



Kunnskap for en bedre verden

MENNESKET I FREMTIDENS HAVROMSOPERASJONER

Ole Andreas Alsos

Førsteamanuensis ved Institutt for design

Leder NTNU Shore Control Lab

Prodekan for Innovasjon ved Fakultet for Arkitektur og Design



Fløttmannen

Foto: Trondheim byarkiv

Kanalen





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Associate Professor in Interaction Design

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Vice Dean for Innovation at Faculty of Architecture and Design

Department of Design

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915 44 825

Previously

Head of Department, NTNU

Founder of two companies

Interaction designer and IT advisor

PhD in interaction design

Master in Computer Science

Officer in the Norwegian Navy

NTNU Shore Control Lab

<https://www.ntnu.edu/shorecontrol>

NTNU Shore Control Lab on YouTube

<https://www.youtube.com/channel/UCvIJvomz5kFg08MA0dRaA>



Institutt for design

Photo: Kjell Are Refsvik

Pilot: Designtenkning for teknologer

En iterativ, ikke-linjær arbeidsmetodikk som går ut på forstå brukere og løse problemer.

Metodikken gjør teknologer istand til å utforme *gode og brukervennlige* teknologier, systemer, produkter som løser *brukernes* problemer (ikke utvikle teknologi for teknologiens skyld)



DESIGN THINKING





HEED

Centre for Human-Centred Engineering Education

Enabling responsible engineering for a sustainable future

Anticipated futures for professional engineering work

The past of engineering work

- Technical
- Specialist (discipline)
- Problem definition
- Analysis
- Design
- Reliable
- Accurate

The future of engineering work

- More complexity
- Multi-disciplinary projects & cross functional teams
- Greater public accountability & societal engagement
- Privileging life cycle & sustainability considerations
- Globalised enterprise

Technical expertise
+
Engineering habits of mind

Future expectations of professional engineers

Emotional intelligence & interpersonal skills

Digital intelligences

Automation, robotics, artificial intelligence, digital technologies, big data

Personal skills

Resilience, adaptability, flexibility, global awareness

Etical and trusted

Deployed in more

- Big picture thinking
- Systems & integration (strategy, design, optimisation)
- Human focussed impacts
- Environment stewardship
- Social licence to operate (risks, ethics & technical trust)
- Problem finding/ framing/ solving
- Design thinking
- Multi-disciplinary collaboration & communication
- Stakeholder interaction, engagement & communication (interpret & translate engineering)
- Creativity
- Innovation
- Imagination
- Breadth







Slingerobot, NTNU



Yara Birkeland



FAST FLEKSIBEL AUTONOM SMART TRANSPORT



OCEAN AUTONOMY CLUSTER

SINTEF



MARITIME ROBOTICS



Moen Marin



Innovation Norge



SFI AutoShip



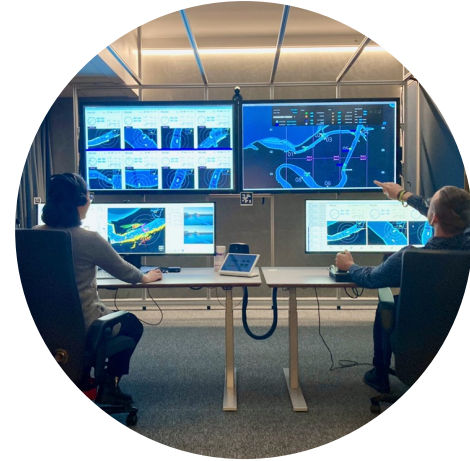
Aim and scope: Contribute to Norwegian players taking a leading role in the development of both technology and business models for autonomous ships, where emphasis is placed on safe, secure, environmentally friendly and cost-effective solutions.

Centre for Research-Based Innovation for the development of autonomous ships for safe and sustainable operations (8 years, 240 MNOK)

