SFI AutoShip – an update after 1.5 years in operation

Professor Mary Ann Lundteigen| **SFI Director**
NFAS seminar, June 8th 2022 (Trondheim)

SFI·AUTOSHIP

Aim and scope of SFI AutoShip

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.
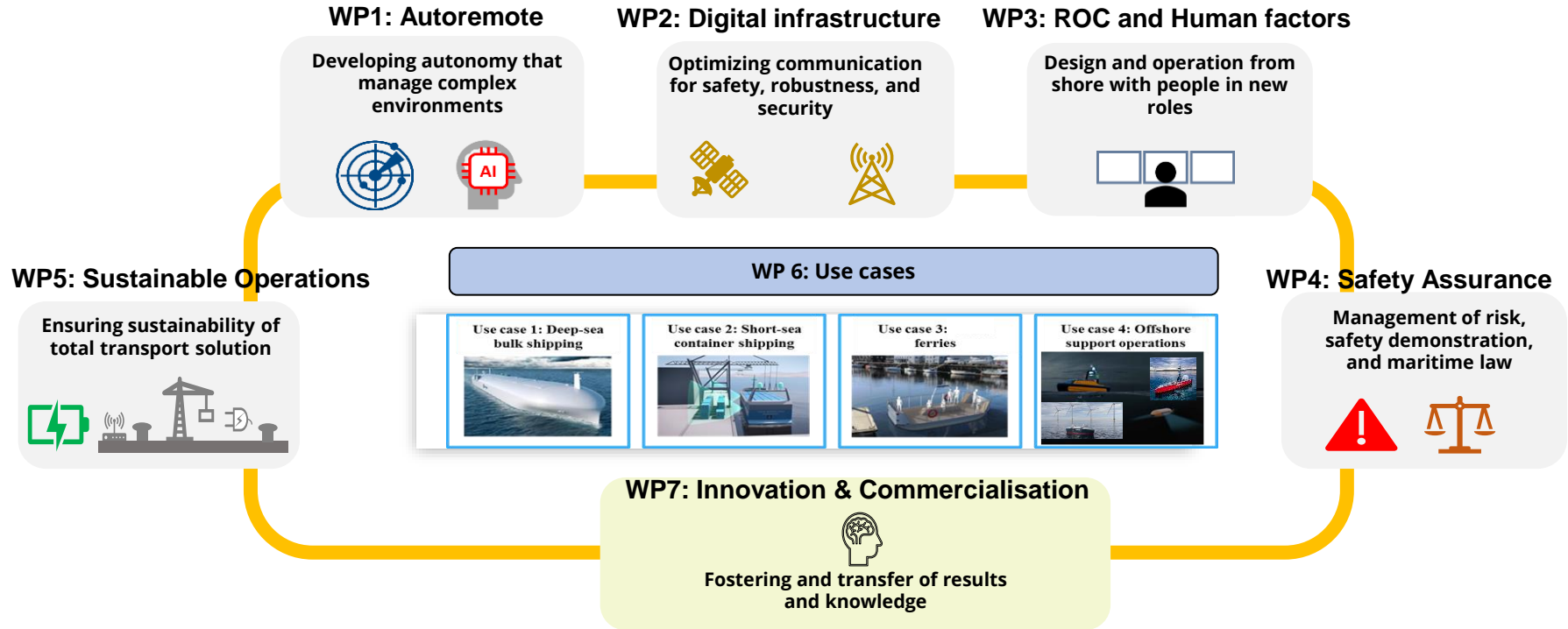
- Started up in Dec 2020
- Part of Research Council SFI scheme on research-based innovation Centers
- Duration of 8 years
- Budget of 240 million NOK
- Total of 25 partners
- Education > 20 PhDs & > 5 Postdocs. > 100 Master thesis projects
- Host: Department of Engineering Cybernetics, NTNU

Partners

Research partners   Technology providers   Shipping companies   Operators   Governmental partners   Insurance   Class

Scope and focus

WP1: Autoremote
Developing autonomy that manage complex environments

WP2: Digital infrastructure
Optimizing communication for safety, robustness, and security

WP3: ROC and Human factors
Design and operation from shore with people in new roles

WP5: Sustainable Operations
Ensuring sustainability of total transport solution

WP 6: Use cases
Use case 1: Deep-sea bulk shipping
Use case 2: Short-sea container shipping
Use case 3: ferries
Use case 4: Offshore support operations

WP4: Safety Assurance
Management of risk, safety demonstration, and maritime law

WP7: Innovation & Commercialisation
Fostering and transfer of results and knowledge

