



NTNU

Norwegian University of
Science and Technology

WHEN TRUST MATTERS

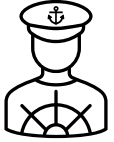
A Human-Centred Design approach to maritime cyber resilience training

HFC Conference

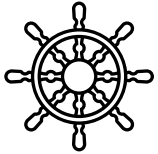
Erlend Erstad
PhD cand, NTNU in Ålesund / Senior Consultant, DNV

18 October 2023

Agenda



Maritime nautical operations and cyber safety issues



Navigators at the sharp end of an operation



How we develop human-centred maritime training for enhanced maritime cyber resilience



Maritime bridge simulator cyber resilience exercises

PhD candidate

Nautical Operations

2020-2023

DNV

NTNU in Ålesund

Erlend.Erstad@DNV.com



Background

- Able Seaman Certificate – Østensjø Rederi AS
- B.Sc. Nautical Sciences – NTNU Ålesund
- Certificate of competence – Deck Officer Class 3 – Østensjø Rederi AS
- M.Sc. Management of Demanding Marine Operations – NTNU Ålesund
- FMEA Auditor – Boatlabs AS
- M.Sc. course instructor/lecturer - NTNU



Picture: Østensjø rederi AS

Maritime Cyber Resilience

- Research Council of Norway project - Knowledge Building project for Industry
- Focus on cyber attacks towards Integrated Navigation systems
- Operational perspective for increased Maritime Cyber Resilience
- Main Supervisor: Runar Ostnes
- Co-Supervisor: Mass Soldal Lund
- Co-Supervisor: Kimberly Tam



Norwegian Defence University College



KONGSBERG



NORWEGIAN HULL CLUB



Norwegian University of Science and Technology

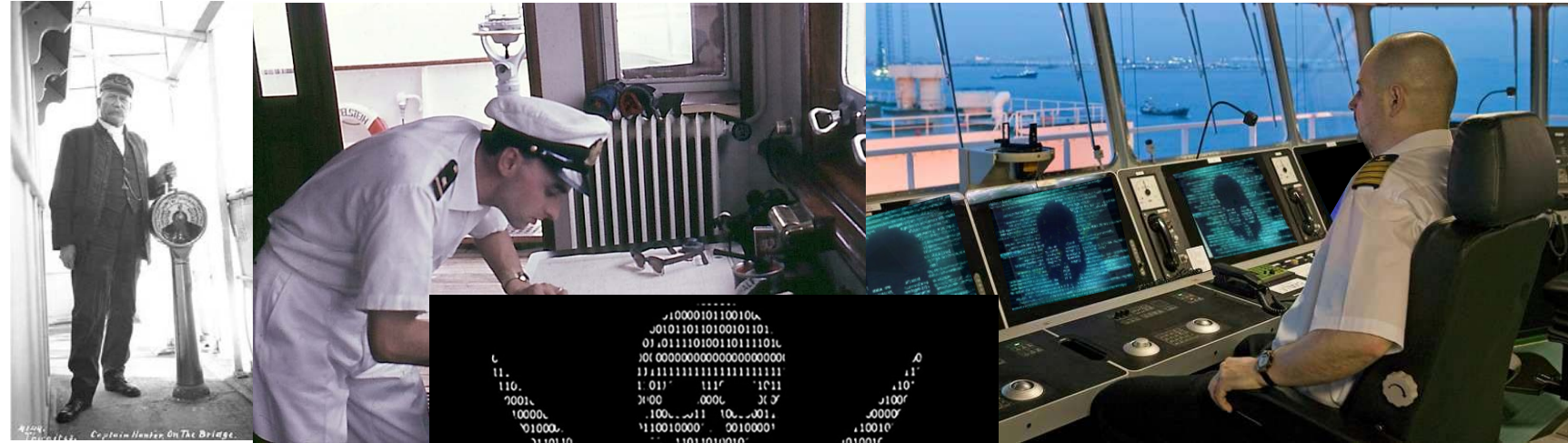


The problem

Nautical education vs cyber-attacks

- Ships have evolved
- New opportunities creates new technologies
- New technologies are creating new risks

- What are we afraid of?
 - Is nautical education up to speed?



Picture: Wikimedia Commons Picture: Wikimed

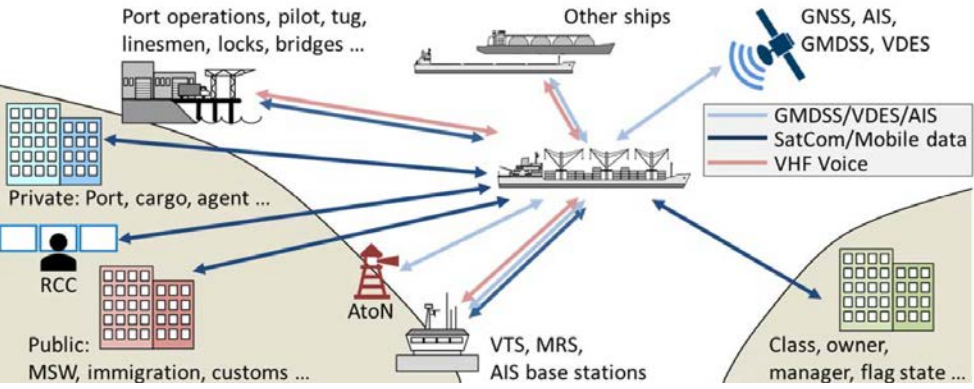


berg



Picture: Kongsberg

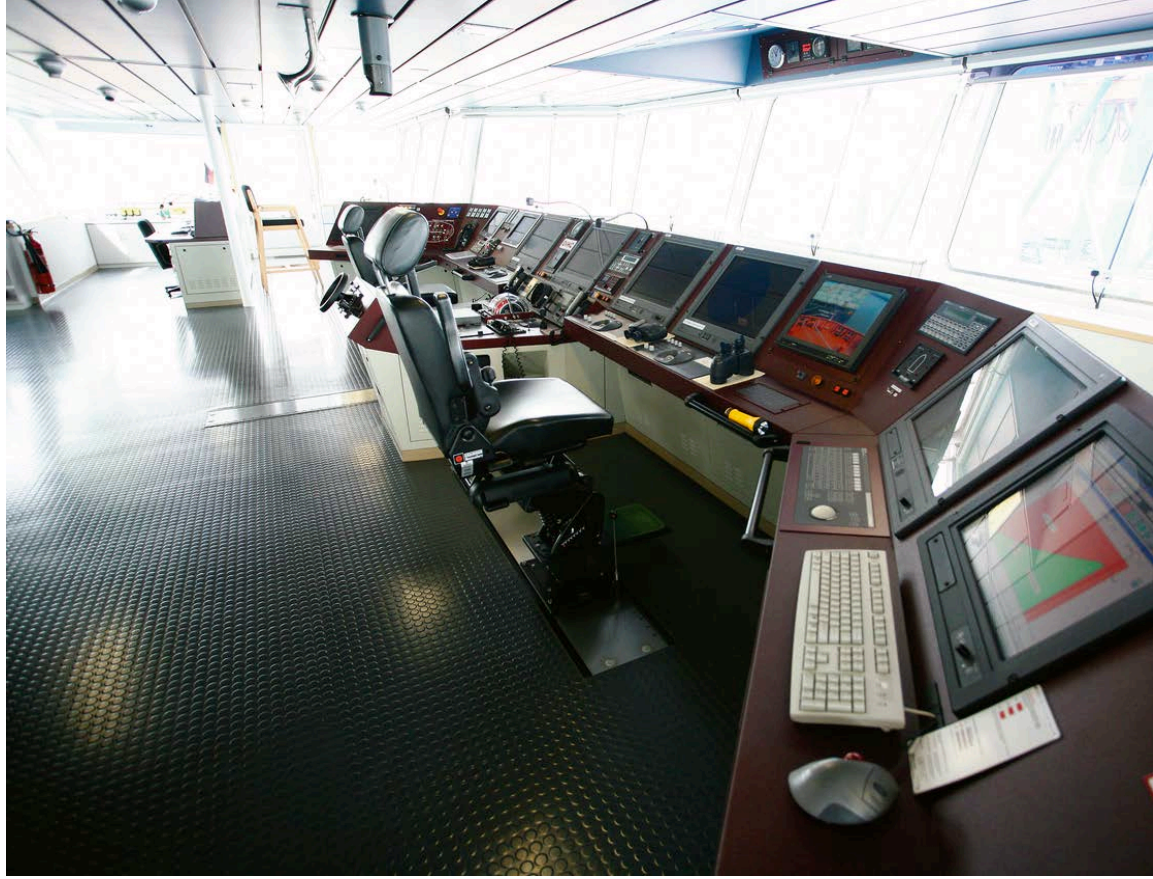
Is it really a problem?



