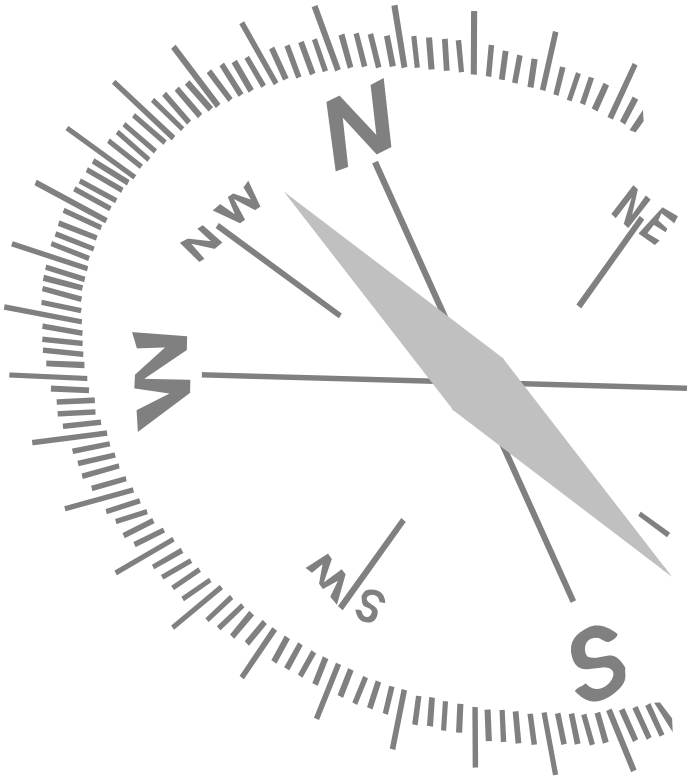

DNV·GL

VOLKER BERTRAM

# Towards Unmanned Ships

# Navigator

- Unmanned Vehicles – Land & Air
- Related technologies
- Visions
- Key tasks & potential solutions
- Autonomous, but manned
- Key hurdles
- DNV GL concept study ReVolt



# Self-driving cars reality

1939: automated highway model in world fair (GM pavilion)

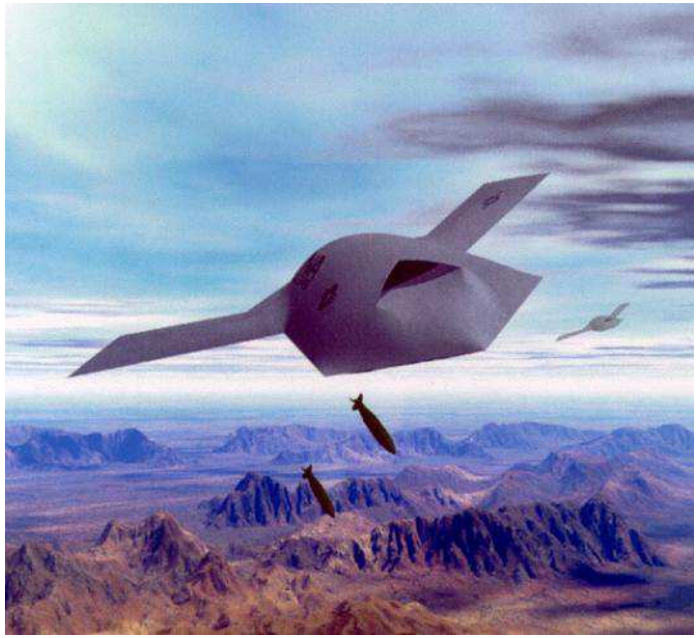
1997: prototype system of intelligent highway in California

1994 – 2001: **“seeing car“** by Prof. Ernst Dickmanns

2014: **Google Driverless Car**

# Unmanned airplanes reality

UCAV prototypes since 2001

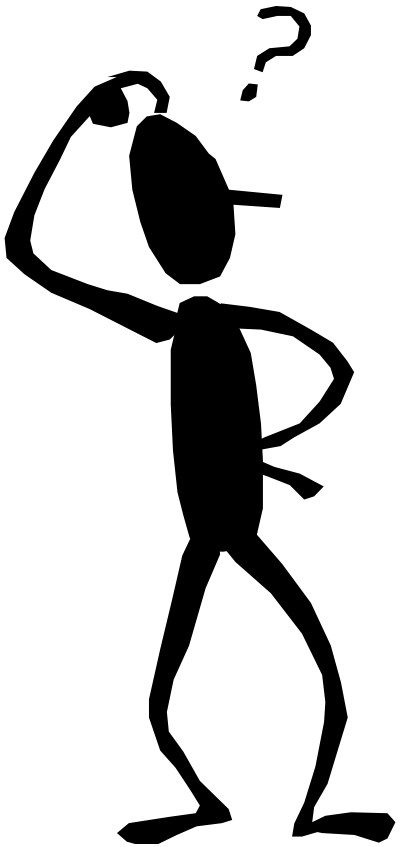


- Stealth technology
- AI allows autonomous flight
- starts and lands on its own
- team capabilities
- sense & evaluate new scenarios

2013

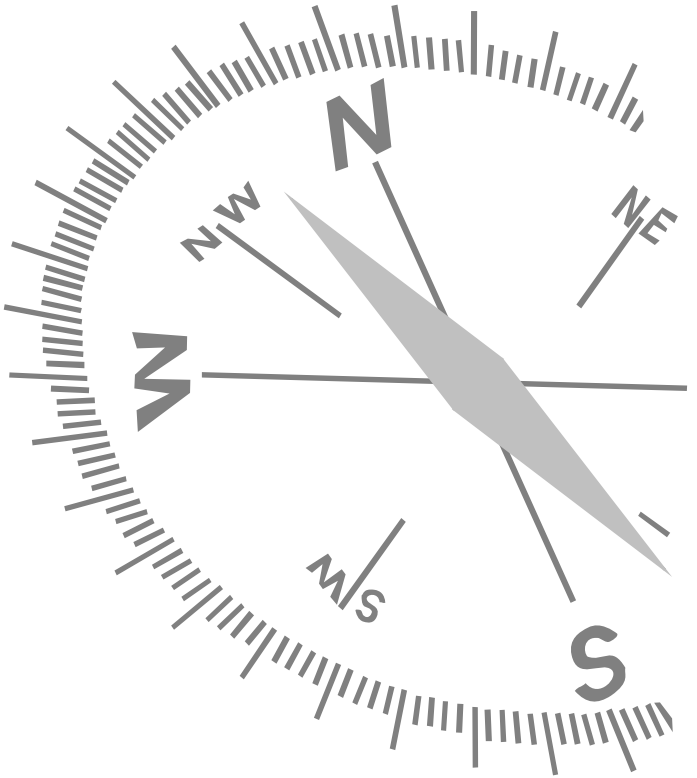
UCAV = Unmanned Combat Aerial Vehicle; AI = Artificial Intelligence

