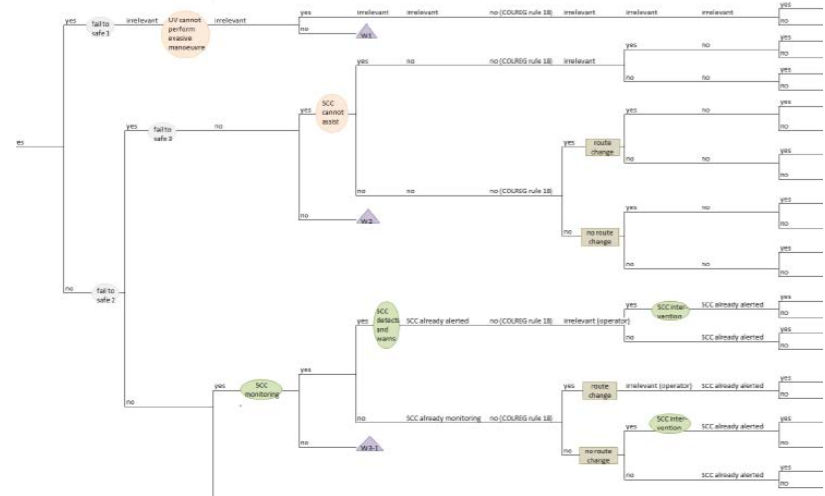
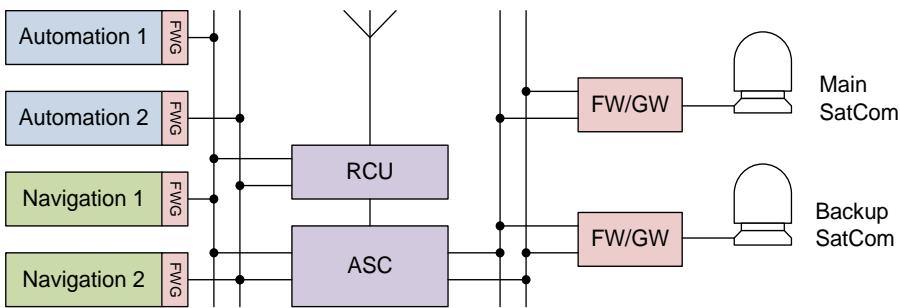
No onboard cargo intervention



# Critical Design Factor 9 - 12



**Extensive and automated fire extinguishing**



**Documented safety**

# Contents

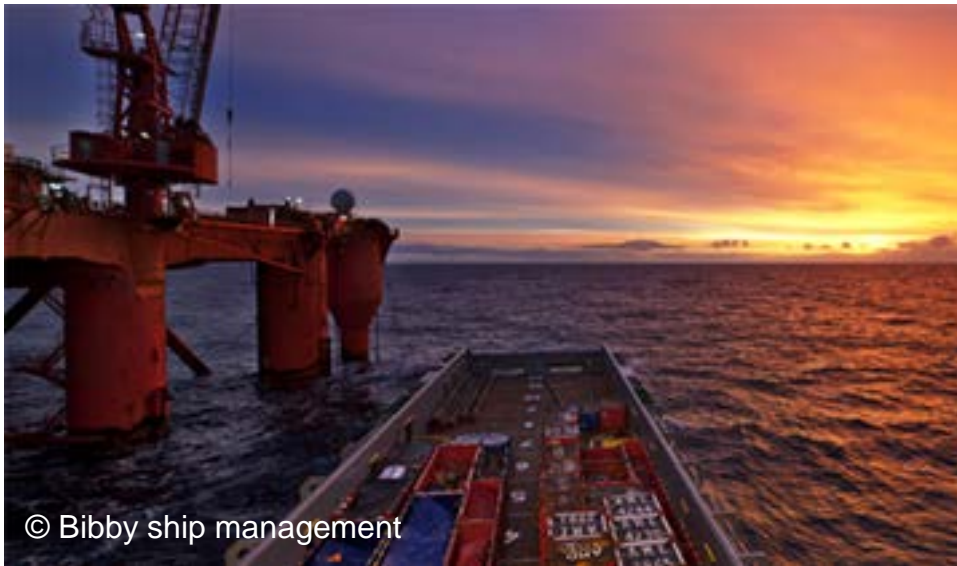
- Driving factors and risks
- Required and yet unqualified technology
- 12 Critical design factors
- **Some possible examples of unmanned ships**
- Conclusions and summary

# Deep sea

- 10 000 TEU container vessel
- Shanghai – Los Angles
  - Two states involved
  - 6000 nm, open sea
  - No channels
  - Short port approach
  - Remote control to port
- Dual propulsion systems
- Two stroke diesels
- Biofuel, methanol ...



# Offshore supply



© Bibby ship management

- Offshore supply vessel
- North Sea, Mexican Gulf
  - One state involved
  - 3-6 day roundtrip
  - Base near open sea
  - Infrastructure at base/rig
  - Remote controlled at base/rig
- Dual propulsion systems
- Diesel-electric
- LNG, biofuel, methanol ...