Picture: Sintef, 2020



(DNV)



(DNV)

Is it really a problem?

Known vulnerabilities



Figure 4. CR displays on top of portable CR computers and servers on left, main rudder testbed components on right with some systems like ECDIS out of view for security purposes, and the “attacker’s” computer.

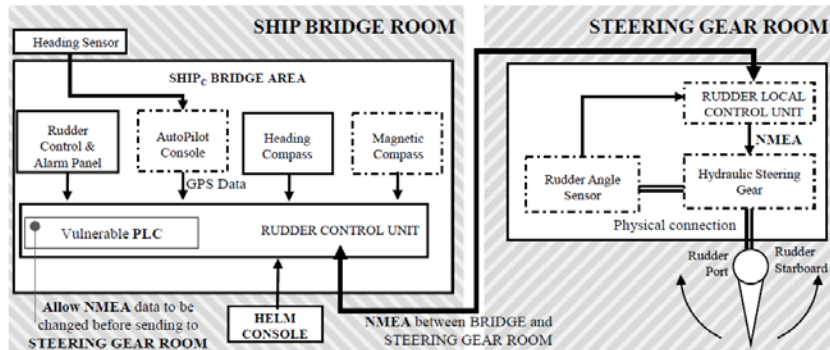


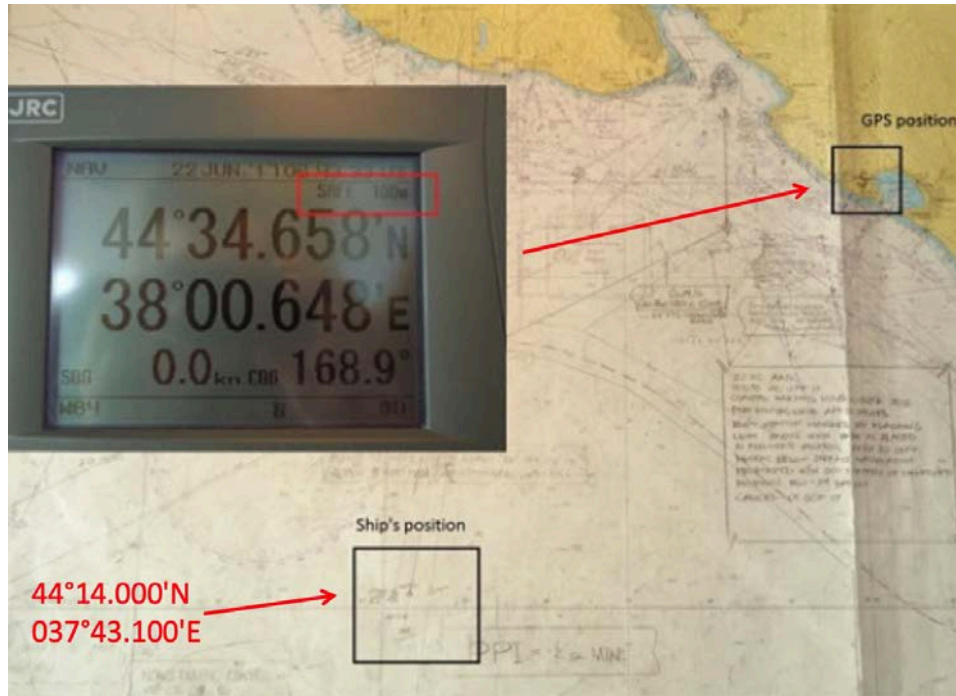
Figure 3. Simulated CR elements on the left in solid lined boxes, and physical hardware testbed on the right, with some hardware, shown with dotted boxes, on left side.

(Tam, et. al. 2022)



Is it really a problem?