# Where is the “unmanned ship”?



# Navigator

- Unmanned Vehicles – Land & Air
- Related technologies
- Visions
- Key tasks & potential solutions
- Autonomous, but manned
- Key hurdles
- DNV GL concept study ReVolt



# Continuing efforts to reduce crews

Crew size for ocean-going cargo-ships

~ 1860: **250 men**

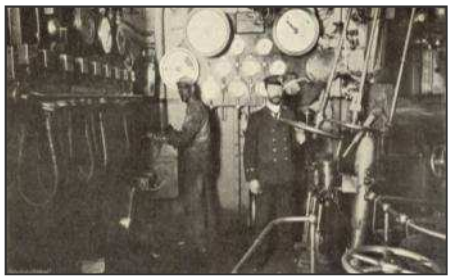
~ 1880: 140 men

~ 1900: 100 men

~ 1950: 40 men (Diesels)

~ 2000: **16 men (containership)**

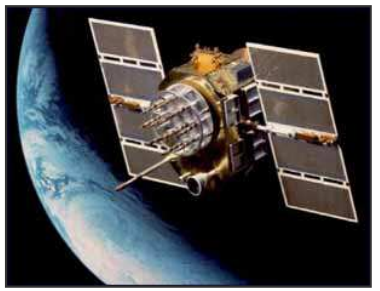
~????: 0 men



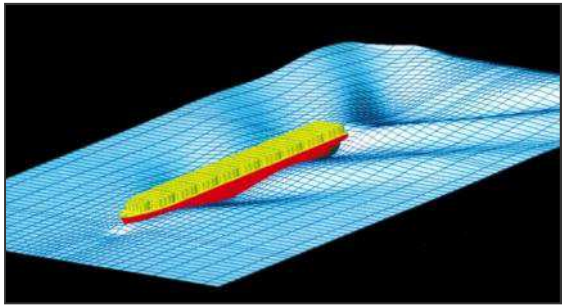
# Various approaches to reduce crews

Master-Slave

Shore Captain



Captain Computer



# Related – Not quite the same



**Underwater robots (AUV, ROV)** – Key differences:

- Radio control impossible
- 6 degrees of freedom (AUV) vs 3 degrees of freedom (ship)
- Little risk of collision & IMO's COLREGs do not apply
- Short-term tasks (~ hours) - Maintenance no problem

**ROV**


**AUV**

ROV = remotely operated vehicle; AUV = Autonomous underwater vehicle

## USV = Unmanned Surface Vessel (oceanographic)

- very slow (different collision avoidance strategies)
- no engine, no propeller
- very long times between overhaul

Wave glider

## USV = Unmanned Surface Vessel (navy & security)

- short-term tasks (~hours) - Maintenance no problem.
- limited payload and space for sensors and computing power
- exempted from IMO regulations
- faster & more manoeuvrable than cargo ships

Owl MK II


Spartan

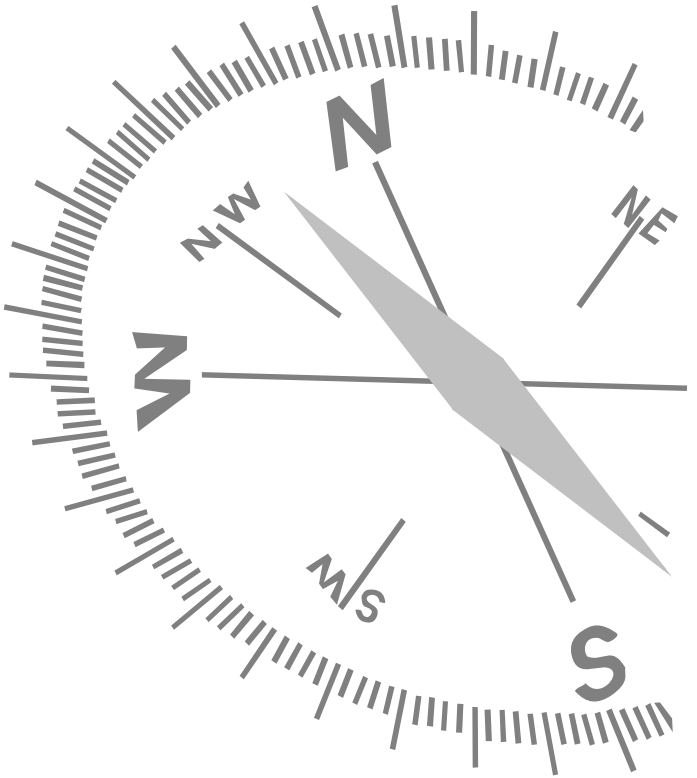
## SailBots = Sailing Robots

- severely limited in payload (= computing power & sensors)
- standard nautical equipment (e.g. radar) not available.
- severe restrictions for manoeuvring
- may have to operate in densely packed groups of vessels (regatta)


Sailbot (Courtesy: INNOC)

# Navigator

- Unmanned Vehicles – Land & Air
- Related technologies
- Visions
- Key tasks & potential solutions
- Autonomous, but manned
- Key hurdles
- DNV GL concept study ReVolt