# Short sea automated transport

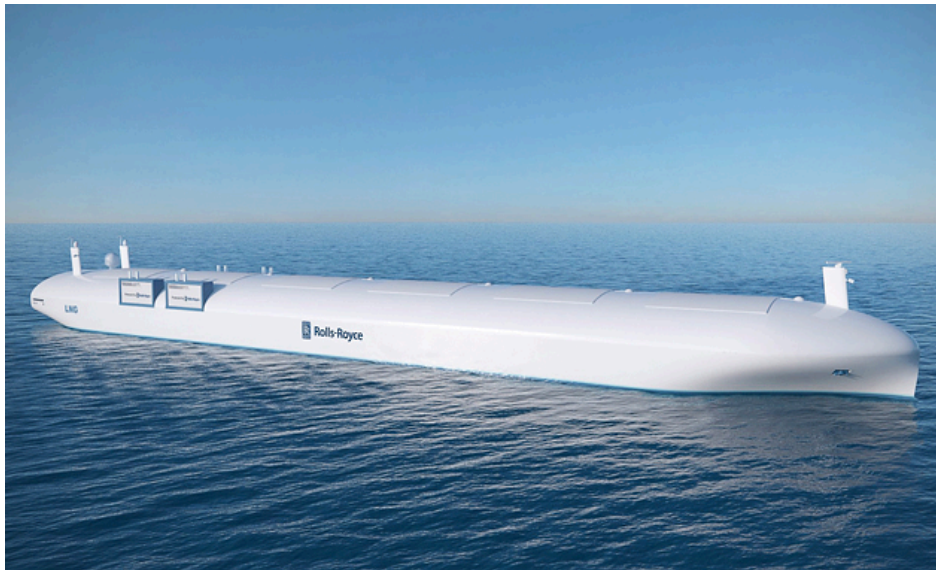
- Transport between small ports
- National/Regional
- 24/7 port calls
- Legs 4-12 hours
- Fully automated cargo handling
- Automated berthing
- Batteries, LNG, biofuel, methanol ...



# Conclusions and summary

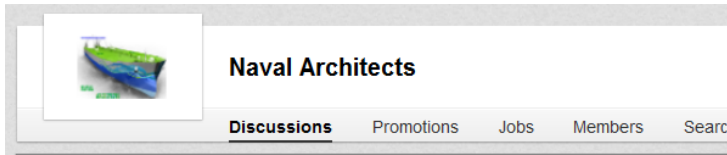
- Largest unmanned ship study in Europe is now completed.
- Overall conclusion is that the unmanned ship will come – no long term show stoppers.
- There are design factors that needs to be considered for successful implementation.
- In addition, the business case must be sound!

# There is already significant interest!



... from the professional sector ...

... as well as the public.



**Naval Architects**  
Discussions Promotions Jobs Members Search

**Electronics Weekly.com**



Breakthrough Technology

**The Economist**

News Blogs Multimedia Companies  
here: Electronics Weekly > News > Business > Viewpoints > Unmanned

**DIE WELT**

Join the group to receive daily or weekly activity updates  
Note: Content in an open group is visible to all LinkedIn visitors



**Rolls-Royce is building Unmanned ships**

**Mihail Mitev**  
Consumer Marketing & Sales Manager

**IHS MARITIME**

Rolls-Royce is building Maritime news - Vessel Holding of Rolls-Royce vessels (drones), which controlled by real ship captains, through

**Unmanned, networked, intelligent ships navigate familiar water**

no comment david manners 7th March 2014 Get news by email



**NDR**  
Das Beste am Norden  
**marine insight**

**THE Motorship**



**IHS Maritime Research & Analysis Round-up**  
data into invaluable insight

**Bloomberg**



**Newsweek**  
WORLD BUSINESS TECH & SCIENCE CULTURE SPORT NEWSWIRE THIS WEEK

HOME NEWS TECH NAVIGATION SAFETY


**Can Futuristic Unmanned Cargo Ships Sail Without Seafarers?**

Facebook 8768 Twitter 70 Google+ LinkedIn Pinterest

Your say on 'unmanned'



**Hamburger Abendblatt**  
**eNav**  
INTERNATIONAL



Meet the Sponsors Behind the People Already in Line  
Court Rules Yelp Can Manipulate Ratings for  
Pirated Copies of The Sims 4 Contain a 'Nudity Glitch'  
Fake Cell Towers Allow the NSA and Police to  
Cell 4ch

**Are Unmanned Vessels the Future for the Ocean?**

By Michael Carroll / July 5, 2014 5:09 AM EDT



# Thank you for your attention!



<http://www.unmanned-ship.org>



SST.2012.5.2-5: Grant no. 314286  
E-guided vessels: The 'autonomous'  
ship

# SEA TONOMY