Research partners

Organization
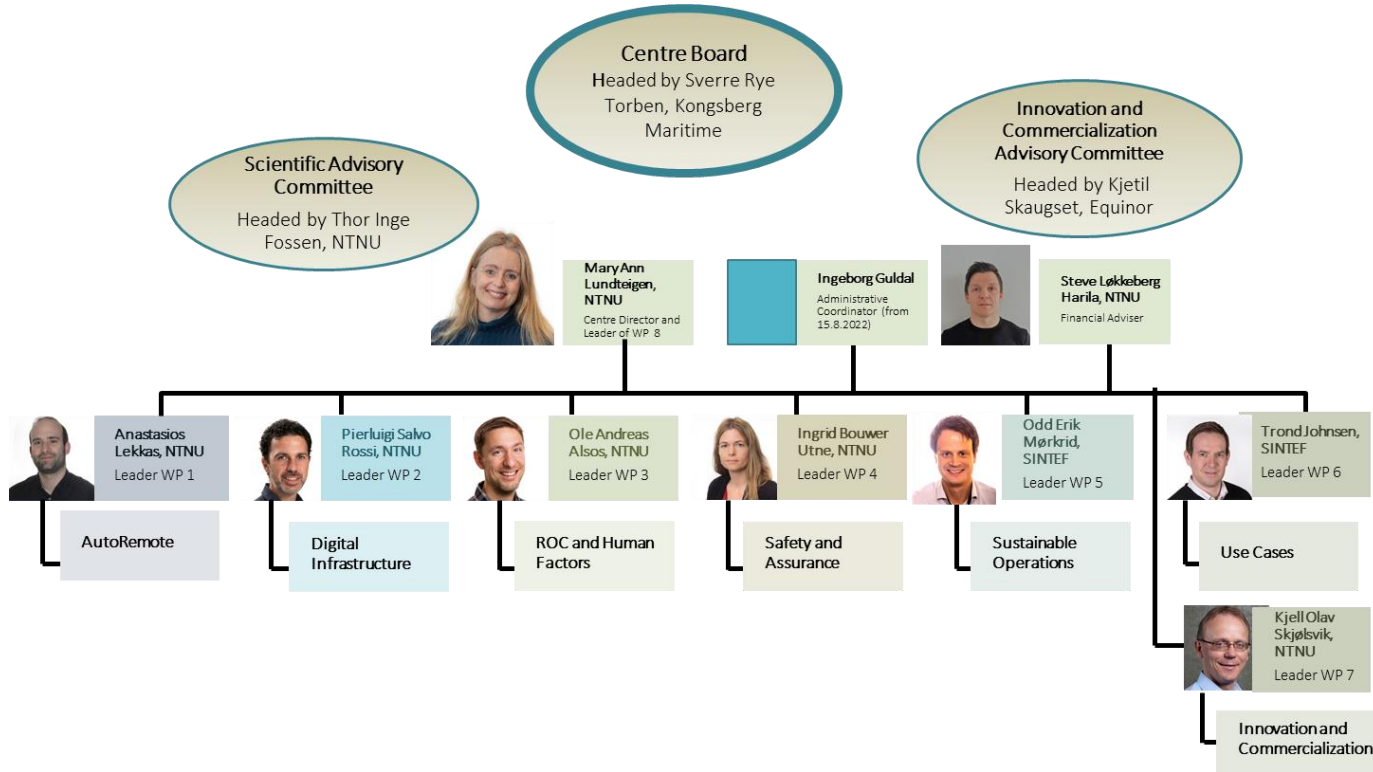
Research activities

WP1: AutoRemote

(Anastasios Lekkas, NTNU)

Advancing on the robustness and capability of perception and decision-making.

Subprojects:
- Non-GNSS loc. for USVs
- Simultaneous localization and tracking
- Risk-based COLAV/anti-grounding
- SITAW for operator
- SITAW for ship and surrounding (Digital twin)
- Docking and rendezvous for USVs
- Multi-sensor detection and classification
- Mission analysis and design
- Automatic sensor calibration

6 PhD + 2 PD. SINTEF researchers

WP2: Digital Infrastructure

(Pierluigi Salvo Rossi, NTNU)

Transforming the digital infrastructure towards autonomous ship-to-ship and ship-to-shore.

Subprojects:
- Channel measurements and modeling (MIMO)
- Real-time maritime radar network
- Radio digital twin
- Channel fusion in Maritime IOT
- Autonomous ship collision avoidance protocols
- Protocols for improved cybersecurity and resilience

5 PhD + 1 PD

WP3: Human Factors/ROC

(Ole Andreas Alsos, NTNU)

Building a remote operation centre that secures the awareness and capabilities of the operators

Subprojects:
- Interaction design
- Design for human-machine interface (autonomous crane operations)
- AI decision transparency in autonomous operations for the onshore operators
- Explainable AI for autonomous ships
- Decision support for autonomous vessels

4 PhD + IFE researchers

WP4: Safety and Assurance

(Ingrid B. Utne, NTNU)

Developing models and tools for demonstrating, monitoring and acting upon safety risks.

Subprojects:
- Online risk modeling of autonomous ships
- Safe operation with MRCs
- Risk acceptance and operational constraints
- Modeling for condition-based maintenance and decision –support
- Dynamic and simulation-based risk modeling
- Supervisory risk analysis and control
- Digital twin for safety demonstration
- Cybersecurity and safety
- Legal Liability in accidents

6 PhD + 2 PD (NTNU) & UiO (1 PhD) + IFE researchers

WP5: Sustainable Operations

(Ørnulf Rødseth, SINTEF Ocean)

Provisions of analyses, tools and indicators for sustainability in the complete transport loop.