# No shortage of visions for unmanned ships



~1970

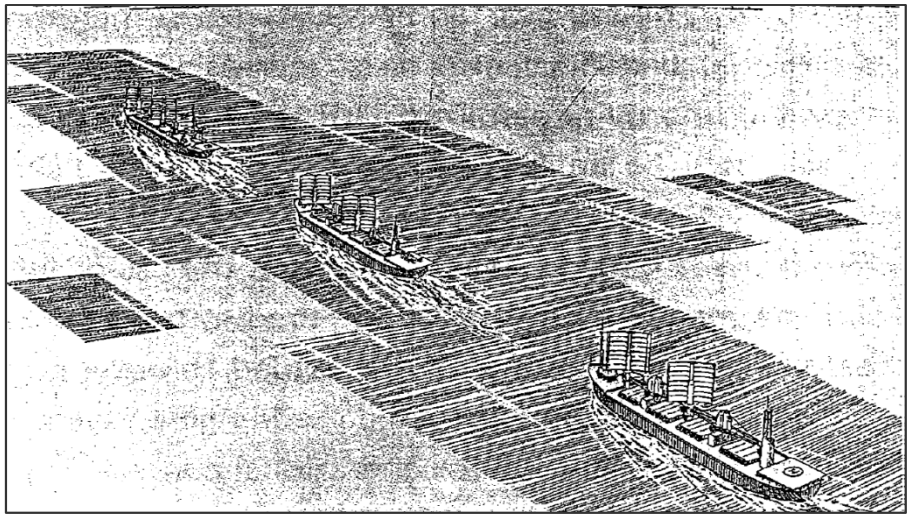
Ships and Shipping of tomorrow

"In this age of […] automation it would not be difficult to imagine a ship without a crew"

# No shortage of visions for unmanned ships



1980s



Japanese Intelligent Ship project

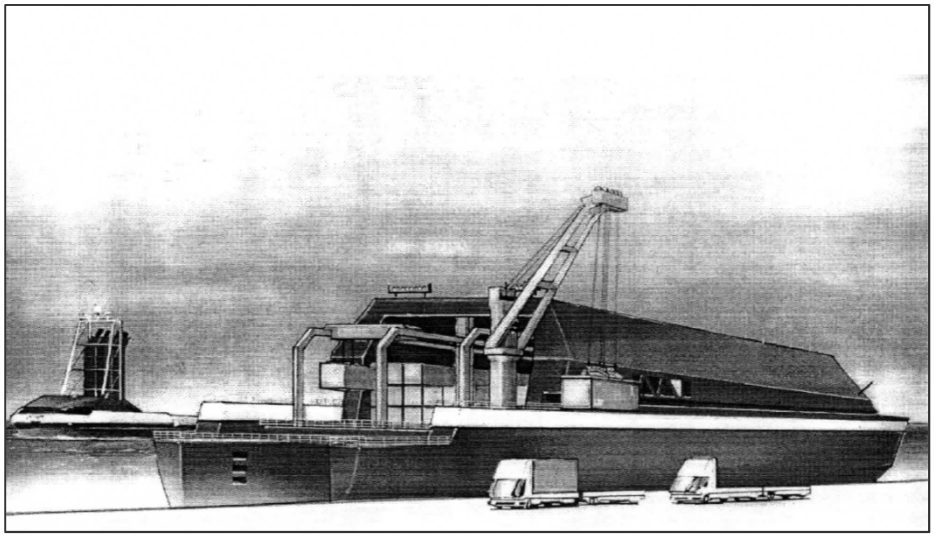
aimed at
“bringing about 'intelligent ships' that can function without help from the crew”

Robot ships in convoy

# No shortage of visions for unmanned ships



1994



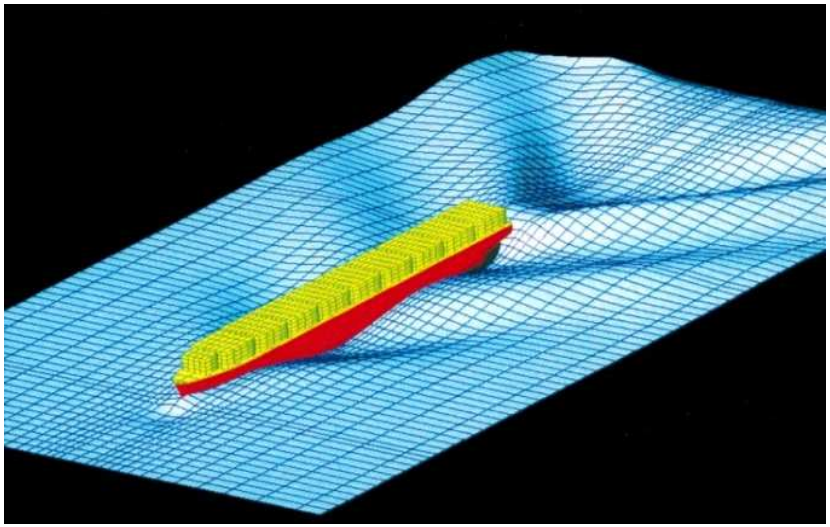
Kai Levander

"Ship without crew" for short-sea shipping:
"A ship with no crew onboard could travel aided by the GPS chain and guided from the traffic stations.
Pilots could board near the harbour and take the [ship] into port.
An automated mooring system secures the [ship] to the quay without help from the crew."

# No shortage of visions for unmanned ships



1996



Bertram & Kaeding

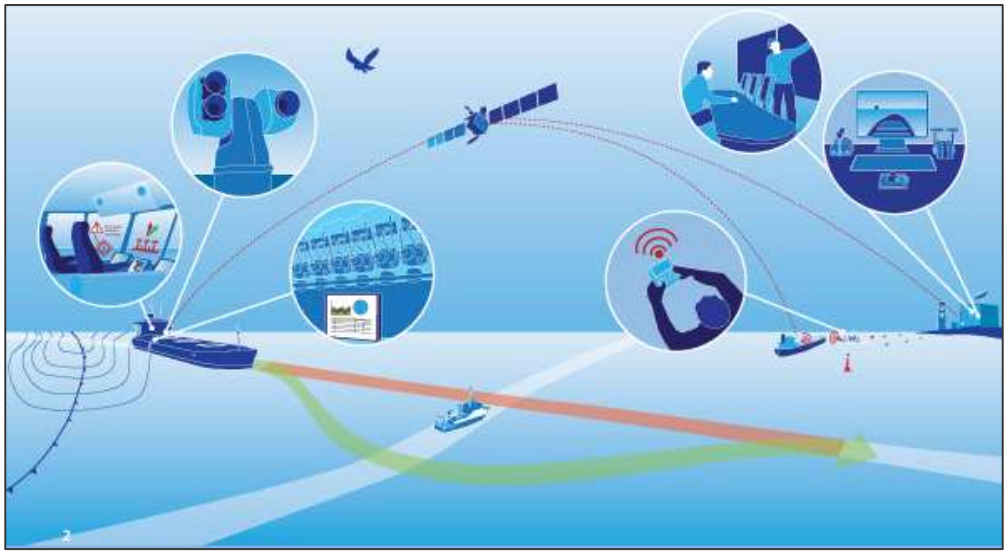
Combination of AI and tele-operation

Feasible but not economically attractive (due to maintenance)