Known vulnerabilities



Kessler & Shepard, 2022



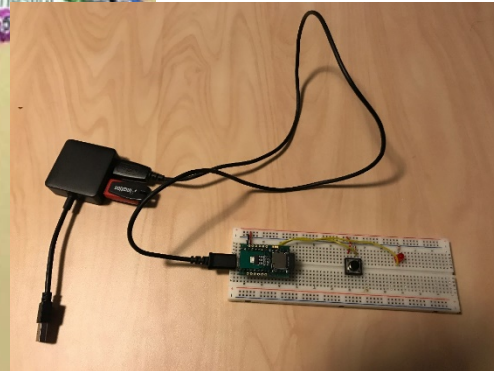
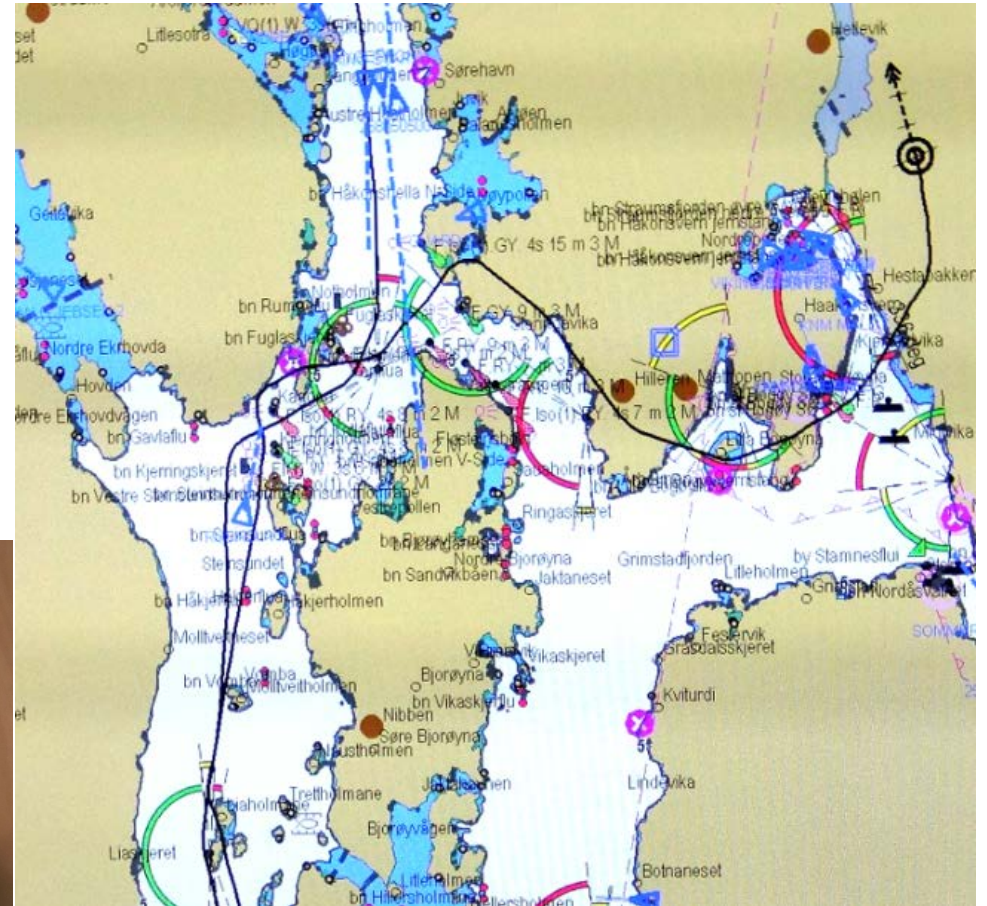
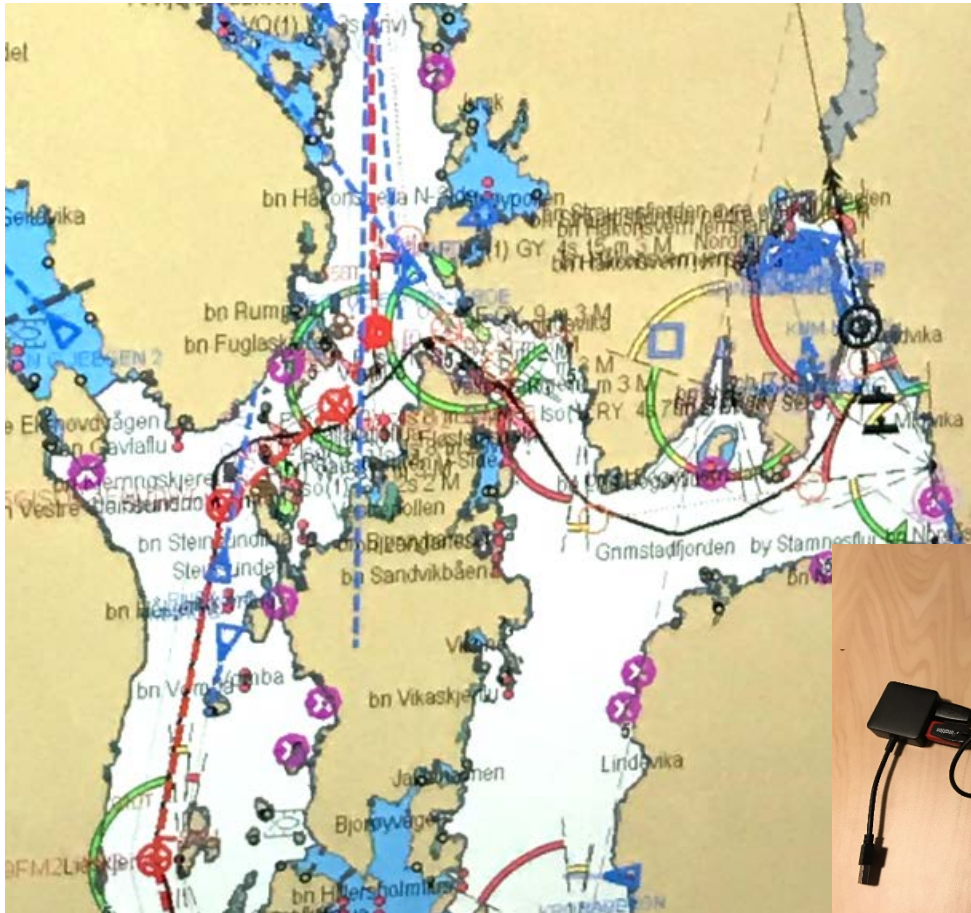
New GPS 'circle spoofing' moves ship locations thousands of miles

Gpsworld, 2020

Artikel: <https://www.gpsworld.com/new-gps-circle-spoofing-moves-ship-locations-thousands-of-miles/>

Is it really a problem?

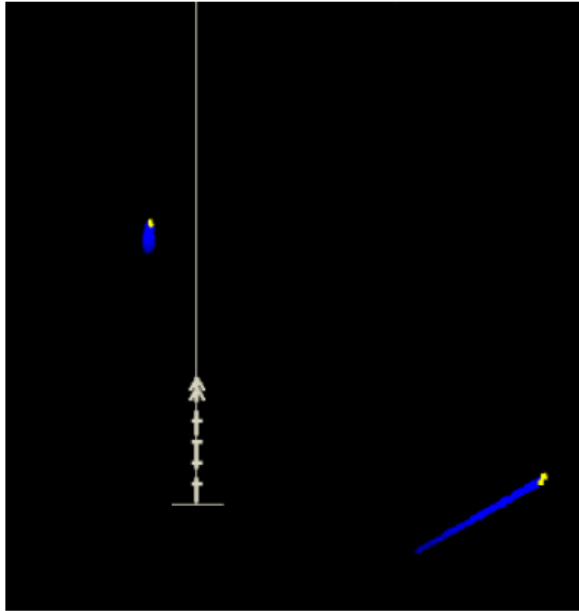
Known vulnerabilities



(Lund et. al 2018)

Is it really a problem?

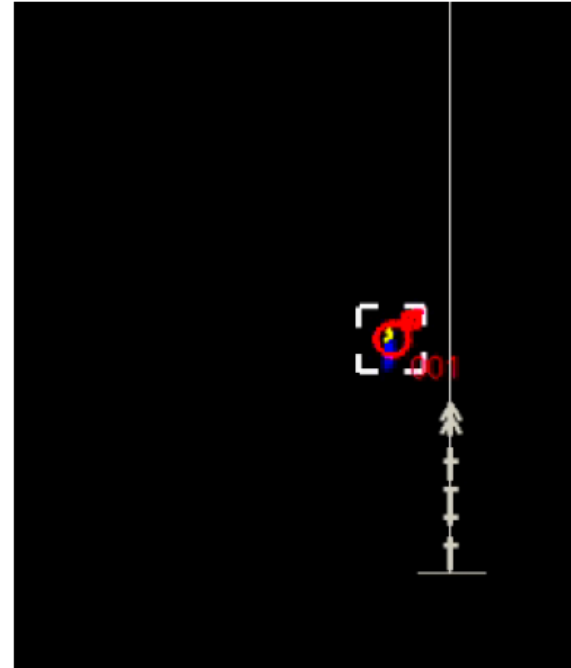
Known vulnerabilities



(a) Real



(Wikimedia Commons)