From the bridge to the shore

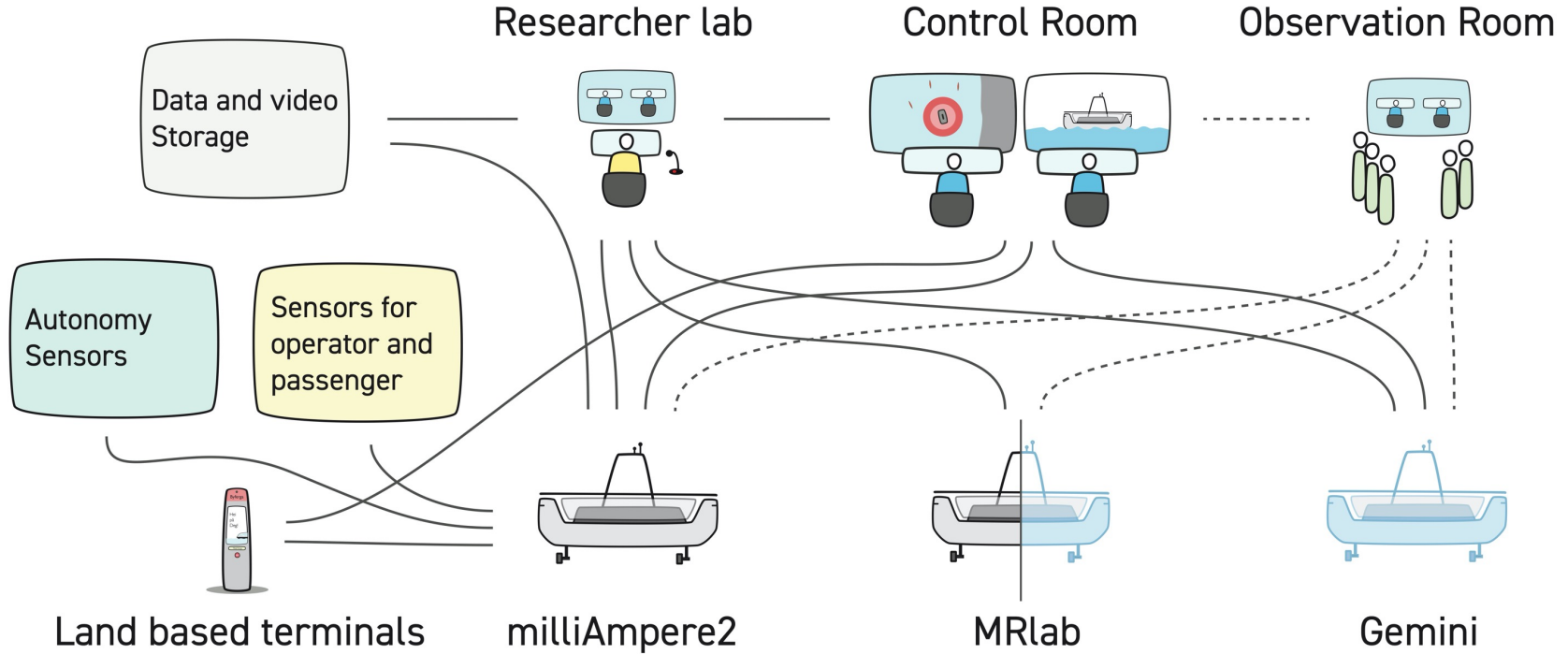


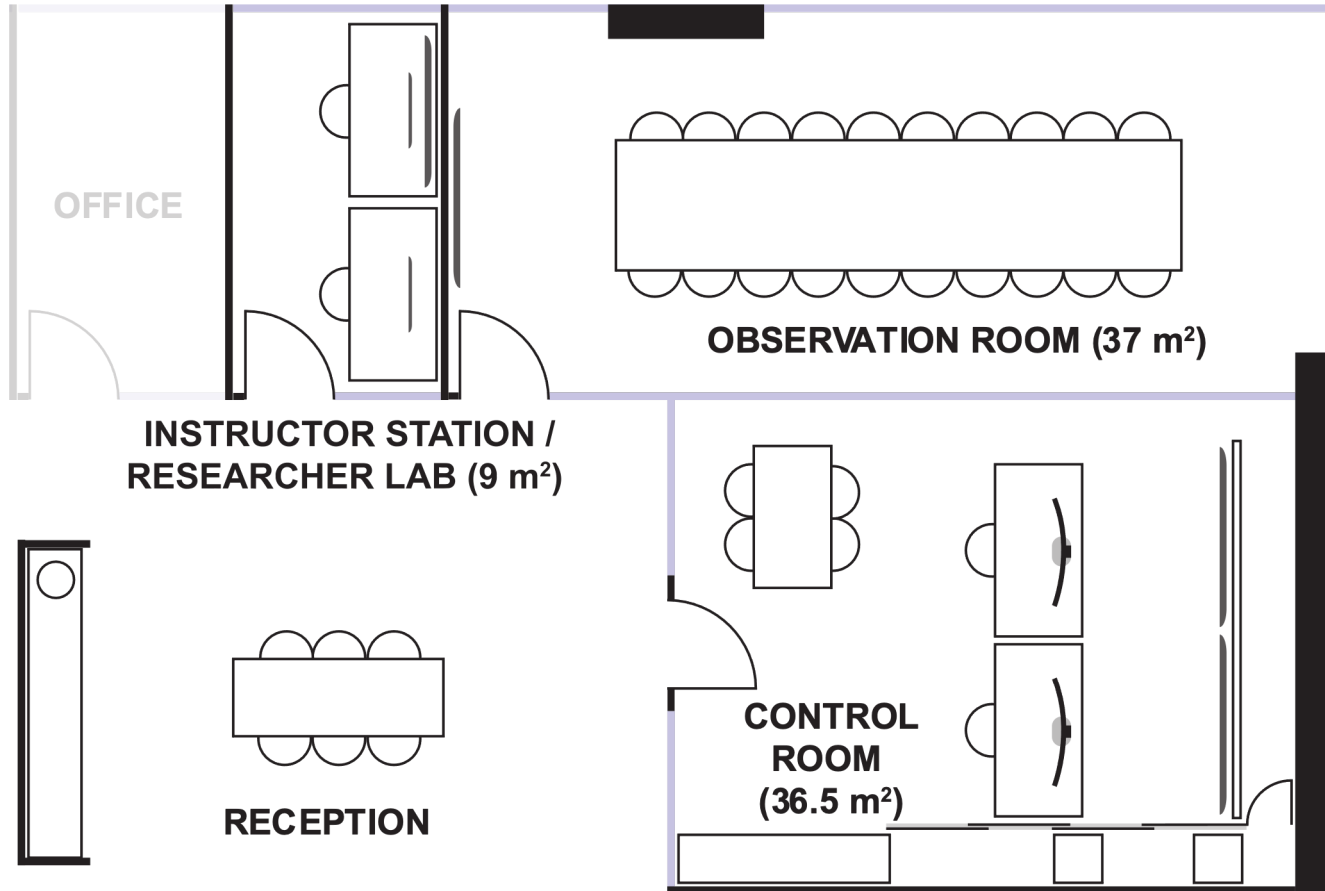
Ship bridges



Shore-based control centers

Shore Control Lab Infrastructure







The image shows a modern control room with two operators seated at desks. The operator on the left is wearing a headset and looking at a monitor displaying a map with yellow and red markers. The operator on the right is pointing at a large wall-mounted screen that shows a detailed map with numbered zones (01-08) and various data points. There are several other monitors on the desks and a large wall-mounted screen above them, all displaying similar data and maps. The room has a glass wall on the left and a window on the right, with a blue and white color scheme.

Control room

For two operators, flexible setup



MARITIME ROBOTICS
PX-31
UNMANNED AIRCRAFT SYSTEMS (UAS)
www.maritime-robotics.com

MAIRI HOBBY
CONTROLLED BALLOON SYSTEM
www.maritime-robotics.com

CENTRE FOR RESEARCH-BASED INNOVATION WITHIN AUTO

NTNU
scl Share your lab

SFI · AUTOSHIP

Autonomous ships for safe and sustainable operations 2020-2028

The Research Council of Norway

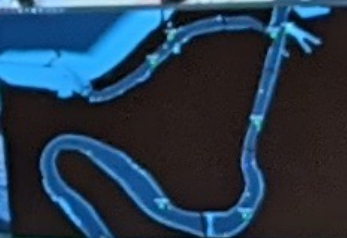
CH-BASED INNOVATION



2022 OCEAN WEEK
WISDOM
KNOWLEDGE

scl | shore
control
lab

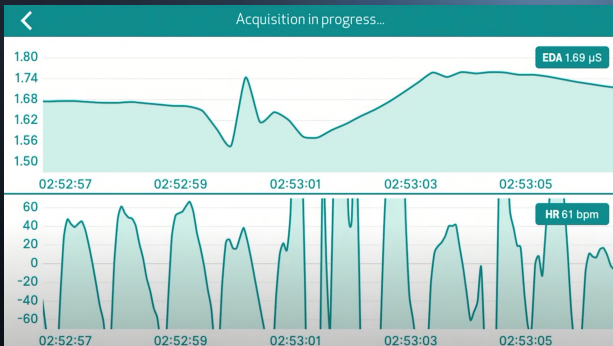
NTNU



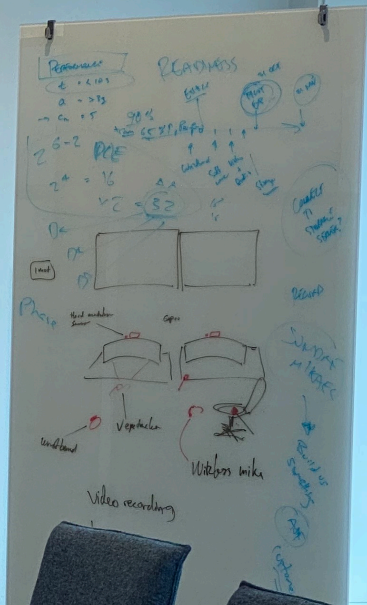
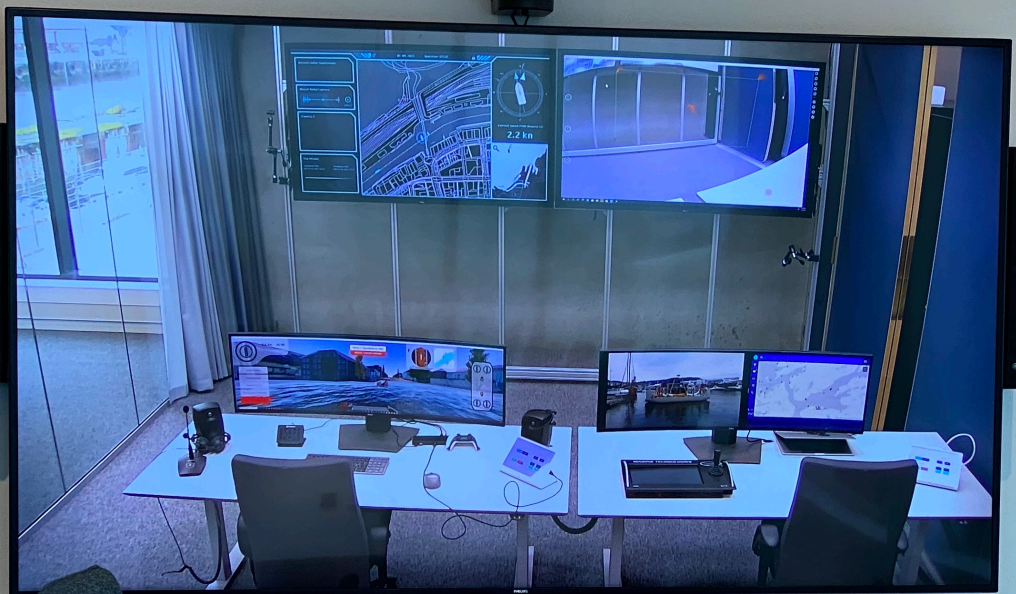
Researcher lab