# No shortage of visions for unmanned ships



2012



## MUNIN (EU Project)

Unmanned bulk carrier simulation
Combination of AI and tele-operation

"Even if it is doubtful whether the unmanned merchant ships will be a reality in the short term the concept of an autonomous ship provides an important pathway for a sustainable development of maritime transport."

# No shortage of visions for unmanned ships



2013

Oskar Levander (Rolls-Royce)

Unmanned containerships

Combination of AI and tele-operation

“The idea […] is not new, […]
the difference is the technology now exists.”

# No shortage of visions for unmanned ships 7/7

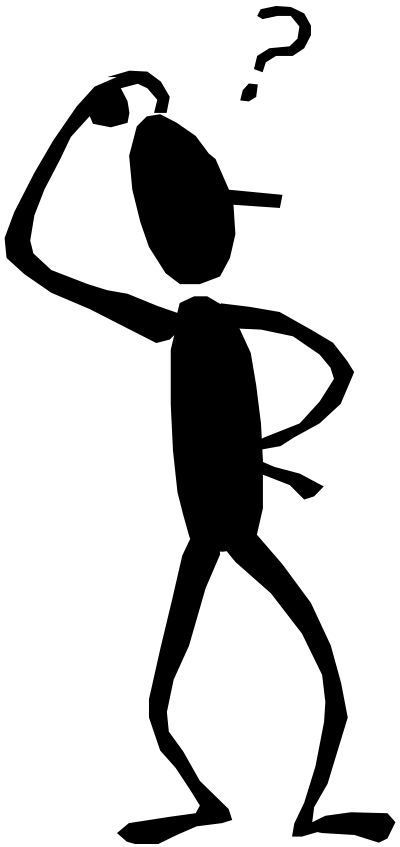
2014


## ReVolt (DNV GL)

Unmanned container feeder vessel
Battery powered, territorial waters of Norway

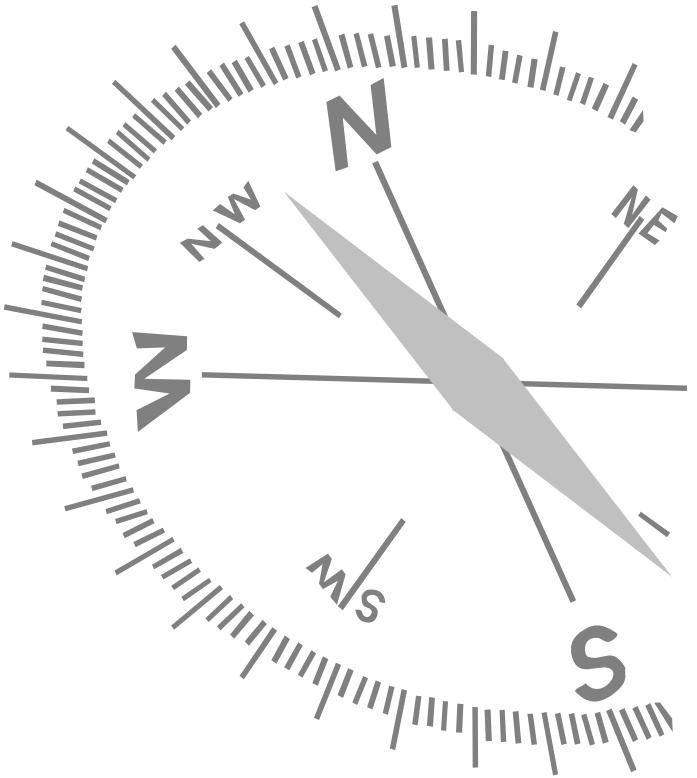
“Building and operating this vessel would be possible with today’s technology. ‘ReVolt’ is intended to serve as inspiration.”

# What is already feasible?



# Navigator

- Unmanned Vehicles – Land & Air
- Related technologies
- Visions
- Key tasks & potential solutions
- Autonomous, but manned
- Key hurdles
- DNV GL concept study ReVolt