Subprojects:
- Logistics system cost-benefit analyses, covering key sustainability indicators
- Autonomy for green ship operations (machinery)
- Automated mechanical ship-port interface

SINTEF researchers

Recruitment status per June 2022

WP1: AutoRemote
(Anastasios Lekkas, NTNU)

Henrik Dobbe Flemmen
Simultaneous localization and mapping (SLAM) for autonomous ships
Supervisors: Edmund Brekke, Rudolf Mester, Kostas Alexis, Anette Stahl, Torleiv Bryne

PhD Daniel Menges
Department of Engineering Cybernetics
Supervisors: Adil Rashid

Emil Martens
Multi sensor detection for autonomous surface vehicles
Supervisors: Annette Stahl, Edmund Farland Brekke, Rudolf Mester

1 PhD + 1 Post doc from fall 2022

WP2: Digital Infrastructure
(Pierluigi Salvo Rossi, NTNU)

Melih Akdağ
Collaborative Collision Avoidance for Autonomous Ships
Supervisors: Tor Arne Johansen, Thor I. Fossen (Co-sup)

1-2 PhDs from fall 2022

WP3: Human Factors/ROC
(Ole Andreas Alsos, NTNU)

Felix-Marcel Petermann
Interaction Design for Autonomous Ships
Supervisor: Ole Andreas Alsos

Post Doc Taufik Akbar Sitompul
Department of Design
Design of human-machine interface

PhD Luka Grgičević
Decision Support for Autonomous Vessels
ICT and Natural Sciences at NTNU Ålesund

Andreas Salnardal Madsen
AI decision transparency in autonomous shipping
Supervisors: Magne Aarset, Ole Andreas Alsos

Eirik Fagerhaug
Explainable AI for Autonomous Ships
Supervisors: Ottar L. Osen, Robin T. Bye, Anastasios Lekkas

WP4: Safety and Assurance
(Ingrid B. Utne, NTNU)

Susanna Dybwad Kristensen
Online risk modelling of autonomous ships
Supervisors: Ingrid B. Utne, Astrid H. Brodtkorb

Alojz Gomola
Risk role in autonomous ship software systems
Supervisor: Prof. Dr. Ingrid Bouwer Utne

Spencer A. Dugan
Reliable design and operation of propulsion systems for autonomous ships
Supervisors: Ingrid B. Utne (main); Mehdi Zadeh (co)

Ayoub Tailoussane
The application of the COLREGs to autonomous vessels, and the challenge of translating legal concepts into machine comprehensible data for the development of COLREGs-compliant autonomous vessels
Supervisor: Trond Solvang

Raffael Wallner
Safety Demonstration of Autonomously Controlled Ships using Digital Twin
Supervisors: Mary Ann Lundteigen (main supervisor, NTNU)
Tor Arne Johansen (co-supervisor, NTNU)
Bjørn Axel Gran (co-supervisor, IFE)

1 PhD from fall 2022
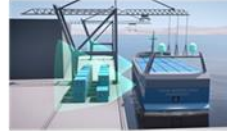
Aligning research to use cases

G2Ocean

NCL

Torghatten

Equinor

Use case 1: Deep-sea bulk shipping

Use case 2: Short-sea container shipping

Use case 3: ferries

Use case 4: Offshore support operations

Research activities

WP 1 - Autoremote

WP2 – Digital infrastructure

WP 3 - RCC & Human Factors

WP 4 – Safety & assurance

WP 5 - Sustainable operations

Each PhDs and Postdocs allocated to one main use case

Use case organized events

Use case 1: Deep-sea bulk shipping

Use case 2: Short-sea container shipping

Use case 3: ferries

Use case 4: Offshore support operations

WP 1 - Autoremote

Autonomous sailing/situational awareness
Autonomous vessel docking
Docking AUV/USV
Autonomous vessel mission planning
Algorithms for sensor calibration

6 PhD + 2 PD. SINTEF Digital researchers

WP2 – Digital infrastructure

Reliable ship-shore con...
Realistic channel modes for maritime communicati...
Robust collision avoidance and cyber ...

5 PhD 1 PD

WP 3 - RCC & Human Factors

...human-machine interaction
Passenger interaction

4 PhD IFE researchers

WP 4 – Safety & assurance

monitoring and management of autonomous sailing
Safety demonstration and safe operation with MRC
...dition-based maintenance and decision-support
Liability/Accountability autonomous ships

7 PhD + 2 PD IFE researchers

WP 5 - Sustainable operations

Crane autonomy
Auto mooring
Cargo connection/release
Remote crane operation
Auto charging
Container handling
Power and propulsion
KPIs and cost benefit analyses

SINTEF Digital &SINTEF Oceans researchers

Participation of industry and governmental partners

Examples of how research activities are relevant for several use cases

Utilizing infrastructure

Research infrastructure

Photos: NTNU

Photo: SINTEF, Tyholt

Photo: Tony Hall/NTNU

Foto: IFE

Test and transfer…

Industry partner infrastructure

Partner vessels and infrastructure

Data collection, problem formulation,…