For monitoring operators





B214



Observation room
For up to 20 persons

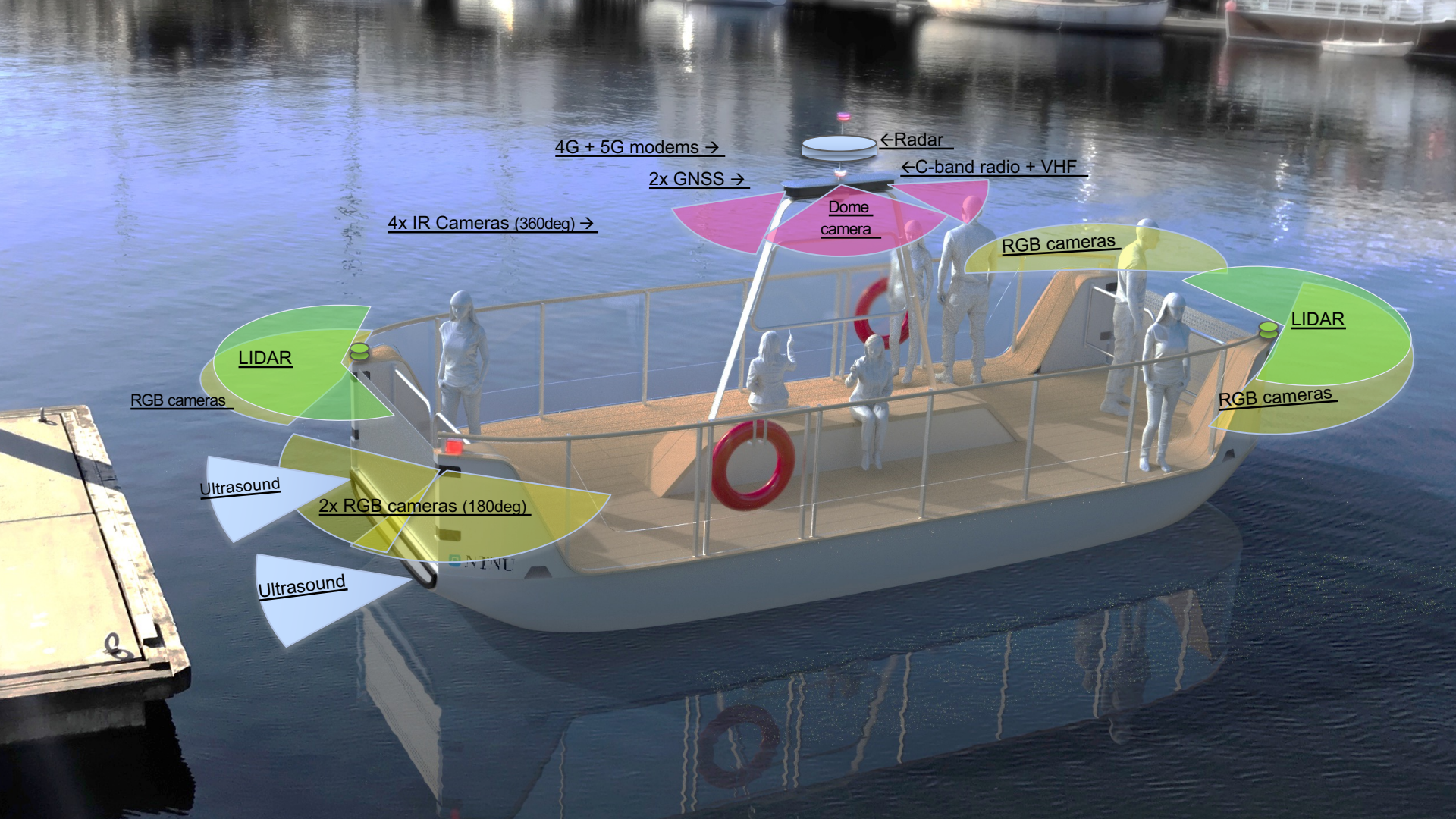


milliAmpere2

A white boat with a blue canopy is docked at a wooden pier. Three people are standing on the boat, looking towards the water. In the background, a large, vibrant rainbow arches across a cloudy sky. The scene is set in a harbor or marina with buildings and a tall tower visible in the distance.

milliAmpere2





4G + 5G modems →

2x GNSS →

4x IR Cameras (360deg) →



Dome camera

← Radar

← C-band radio + VHF

RGB cameras

LIDAR

RGB cameras

Ultrasound

2x RGB cameras (180deg)