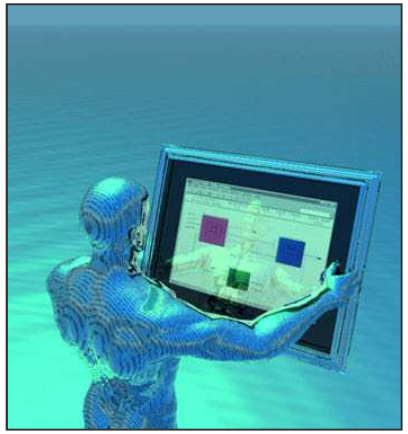


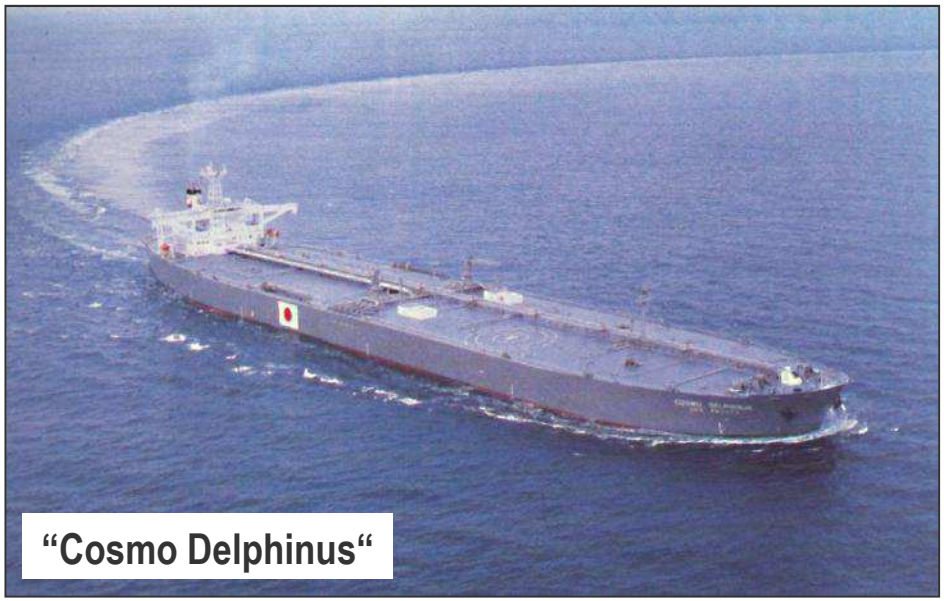
# Collision avoidance – Expert systems in practice for 25 years

**1989: First prototype** demonstrator in **Japan**

subsequently marketed as SuperBridge(-X)

advisory





“Cosmo Delphinus“

# Collision avoidance – Hurdles & solutions

Radar shortcomings:

- **Ship type** (required for COLREGs)
- **Plastic / wood / ice**

Possible solutions:

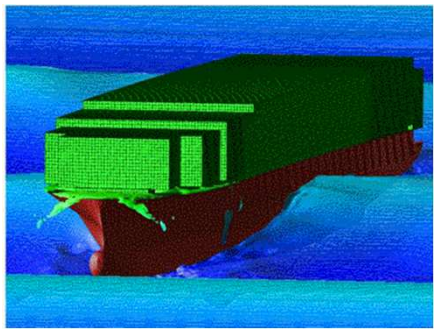
- Change COLREGs
- Use LIDAR for detection
- Use transponders for detection
- Use automatic identification
- Use ECDIS + iceberg tracking
- Use remote human vision

# Voyage execution

## Avoid excessive loads

Substitute human “feel” by sensors & software

- Ship acceleration sensors
- Strain gauges
- Short-term routing software



## Route planning

Already frequently performed on-shore

Both strategic & operational planning feasible

# Berthing – "Normal" ships requiring tug assistance

**Manned Tug + Unmanned ship**

- Remote control
- Successful simulations in Japan (1990)

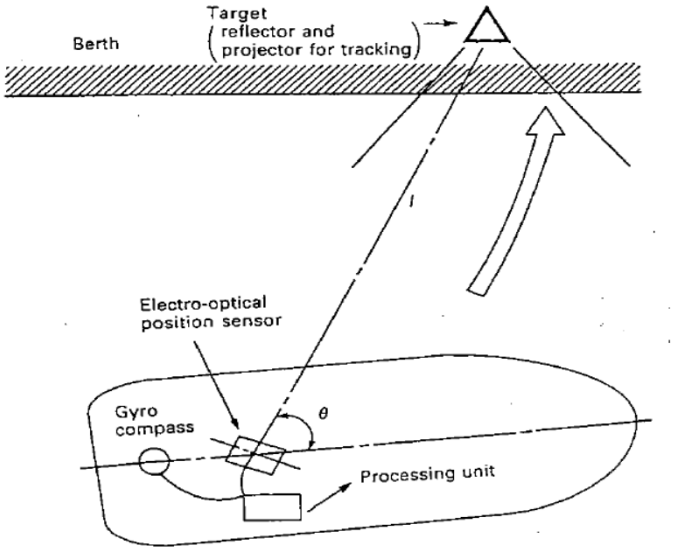
# Berthing – Highly manoeuvrable ships

## Various approaches

- Conical Radar
- Lidar (electro-optical system)

  successful field test in Japan (1990)
- DGPS

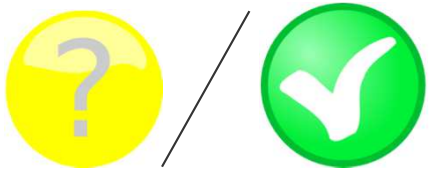
- DP technology for control strategy




DP = Dynamic Positioning

DGPS = Differential GPS

# Mooring & Anchoring



Automatic **anchor handling**

- simulations in 1980s
- (Japanese Intelligent Ship project)

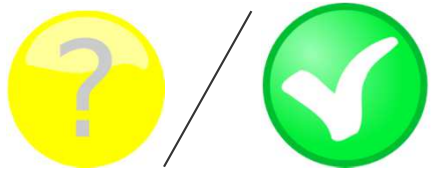
Automatic **mooring**

- Magnetic systems (already used)
- Suction systems

Automatic **tug connection** via tug lines

- Cooperative robotics
  (successful sea trials in 2013)

## Cargo supervision



Reasons for supervision:

- Cargo security (theft & tampering)
- Cargo safety (shifting, fire, …)
- Cargo care (life-stock, refrigerated, LNG, …)

☺ **diligent & fast**

☹ **dumb**

Requirements depend on cargo type, **easy-to-difficult** task

## Cargo document handling


Moving towards “paperless” document handling:

- Automated **electronic report** making & transmission
- **“Internet of Things”**

Driven by general logistics industry

“Just” needs to be implemented in practice

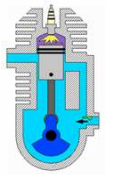
# Machinery – General technical development helps

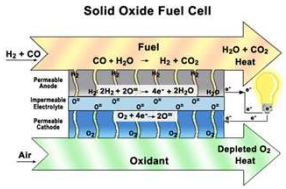
Machinery requires care:

- Maintenance (lubrication, filters, …)
- Repairs

**Classical "show-stopper"** for unmanned ships

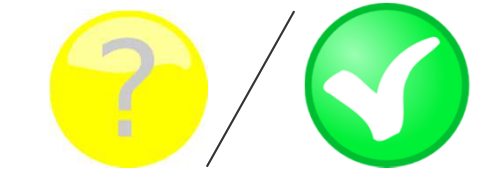
Low-emission paradigm change makes things easier

