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

UCAV = Unmanned Combat Aerial Vehicle; AI = Artificial Intelligence
Where is the “unmanned ship”? 
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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
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 = 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
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)
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Ships and Shipping of tomorrow
“In this age of [...] automation it would not be difficult to imagine a ship without a crew”
1980s

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

Robot ships in convoy
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.”

1994
Bertram & Kaeding
Combination of AI and tele-operation
Feasible but not economically attractive (due to maintenance)
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.”
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

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?
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Collision avoidance – Expert systems in practice for 25 years

1989: First prototype demonstrator in Japan

subsequently marketed as SuperBridge(-X)

“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
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
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 requires care:

- Maintenance (lubrication, filters, …)
- Repairs

**Classical “show-stopper”** for unmanned ships

Low-emission paradigm change makes things easier
Fire & Co.

• Respond quickly
• Keep calm

**Expert systems** exist

Robots better for **dangerous task**

• Smart sprinkler systems
• Fire-fighting mobile robots
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The near-term issue is the “Smart Ship”

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”
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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!

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.
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
- …
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 will love it!

Not really.

They get more money

if crew is taken as hostages.

Crews are not action heroes…
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
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

**Easier for territorial waters** – National regulations (e.g. Norway)
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Movie-time!

Hans-Anton Tvete
Information & Discussion lead eventually to political consensus

Embrace change! I have a dream...

Your dream is my nightmare!
We are here to help you!

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