Ultrasound

LIDAR

RGB cameras

NTNU



Mixed Reality Lab

for testing milliAmpere2

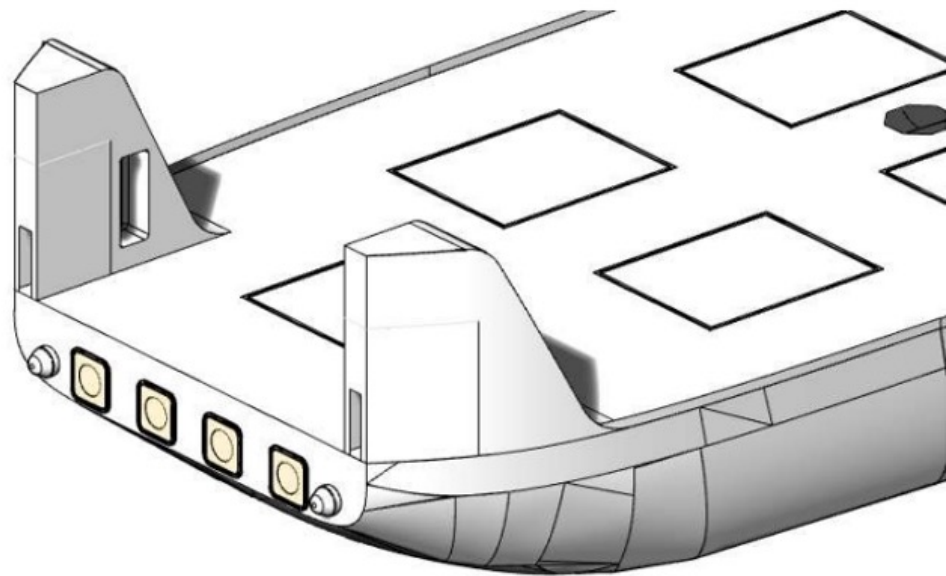
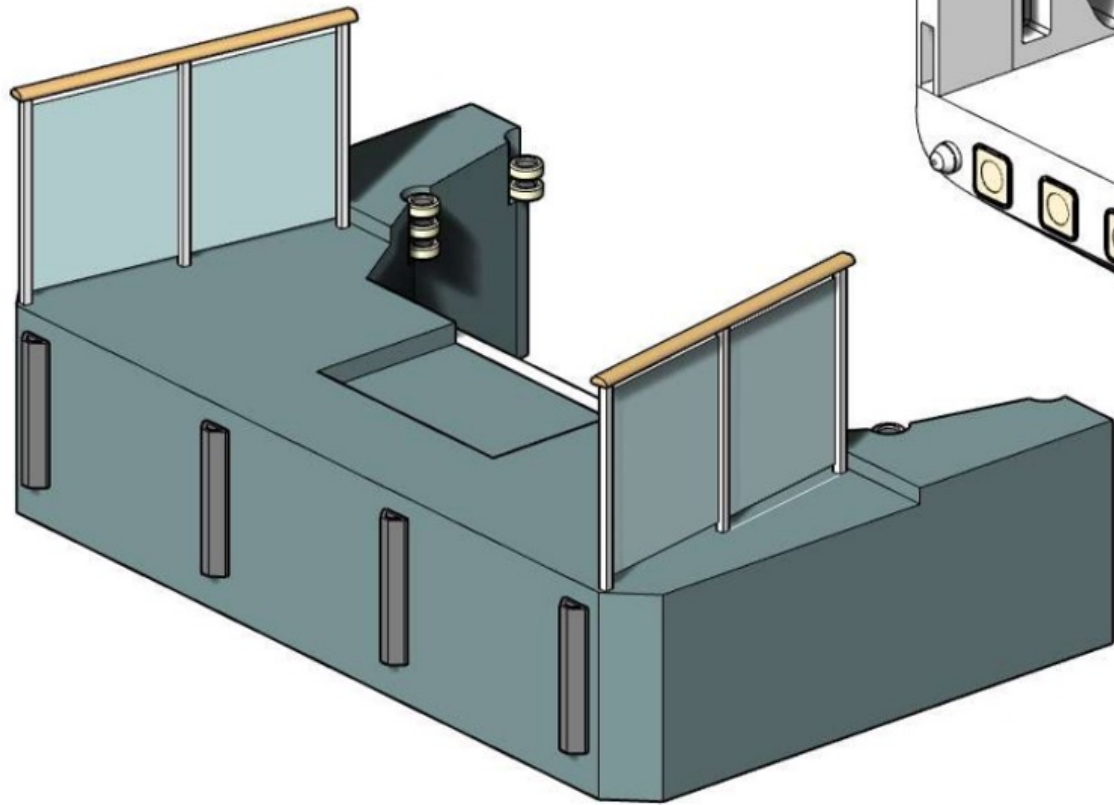


Gemini Simulator

Simulator for testing milliAmpere2 and operators

A 3D architectural rendering of a land-based terminal and dock. The structure is built on a concrete pier extending into dark water. It features a large, flat deck area with a black mat, surrounded by a tan-colored railing. A ramp with a wooden deck and metal handrails leads to an upper level. Several white mannequins are positioned throughout the scene: two on the upper deck, two on the ramp, and one on the pier. A blue vertical structure with a white sign is located on the pier. The overall design is modern and functional, with a focus on accessibility and safety.

Land based terminal and dock





Plasser igjen
Spots left

3



9/12

Maks 12 passasjerer
Max 12 passengers



Plasser igjen
Spots left

3



9/12

Maks 12 passasjerer
Max 12 passengers

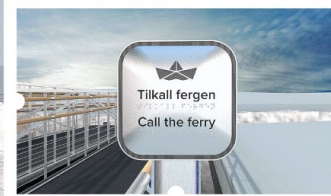


For mange passasjerer
Too many passengers

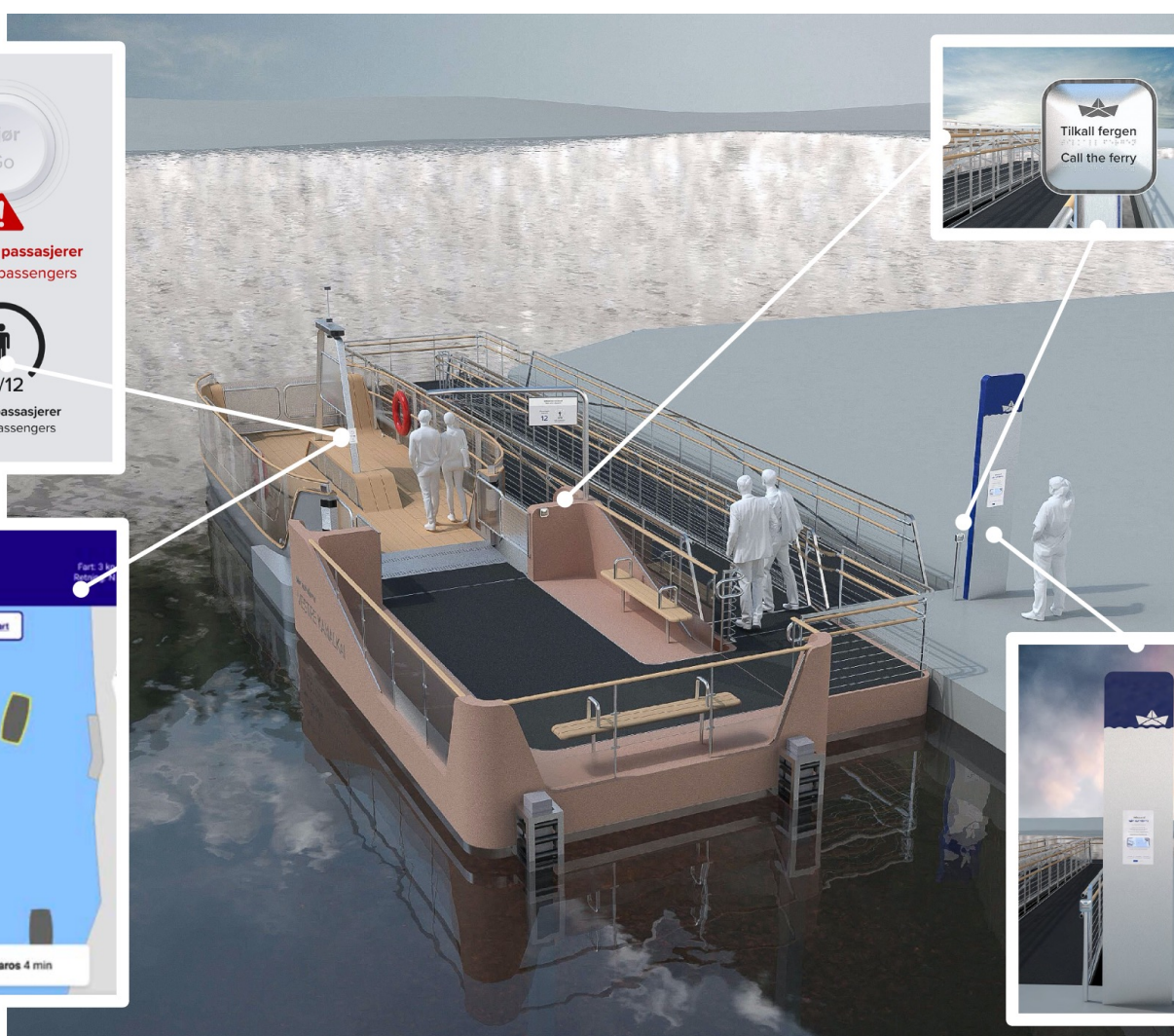


13/12

Maks 12 passasjerer
Max 12 passengers



Tilkall ferjen
Call the ferry



Avganger

Finne ferjekal

Nærmeste kai: Brattera

Neste ferje til Nidaros Forlater kaia om 3 min ankomst 15:20

Nidaros	15 min ankomst 15:45
Solsiden	35 min ankomst 16:05
Se mer	>
Solsiden (400m)	>
Nidaros (1.2 km)	>
Lerkendal (6 km)	>