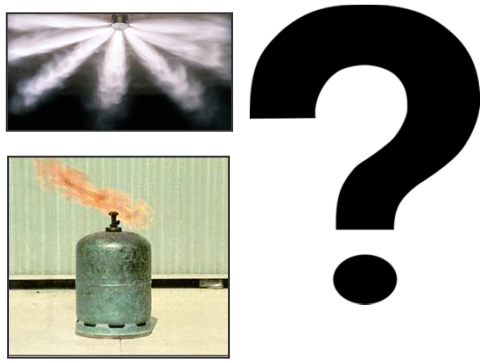





time

# Emergency Response





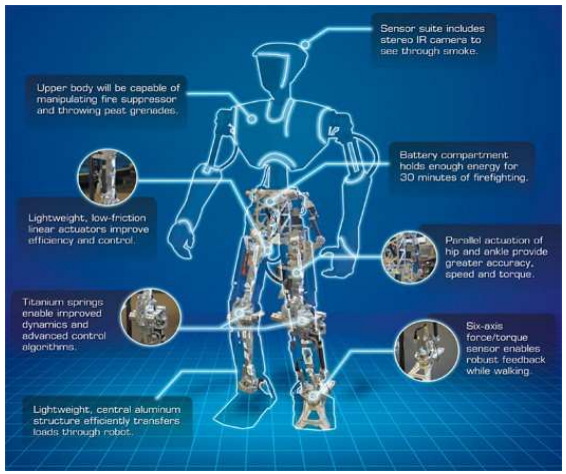
**Fire** & Co.

- Respond quickly
- Keep calm

**Expert systems** exist

Robots better for **dangerous task**

- Smart sprinkler systems
- Fire-fighting mobile robots



# Navigator

Unmanned Vehicles – Land & Air

Related technologies

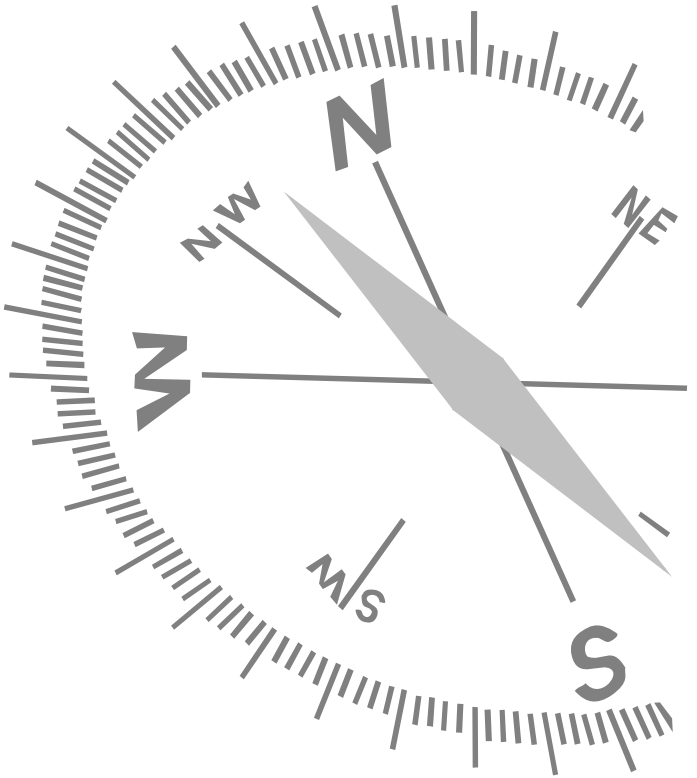
Visions

Key tasks & potential solutions

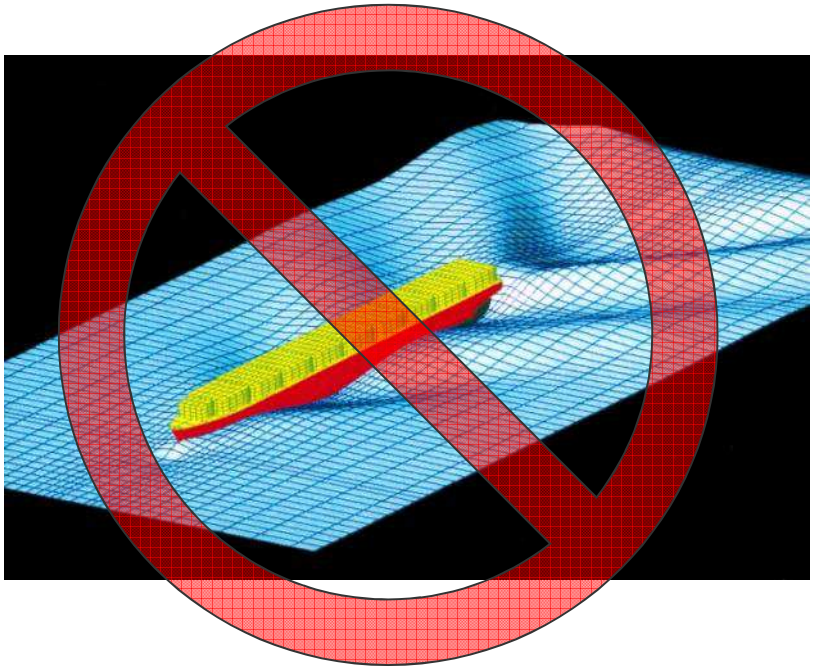
Autonomous, but manned

Key hurdles

DNV GL concept study ReVolt



# The near-term issue is the “Smart Ship”



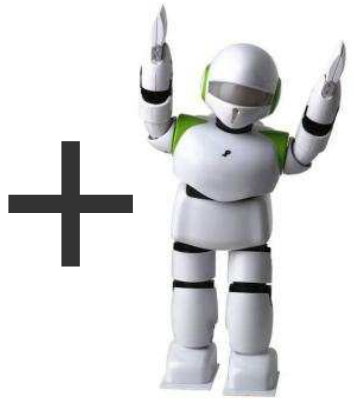

Alias “autonomic“
Alias “intelligent“
Alias “Cybership“

Both concepts share task for extending automation

# Next step: The "smart" ship

**"Smart" ship = Combine strengths**

- Autonomous (= highly automated)
- Manned (= smaller crews operating "easy-to-drive" vessel)