(a) Real



(Wikimedia Commons)

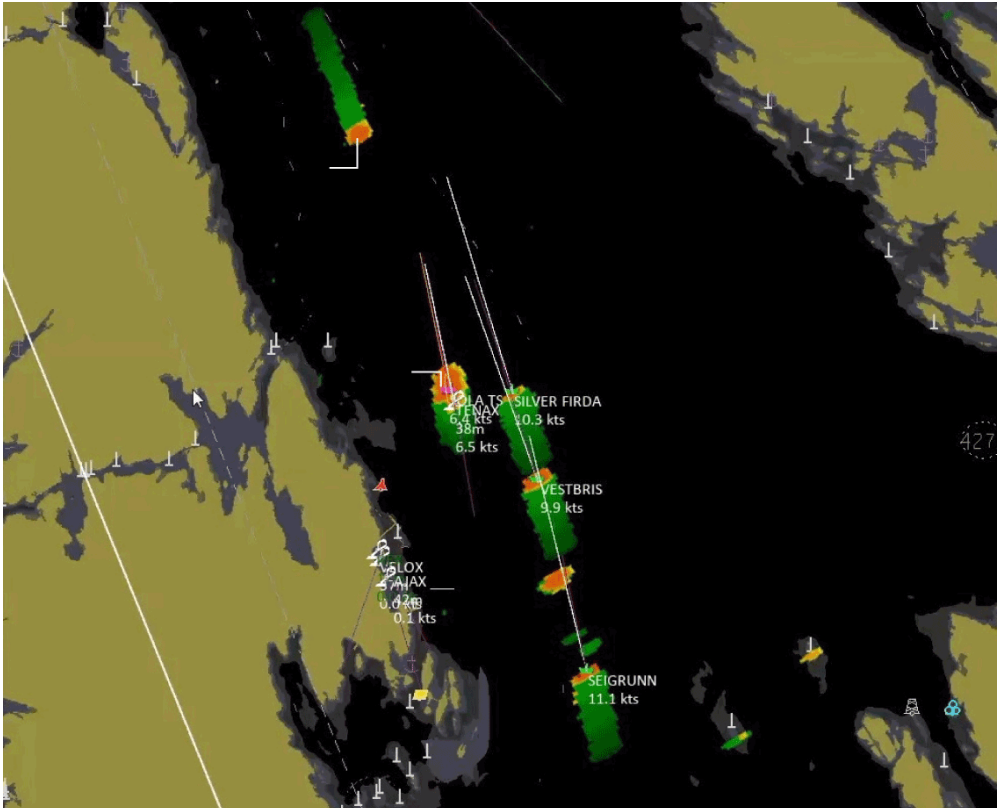
Fig. 10: Comparison of video feeds during V-B1.

Fig. 11: Comparison of video feeds during V-B2.

(Longo, 2022)

Potential consequences

Not related to cyber-attacks



<https://www.vg.no/spesial/2018/helge-ingstad-ulykken/>



<https://finansavisen.no/nyheter/shipping/2021/07/04/7700534/forlik-etter-ever-given-grunnstotingen>

NTNU in Ålesund

- Educating seafarers and maritime industry workers
 - Innovative campus – new solutions using traditional tools
- Want to be the preferred university for nautical education
- Regulations for standard training (STCW) is slow to implement new things



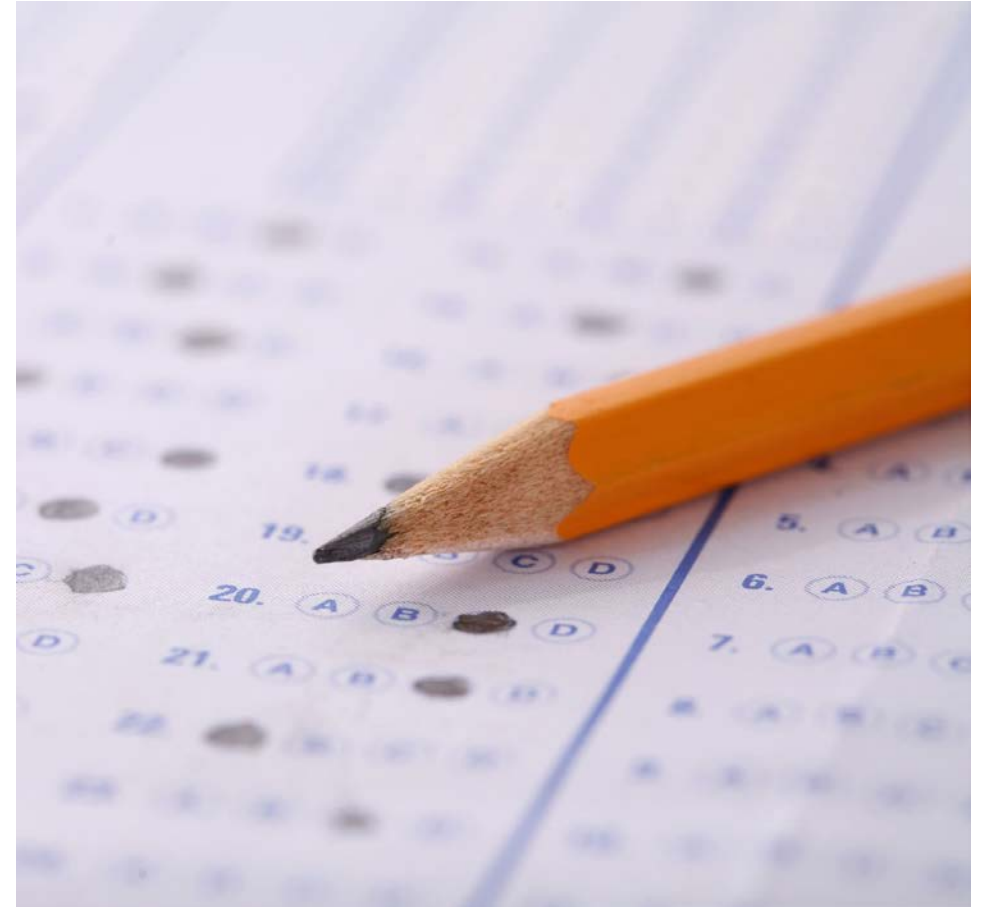
Rules and regulations

- International regulations:
 - Safety of Life at Sea / International Safety Management Code
- Cyber specific international resolution
 - Maritime cyber risk management in safety management system
 - Guidelines on maritime cyber risk management
- Industry best-practice and class notations / guidelines
 - BIMCO Guidelines on cybersecurity onboard ships / DNV-CG-0325 Cyber Secure
- New and stricter regulations
 - International Association of Class Societies
 - Unified Requirements for Cyber Resilience