Live kart

Ferje Målanger 1
Anfall passasjerer: 8

Fart: 3 km/h

Sakker fart

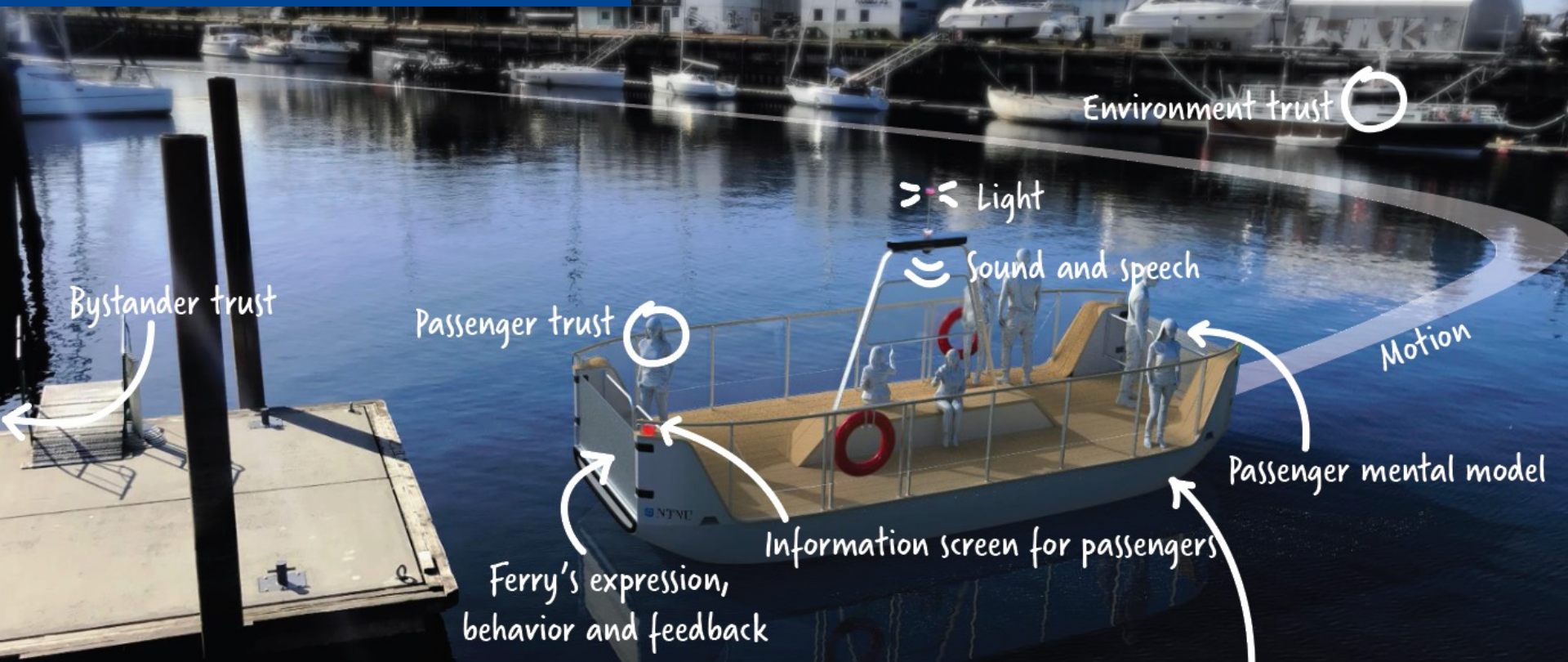
Neste stopp: Nidaros 4 min



Tilkall ferjen
Call the ferry

Explainable AI

Automation transparency



Environment trust

Light

Sound and speech

Motion

Passenger mental model

Information screen for passengers

Ferry's expression, behavior and feedback

Passenger trust

Bystander trust

Automation transparency



MASS

*Express current state
and future intention*



Nearby ship

Automation transparency



MASS

Express current state
and future intention

Perceive current state
and future intention



Nearby ship

Stakeholders of autonomous ships



Developers



Operators



Passengers



Non-SOLAS
ships



SOLAS ships

Article

Human-Centered Explainable Artificial Intelligence for Marine Autonomous Surface Vehicles

Erik Veitch * and Ole Andreas Alsos

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* Correspondence: erik.a.veitch@ntnu.no

Abstract: Explainable Artificial Intelligence (XAI) for Autonomous Surface Vehicles (ASVs) addresses developers' needs for model interpretation, understandability, and trust. As ASVs approach wide-scale deployment, these needs are expanded to include end user interactions in real-world contexts. Despite recent successes of technology-centered XAI for enhancing the explainability of AI techniques to expert users, these approaches do not necessarily carry over to non-expert end users. Passengers, other vessels, and remote operators will have XAI needs distinct from those of expert users targeted in a traditional technology-centered approach. We formulate a concept called 'human-centered XAI' to address emerging end user interaction needs for ASVs. To structure the concept, we adopt a model-based reasoning method for concept formation consisting of three processes: analogy, visualization,

Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Safety Science

journal homepage: www.elsevier.com/locate/safety

A systematic review of human-AI interaction in autonomous ship systems

Erik Veitch^{*}, Ole Andreas Alsos

NTNU, Department of Design, Kolbjørn Hejes Vei 2b, 7491 Trondheim, Norway

ARTICLE INFO

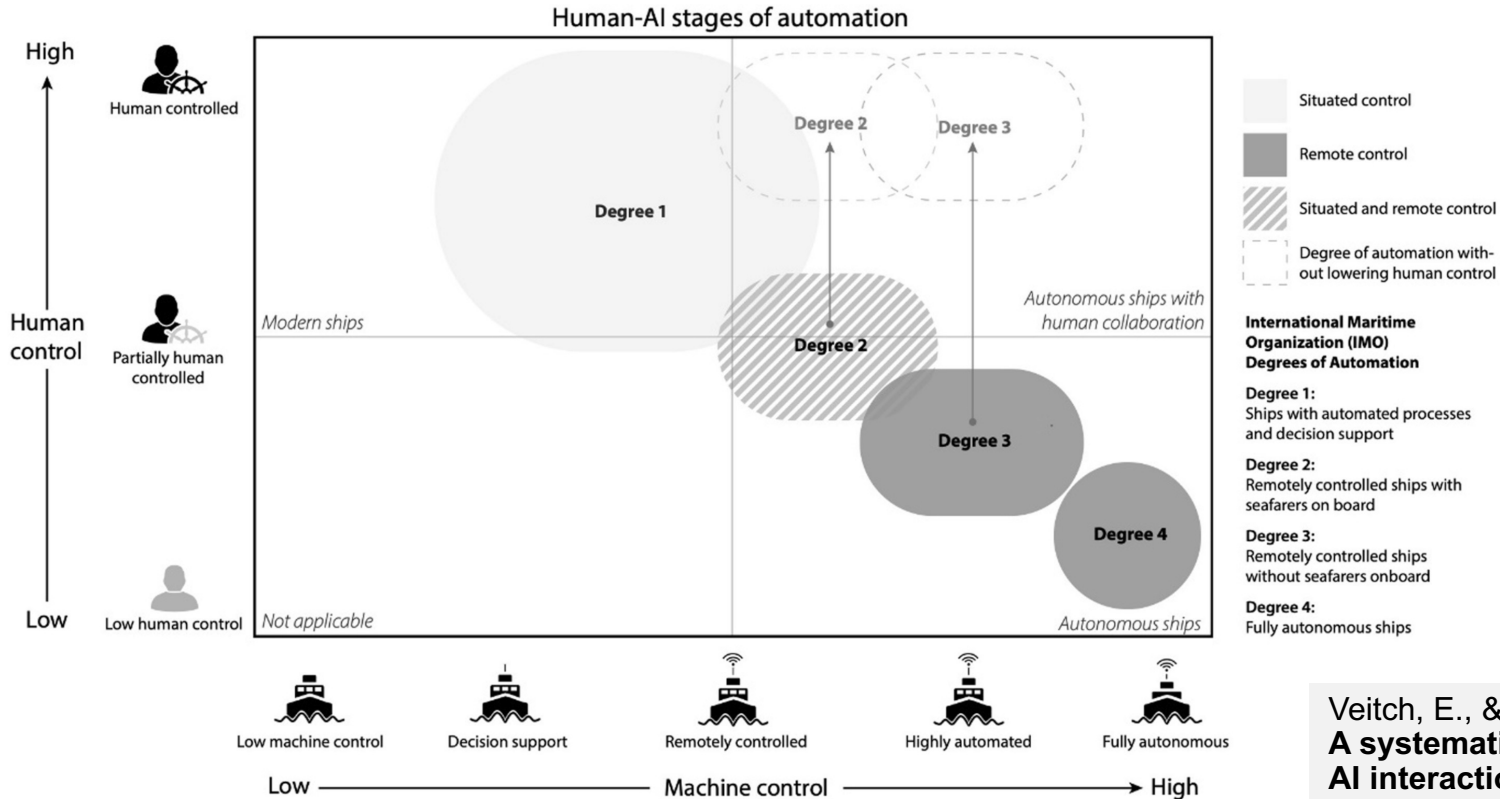
Keywords:

Automation
 Artificial Intelligence
 Work
 Safety
 Marine Navigation
 Human-Computer Interaction
 Safety management
 Resilience Engineering
 Interaction Design
 Maritime Autonomous Surface Ships
 STPA
 Bayesian Networks

ABSTRACT

Automation is increasing in shipping. Advancements in Artificial Intelligence (AI) applications like collision avoidance and computer vision have the potential to augment or take over the roles of ship navigators. However, implementation of AI technologies may also jeopardize safety if done in a way that reduces human control. In this systematic review, we included 42 studies about human supervision and control of autonomous ships. We addressed three research questions (a) how is human control currently being adopted in autonomous ship systems? (b) what methods, approaches, and theories are being used to address safety concerns and design challenges? and (c) what research gaps, regulatory obstacles, and technical shortcomings represent the most significant barriers to their implementation? We found that (1) human operators have an active role in ensuring autonomous ship safety above and beyond a backup role, (2) System-Theoretic Process Analysis and Bayesian Networks are the most common risk assessment tools in risk-based design, and (3) the new role of shore control center operators will require new competencies and training. The field of autonomous ship research is growing quickly. New risks are emerging from increasing interaction with AI systems in safety-critical systems, under-

Two-dimensional degrees of automation



Veitch, E., & Alsos, O. A. (2022). **A systematic review of human-AI interaction in autonomous ship systems.** Safety Science, 152, 105778.



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Kapasitetsløft for å styrke kompetanse og forskning for regionalt næringsliv

Publisert 15. apr 2021 | Oppdatert 15. des 2021

[Last ned](#) 

 GJENNOMFØRT

 SE RESULTAT

Søknadstype: Kompetanse- og samarbeidsprosjekt

Søknadsfrist: 15. september 2021, 13.00 CEST

Aktuelle temaområder: [Bransjer og næringer](#)

Målgrupper: Forskningsorganisasjon

Støttegrenser: Kr 18 000 000-30 000 000

Antatt tilgjengelige midler: Kr 240 000 000

Prosjektvarighet: 72-72 måneder

Utlvsningskontakt: Kai Miøsund |

Utfordringer med dagens situasjon

Teknologibedriftene er allerede gode på teknologi, men

- mangler kompetanse og kapasitet rundt **design og menneskelige faktorer**.
- har liten kunnskap om hvordan **designe for tillit** slik at brukere aksepterer og stoler på autonom teknologi.
- fokuserer for **lite på forretningsutvikling**
- må **tilpasse eksisterende metodikk** for design og innovasjon til autonom teknologi
- **mister nyutdannede teknologer** til Østlandet

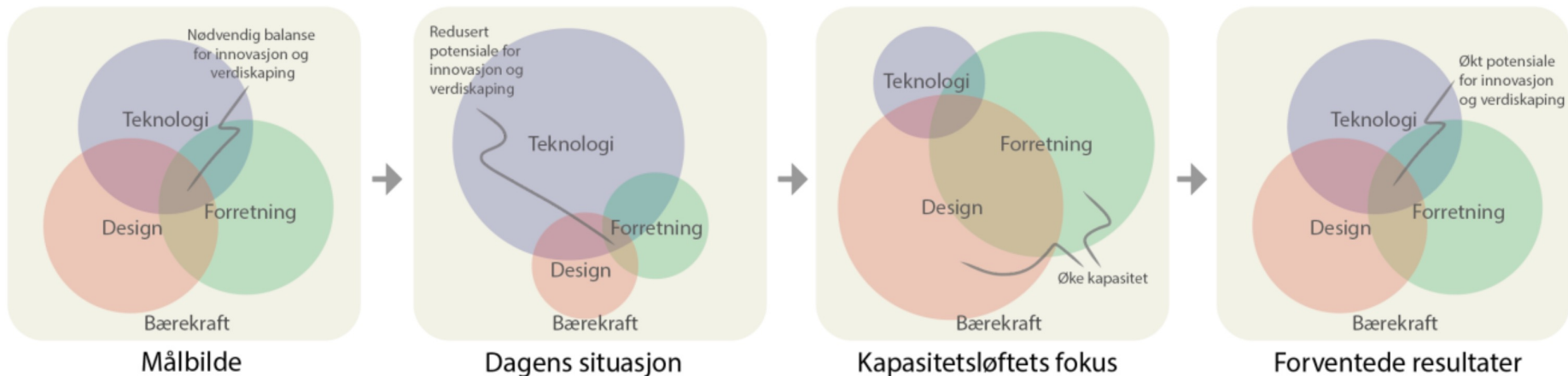
Mennesket i fremtidens havromoperasjoner (MIDAS)