**Assorted technology**

- Collision avoidance system
- Cargo supervision systems
- Emergency response systems
- "Distributed Bridge"
- Operator fatigue sensors
- …

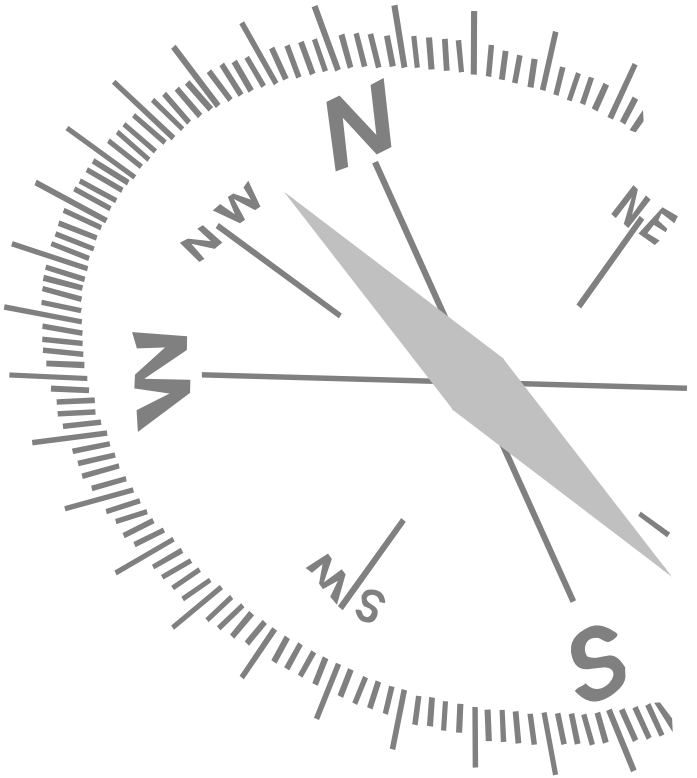
# Wide acceptance & vital test phase

- Better work environment
- Safer shipping
- In-situ testing

**“Like a Mercedes”**

# Navigator

- Unmanned Vehicles – Land & Air
- Related technologies
- Visions
- Key tasks & potential solutions
- Autonomous, but manned
- → Key hurdles
- DNV GL concept study ReVolt



# Hurdles remain towards unmanned shipping

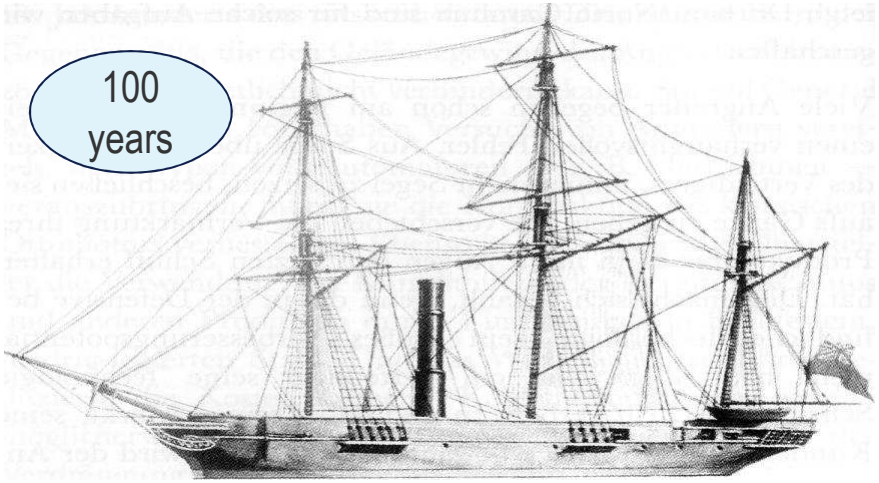
**“Frequently Asked Questions”** (depending on background, age & nationality)

- Never, ever trust technology
- You just can’t replace a (real) man by a machine
- Pirates will love it !
- But it is not legal…
- What about the jobs?
- …

Let‘s have
a closer look

# Never, ever trust technology! 1/2

**Very conservative industry**




Yes, things can go wrong…

… especially if you involve humans

Don’t expect 100% safety from machines.

**Equal or better safety** suffices.

# Never, ever trust technology! 2/2

## Diffuse technophobia

"Don't underestimate public opinion."


- Generation problem ?
- Time and good track records will solve the problem

# Emotional concerns & human ego

**A computer can't do the job**

Really? Heard that one before…

- Play chess
- Fly airplane
- Drive car
- …

Captain Realdeal

Captain Computer

# Solidarity with seafarers

**Seafarers & trade unions** look with concern at “automatic” ships:

- Devalues profession implicitly
- Threatens employment
- Degrade working conditions


It depends on how we do it.

**Poorly designed automation is detrimental to our goals and values.**

But “driving a Mercedes”, seeing wife & family each evening, … is not that bad

# Pirates ahoy!



**Pirates will love it!**

Not really.

They get more money

if crew is taken as hostages.

Crews are not action heroes…

# Pirates ahoy! 2/3

**But anybody could take ship & cargo legally**

Abandoned ships belong traditionally to the finder.

(Horatio Hornblower loved this)


Legal frameworks can be changed

- Tele-operated ship is not abandoned
- Treat unmanned ships same as unmanned buoys

# Pirates ahoy!



**Cyber-Pirates**

Any old hacker could take over the ship

Any old hacker could take over e-banking

… but only in Hollywood movies

# Net savings debatable

## Economic concerns for unmanned ships

- **Liability** for system suppliers
- **Insurance** rates (initially)
- **Initial costs** for equipment – higher / lower?
- Lower **resale** value (initially)

Net **savings debatable / speculative**

# Several IMO regulations would require updates

Concerns regarding **IMO regulations**:

- COLREGs (under discussion)
- Seafarers in distress
  - robotic retrieval feasible
  - legal treatment as unmanned buoys
- Cargo supervision (security)
- "Sufficient & qualified crew" – "equivalent safety approach"?