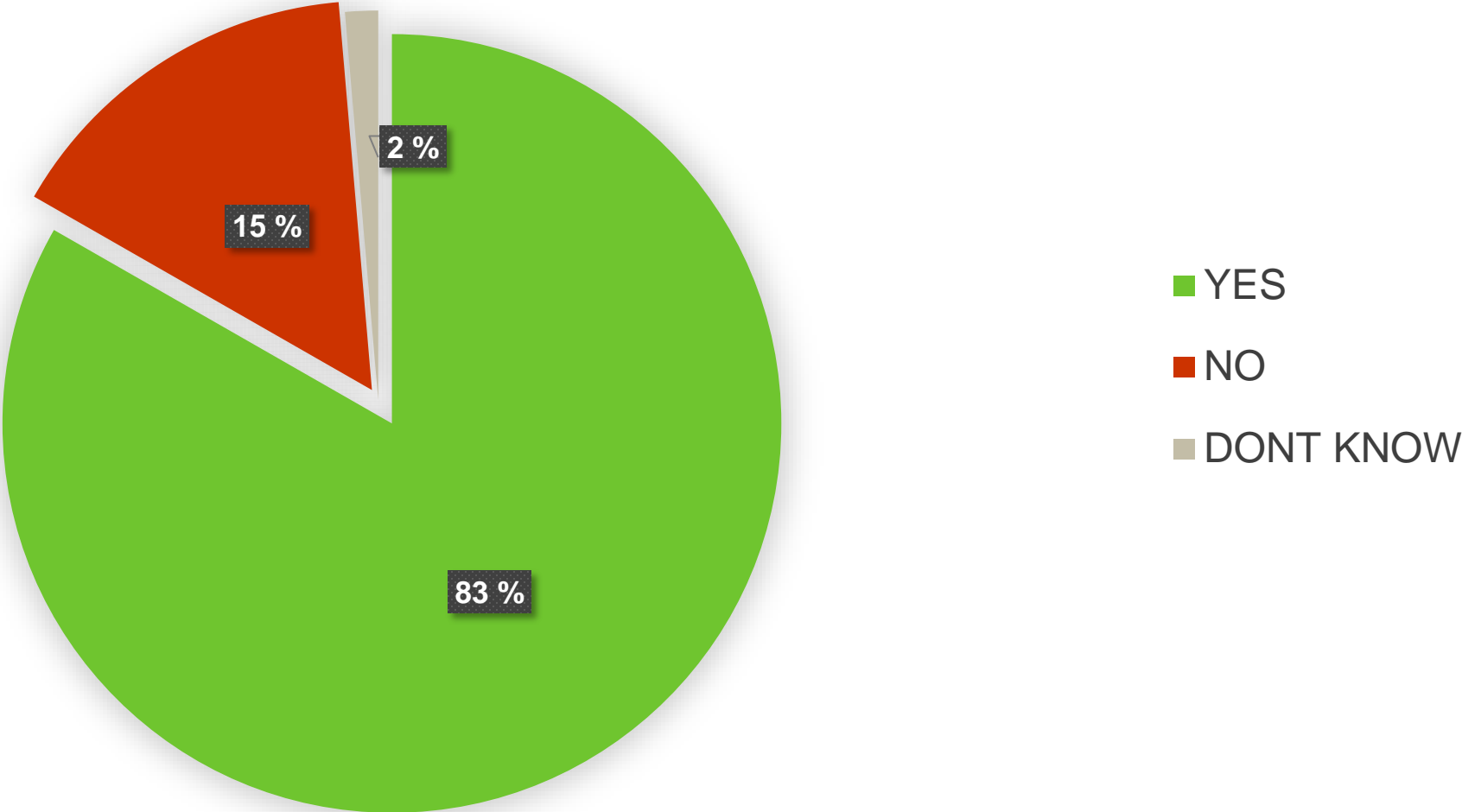


How is the industry doing?

- Deck officers cyber risk perception
 - Marie Haugli-Sandvik (in review)
- Theme: Experience and training with cyber security
- 293 sailing deck officers responded
- 11 offshore shipowner companies
- October to December 2022



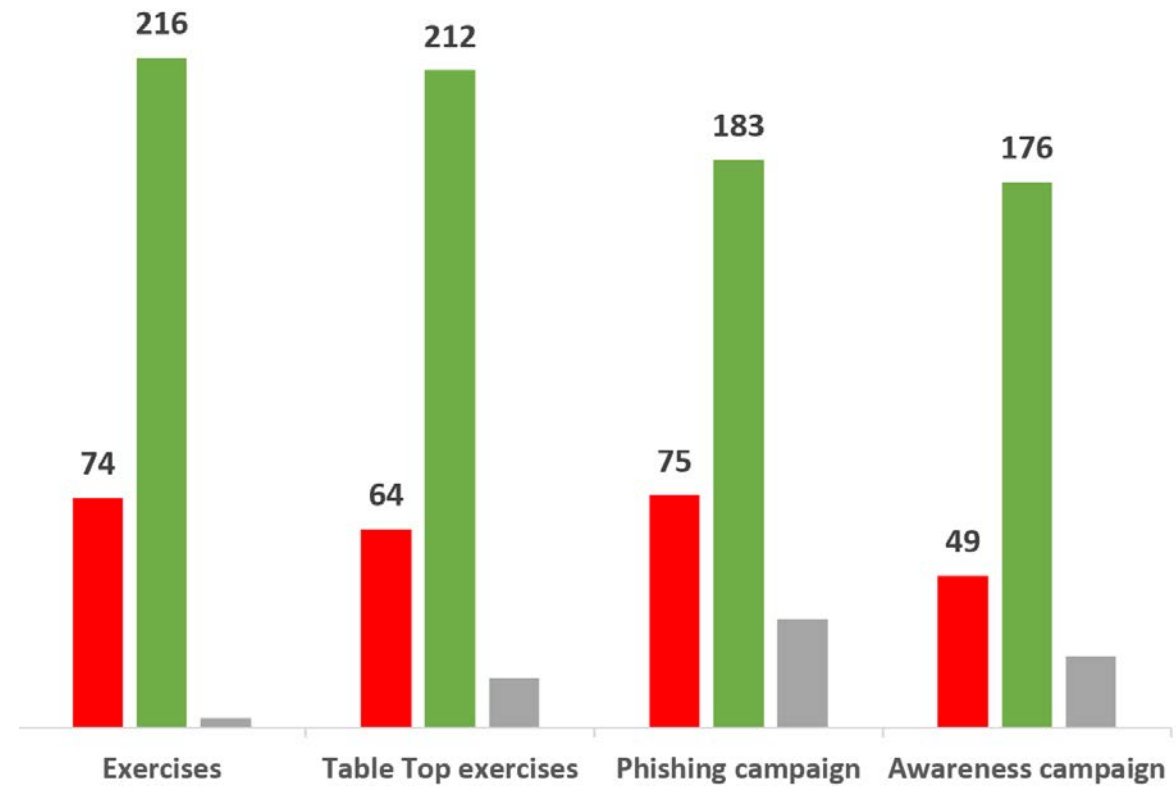
Cyber security training



(Haugli-Sandvik, in review)

The type of training

Great!
But is it working?