Visjon: Styrke midtnorsk næringslivs innovasjonsevne, utvikling og eksport av autonom havromsteknologi

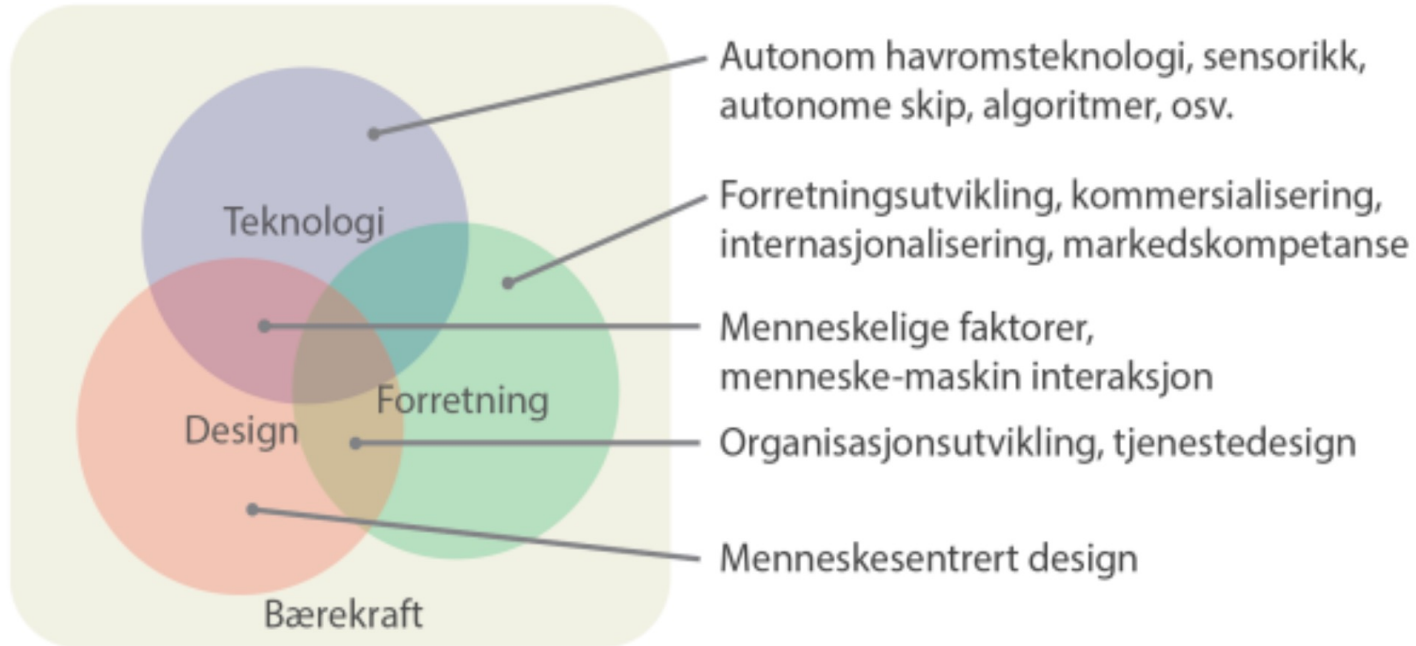
Hovedmål: MIDAS skal bygge en kompetanse- og samarbeidsplattform mellom regionalt næringsliv og FoU som skal løfte regionens kapasitet innen kompetanseområdene design og forretning, og sørge for sterkere samhandling og mer effektiv bruk av eksisterende kompetanseressurser.