14 IMO conventions concerned,,,

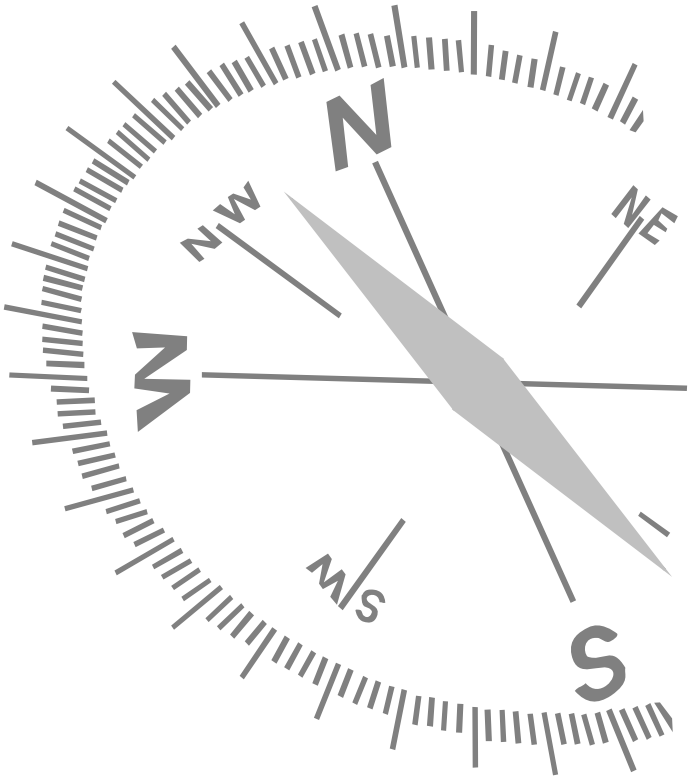
… but IMO regulations evolve with time & technology

>5-15 years

**Easier for territorial waters** – National regulations (e.g. Norway)

# Navigator

- Unmanned Vehicles – Land & Air
- Related technologies
- Visions
- Key tasks & potential solutions
- Autonomous, but manned
- Key hurdles
- DNV GL concept study ReVolt

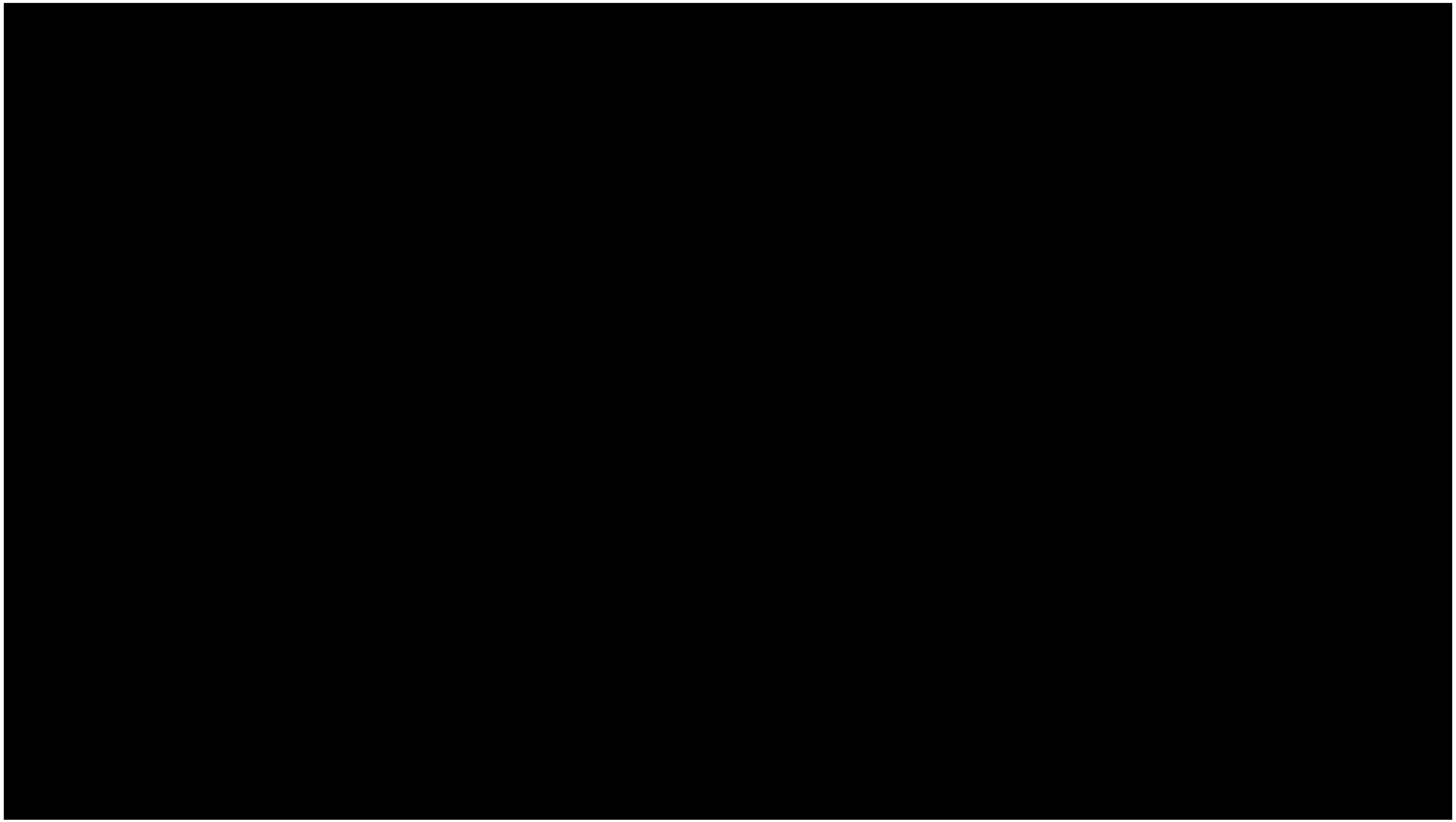


# Movie-time !



Hans-Anton Tvete

# Movie-time !



# Information & Discussion lead eventually to political consensus

# We are here to help you !

**Volker Bertram**

**DNV GL – Maritime Services**

volker.bertram@dnvgl.com
+49 40 36149 3457

**www.dnvgl.com**

SAFER, SMARTER, GREENER