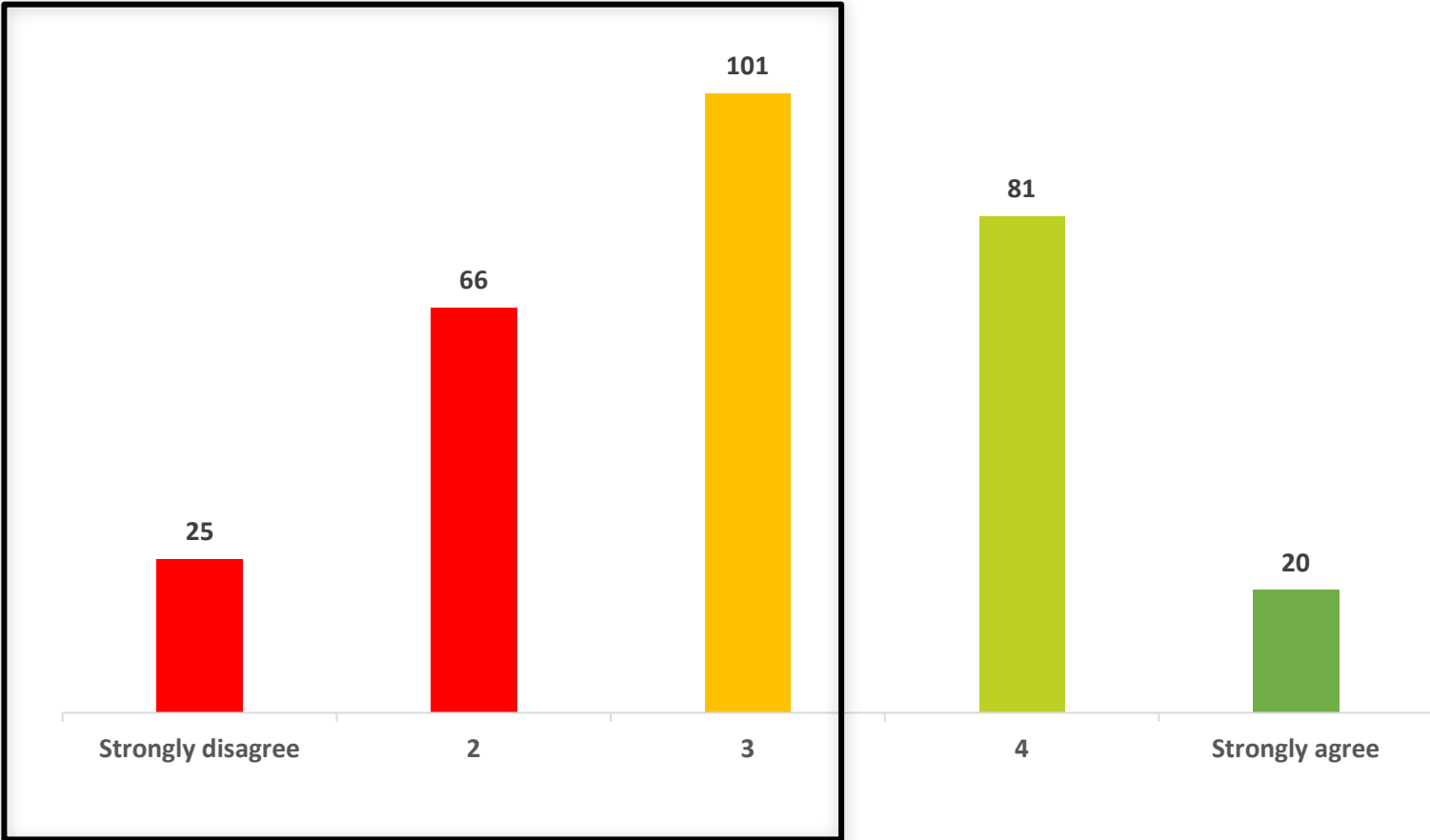


(Haugli-Sandvik, in review)

■ Never ■ Once or more ■ Dont know

Handling a cyber incident onboard

- 66% do not have sufficient knowledge



(Haugli-Sandvik, in review)

Bridge operational safety and cyber security

- A need for innovative thinking
- Traditional “learning-by-doing”

- Introduce a very technical problem for operational and “non-technical” people
 - Sailing crew
 - Onshore management staff

- Human-Centred design + Learning and training

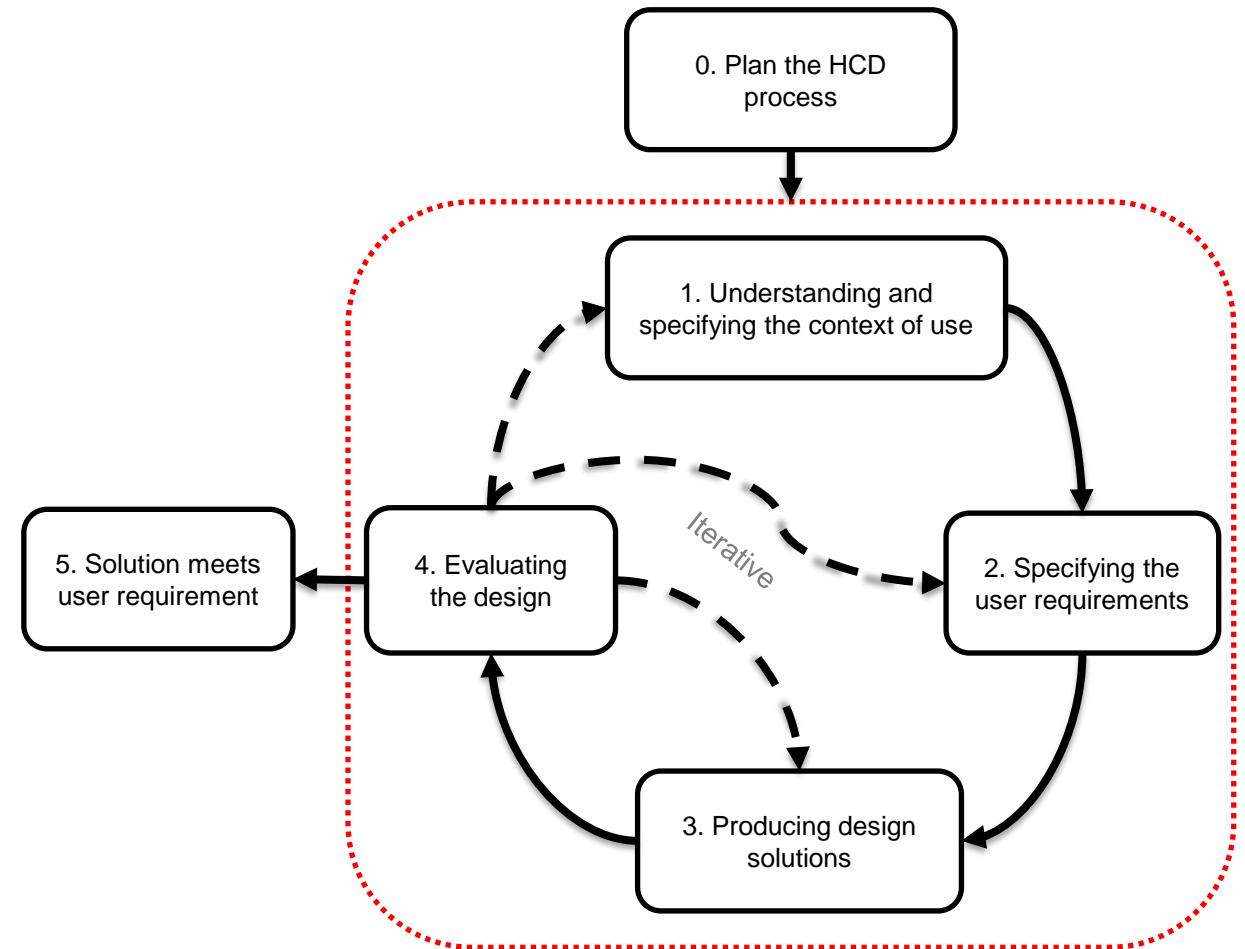


Human-Centred Design

“An approach to interactive systems development that aims to make systems usable and useful by focusing on the users, their needs and requirements” (page vi)

“It is intended to be used by those managing design processes, and is concerned with in which both hardware and software components of interactive systems can enhance human-system interaction” (page 1)

We used it for designing training and education.