MIDAS: Mennesket i fremtidens havromsoperasjoner

38 MNOK, 6 år

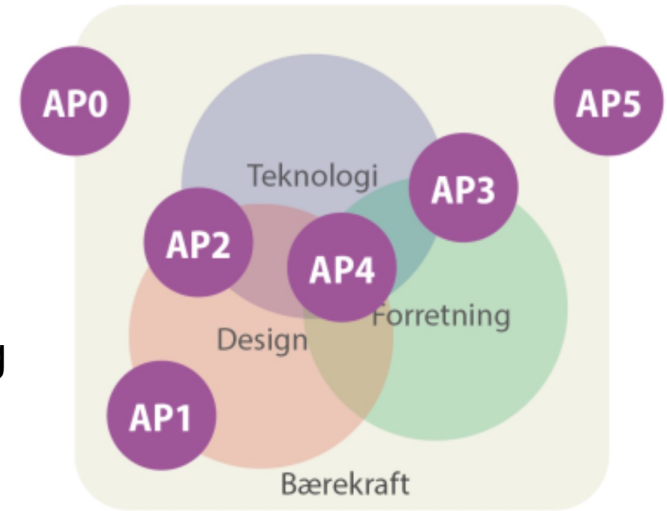


Figur 2: Våre begrepsdefinisjoner og fokus

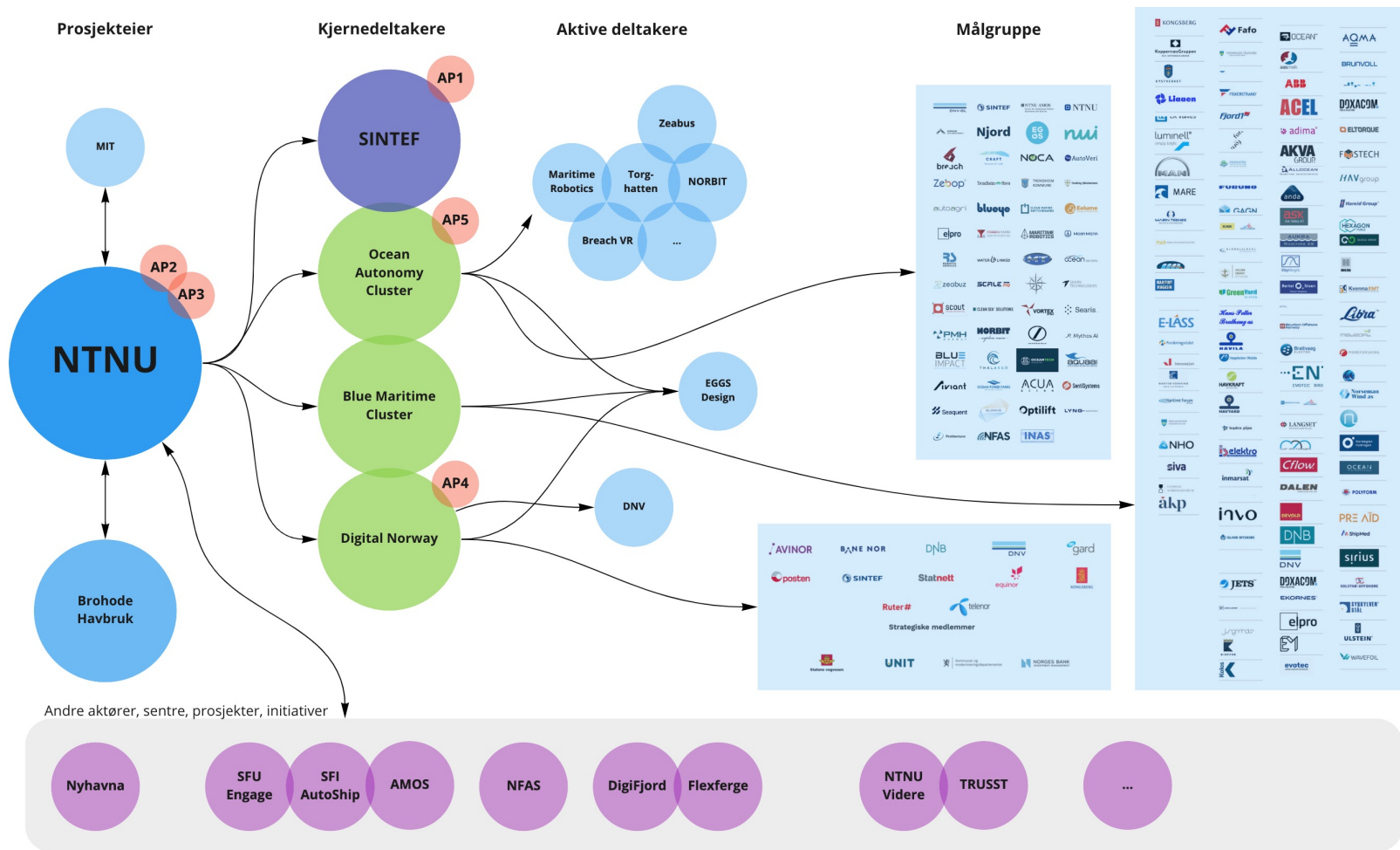


Arbeidspakker

1. Menneskelige faktorer i autonome systemer
2. Tillit til autonomi gjennom systemforståelse og – design
3. Forretningsutvikling, kommersialisering og internasjonalisering
4. Nye metoder innen design og forretningsutvikling for autonome systemer
5. Midt-Norge som attraktiv arbeidsplass og studenter som ressurs



MIDAS: Partnere



Eksempler på virkemidler

Nettverk

Kurs

Konferanse

Arbeids-
møter

Kompetanse

Emne:
Maritime
work system
design

Emne:
Designtenkning
for teknologer

Minor i
Human
factors

Studentsamarbeid

Master-
oppgaver

Student-
oppgaver

Student-
konkurranser

Publikasjoner

Lærebok
i HF

Kronikker og
Populær-
vitenskapelige
publikasjoner

Vitenskapelige
artikler

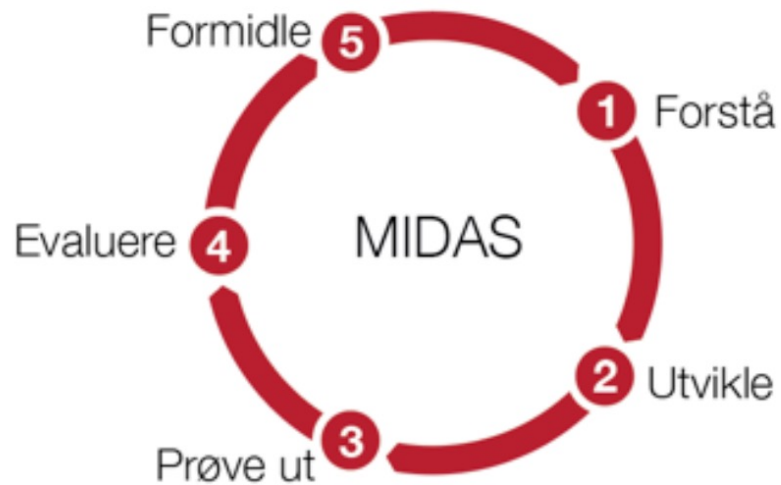
Mobilitetsordninger

"Lån en
forsker"

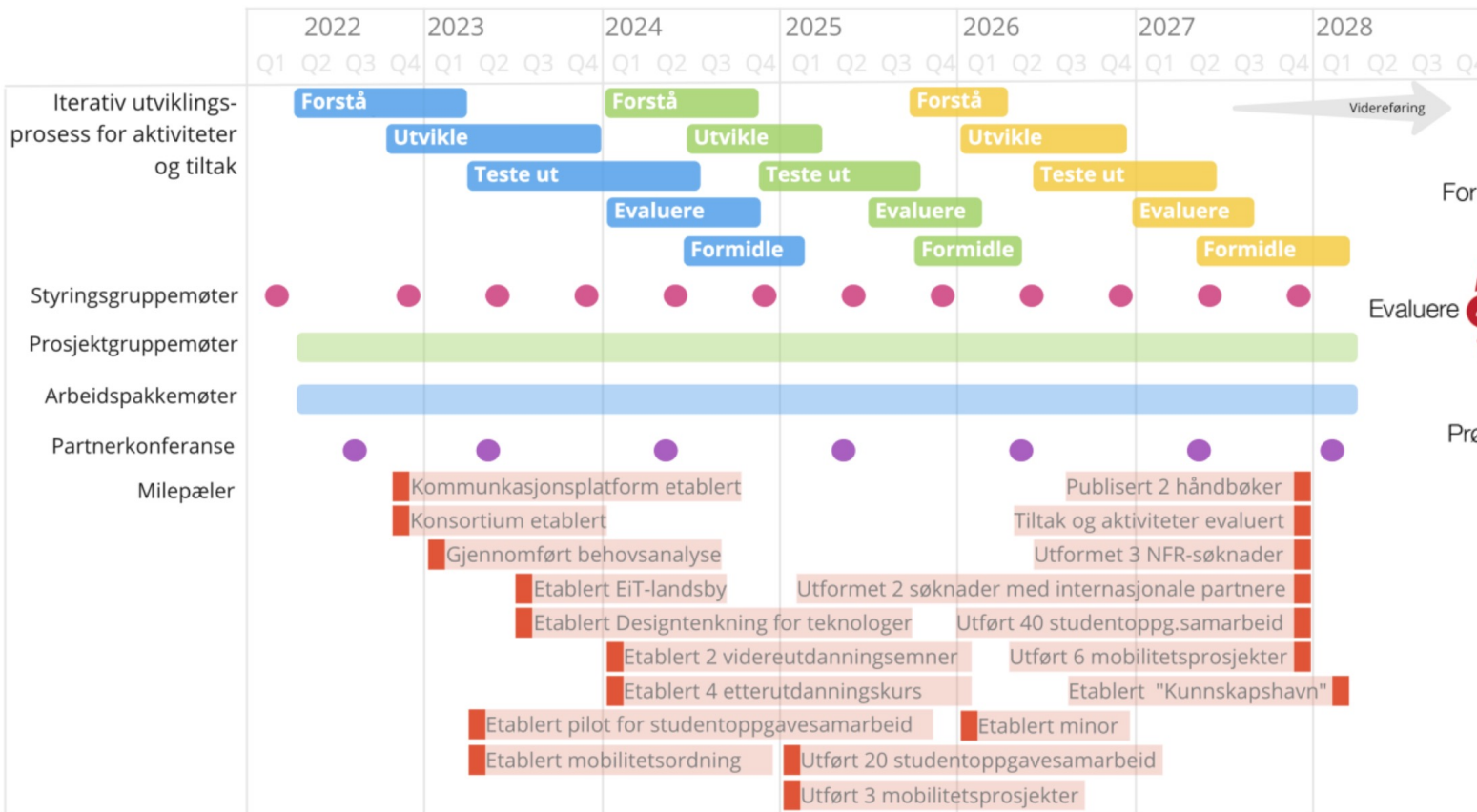
Toer-
stilling

Sommer-
jobber

Prosess



Prosjektplan





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