The Human-Centred Design process (ISO, 2019)

The development process

Who is the user?

- Users
- Tasks
- Characteristics
- Environment

Seafarers and shore support
 Keep ship safe / understand cyber risks
 Traditional line of work
 Specialized environment

Does it work?

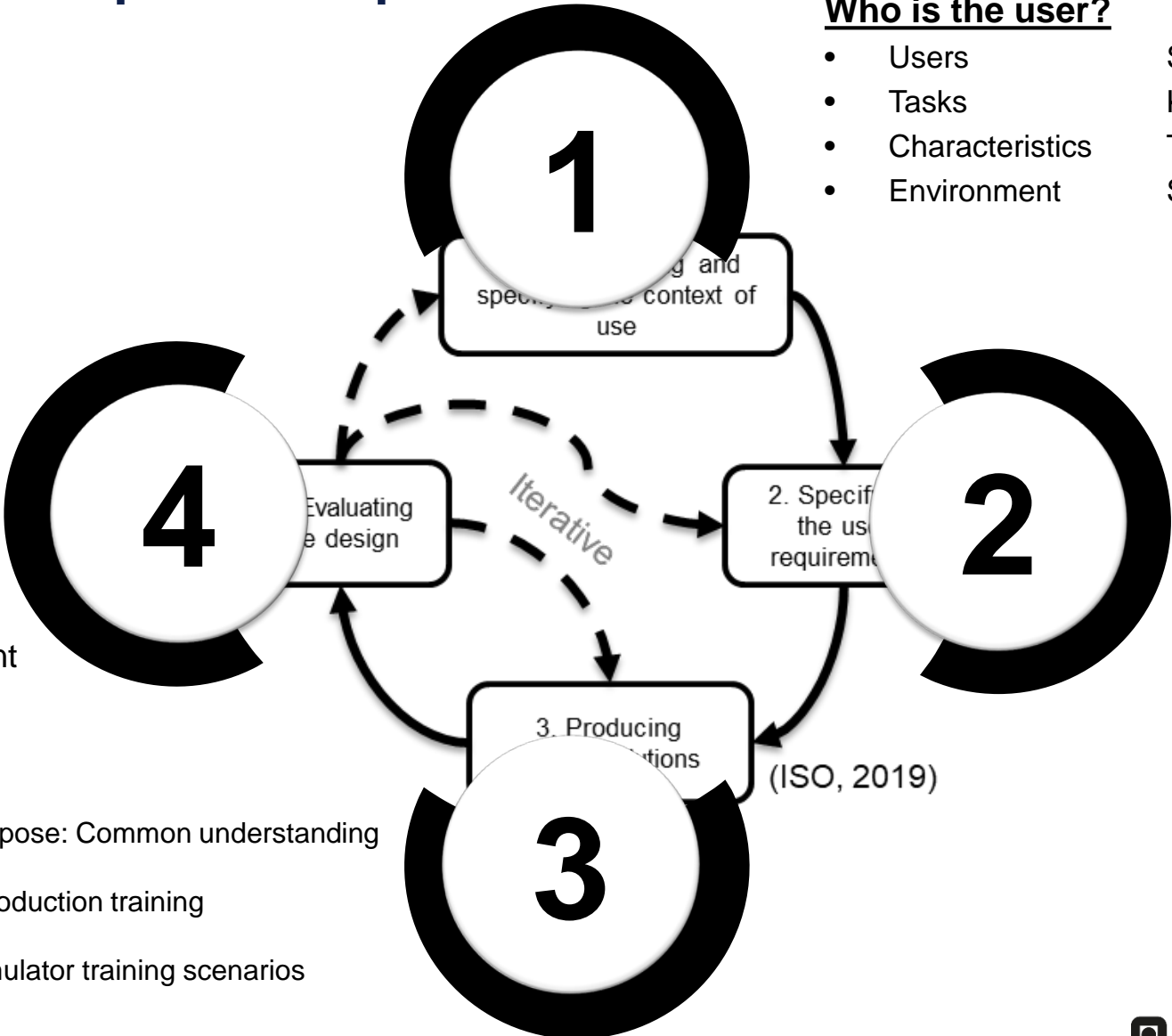
- Workshop
- M.Sc. Level course
- Questionnaire
- Industry involvement

How?

- Interviews with navigators
 - Cyber threats is not easy
- Workshops
 - Utilize known tools and platforms
- Known theory
 - Learning theories
 - Connectivism and constructivism (Siemens, 2004) (UoB, 2022)

What?

- Purpose: Common understanding
- Introduction training
- Simulator training scenarios

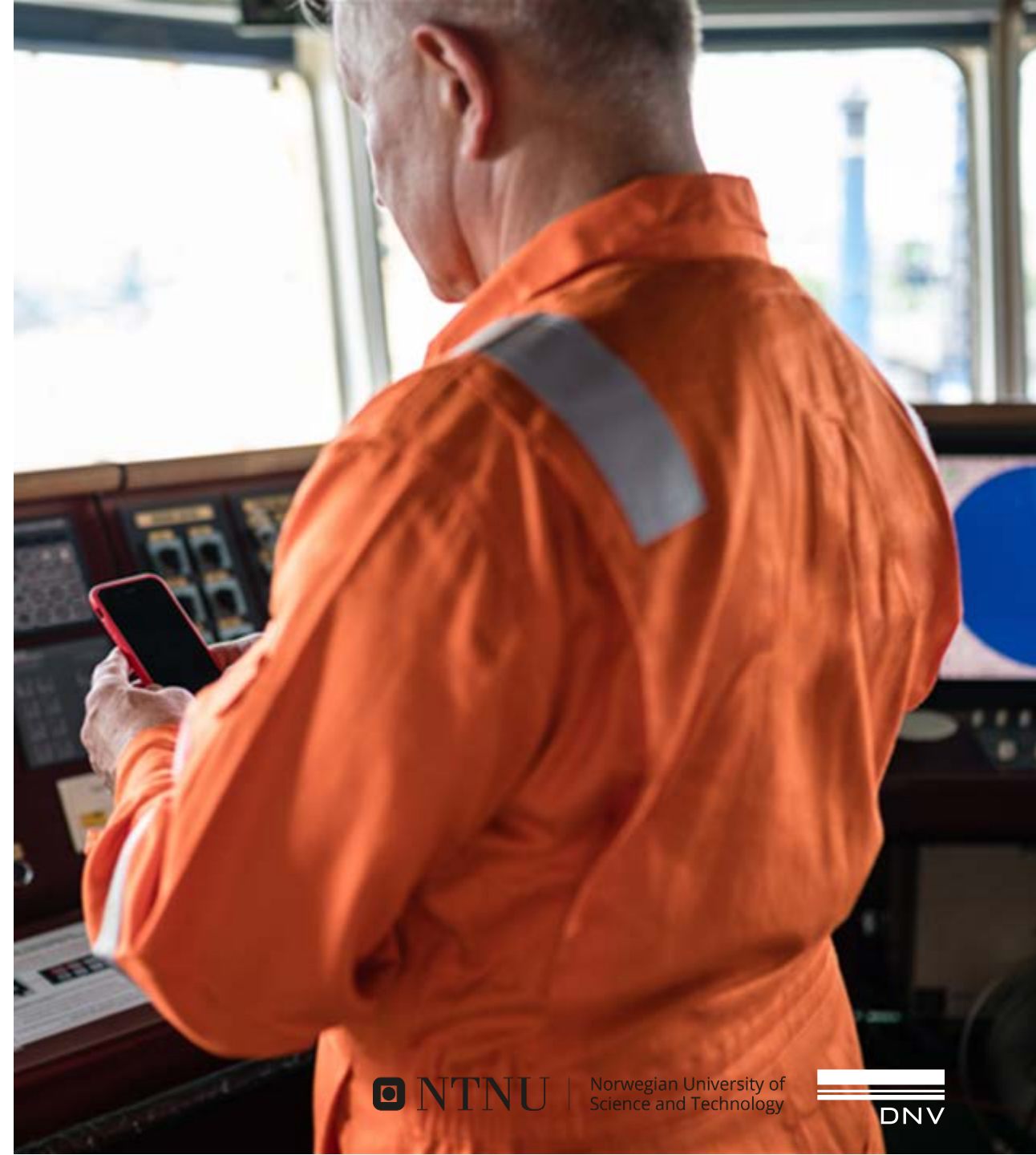


Include the workers

- **How does navigators experience cyber threats?**
- Interview with 10 deck officers (Erstad, 2021)
 - Intangible threat
 - “Just another technical error”
 - Cyber is “one more job to do” without any more time to do it
 - Unaddressed issue – lack of training and awareness

Common agreement:

- A need for tailored and specified training



Develop maritime cyber training

NTNU Studier v Studentliv v Forskning og innovasjon v Om NTNU v

Videreutdanning og deltidsstudier > Enkelkurs



Foto: Adobe Stock, Metamorworks

Maritim digital sikkerhet

Start: 09.01.2023
Slutt: 11.04.2023
Søknadsfrist: 01.12.2022
Sted for samlinger: Ålesund



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Operational training for onboard crew and onshore management

1. Introduction

- General information
- Common ground and understanding

2. Cyber risk analysis

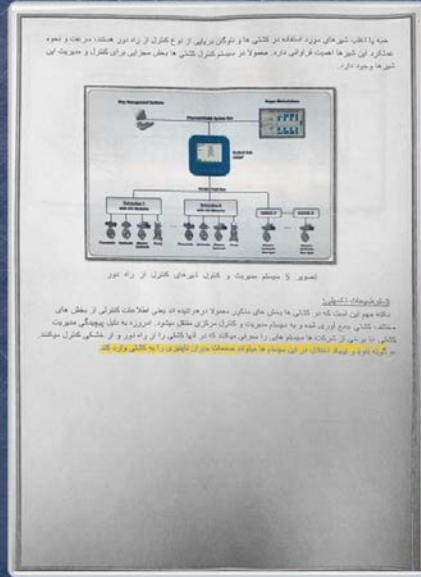
- Requirements in the maritime industry

3. Cyber Exercises

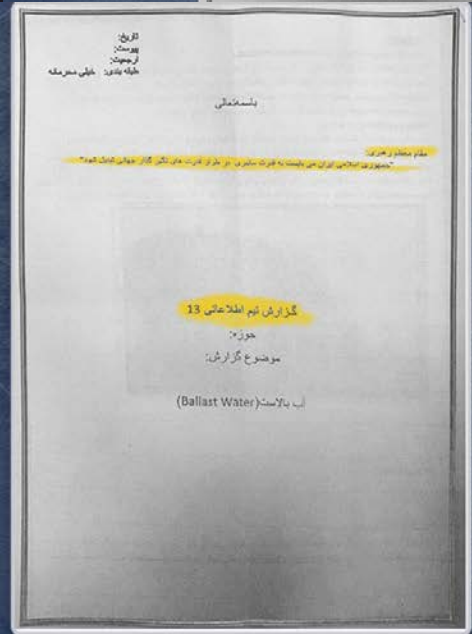
- Safety related incidents
- Visualizing events
- Bridge simulators



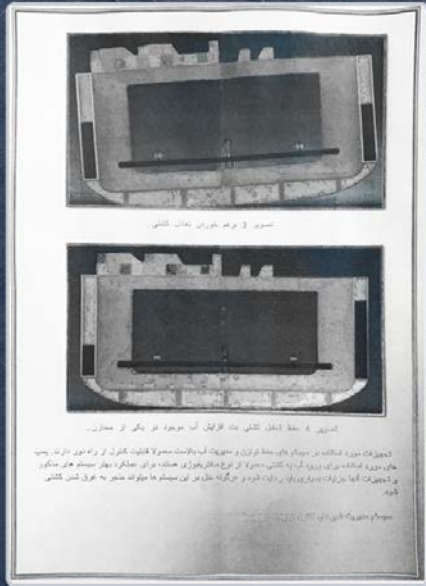
IRAN'S SECRET CYBER FILES



Any cyber attack or disruption of these systems could cause irreversible damage to the ship



The Islamic Republic of Iran must become among the world's most powerful in the area of cyber



Feedback



The ship is not behaving as it should. What's up? Captain Odd Sveinung Hareide explains to the others on the bridge what he has done, what he is prioritizing right now and the next move. Photo: Eli Anne Tvergrov, NTNU

What do you do if a hacker takes over your ship?

The risk of cyber attacks against a ship is real. The working crew on board must be allowed to practice handling these risks in a realistic way. Now they can.

By [Eli Anne Tvergrov](#) - Published 22.03.2023

You're on the bridge, with the ship's course shown on the digital display. But why is the ship continuing to turn west?

Synes du kurset var relevant for din arbeidshverdag?

Antall svar: 17

Svar	Antall	% av svar	
Vet ikke	0	0%	0%
5 Absolutt	11	64.7%	64.7%
4	5	29.4%	29.4%
3	1	5.9%	5.9%
2	0	0%	0%
1 Slett ikke	0	0%	0%

I hvilken grad oppfylte kurset behovet ditt for kompetanseheving innen maritim digital sikkerhet?

Antall svar: 17

Svar	Antall	% av svar	
Vet ikke	1	5.9%	5.9%
5 I stor grad	8	47.1%	47.1%
4	8	47.1%	47.1%
3	0	0%	0%
2	0	0%	0%
1 I liten grad	0	0%	0%

Synes du at du lærte mye av simulatorøvingene?

Antall svar: 17

Svar	Antall	% av svar	
Vet ikke	0	0%	0%
5 Absolutt	9	52.9%	52.9%
4	7	41.2%	41.2%
3	1	5.9%	5.9%
2	0	0%	0%
1 Slett ikke	0	0%	0%

Not only suitable for the maritime simulator



Thank you for the attention

Any questions is welcomed and appreciated.

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