SFI · AUTOSHIP
Autonomous ships

SFI AutoShip
Norway-Singapore Science Week 2020

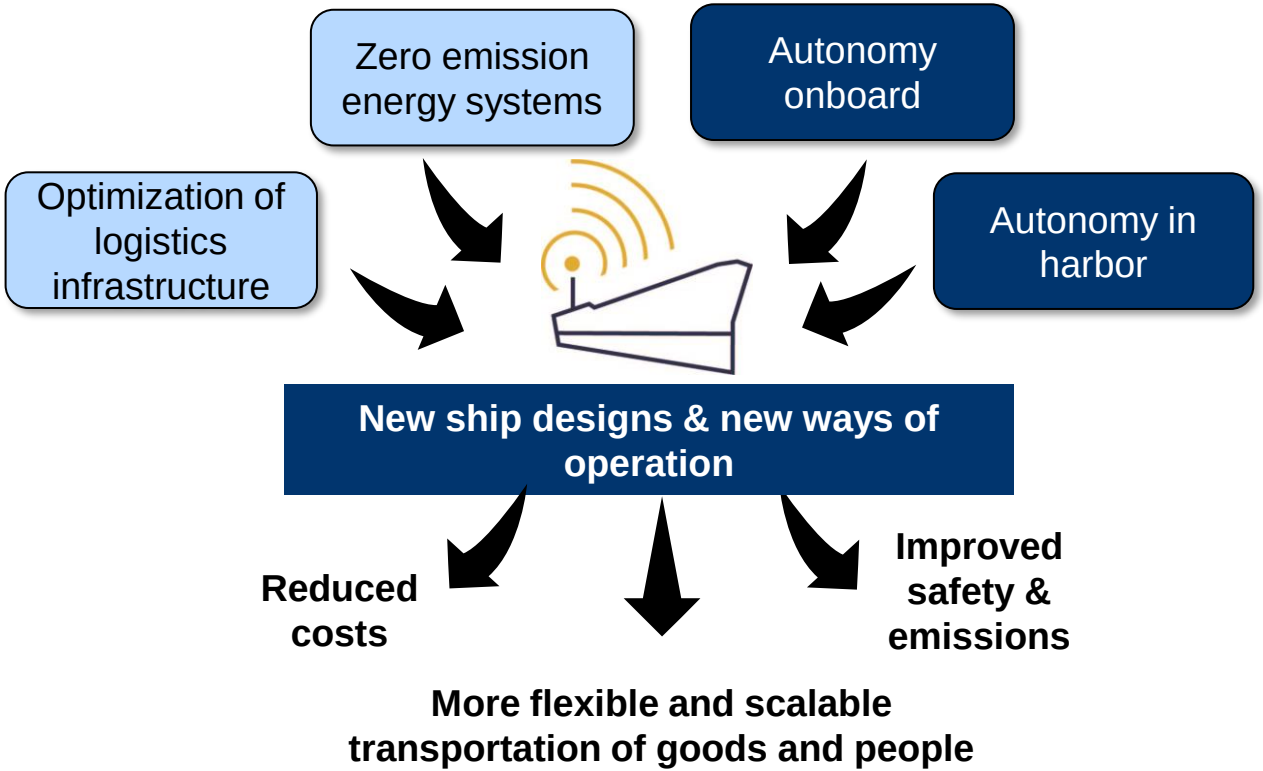
Mary Ann Lundteigen, Professor & Center Director SFI AutoShip,
Department of Engineering Cybernetics, NTNU

What is an SFI?

- SFI: Research-based innovation centre with co-funding from the Norwegian Research council. max. NOK 12 million per year
  (1 NOK≈0.10 Euro)
- Requires funding from industry, including active participation through in-kind contribution.
- Long term horizon: 8 years
- Focus on technology and knowledge transfer, internationalization, and researcher training to enhance the competitiveness of Norwegian industry
- 15-20 Centres are typically started every 4-5 years
- Many success criteria – including international collaboration

Link: https://www.forskningsradet.no/en/about-the-research-council/programmes/sfi/

Why *autonomous* ships?



SFI Autoship *in short*

Objective:
Develop and manage technologies, systems, and operations for **safe, sustainable, secure and cost-effective** autonomous sea transport and operations.

Why:

- Norway is in a strong position with internationally leading manufacturers, research institutes, academic groups, and class companies.
- Our coast, waterways, and intercontinental transportation needs give relevant business cases for ship owners and operators.
- Already infrastructures for testing at sea.

Selected key information:

- More than 20 partners
- Host: Department of Engineering Cybernetics, NTNU
- Multi-disciplinary
- Budget of approx. 240 mill NOK over 8 years
- Education: 20 PhD, 5 Postdoc, 150 master students
- Centre Director: Professor Mary Ann Lundteigen
- **Startup December 2020**

Research partners:

NTNU · SINTEF · UiO · IFE

Industry partners:

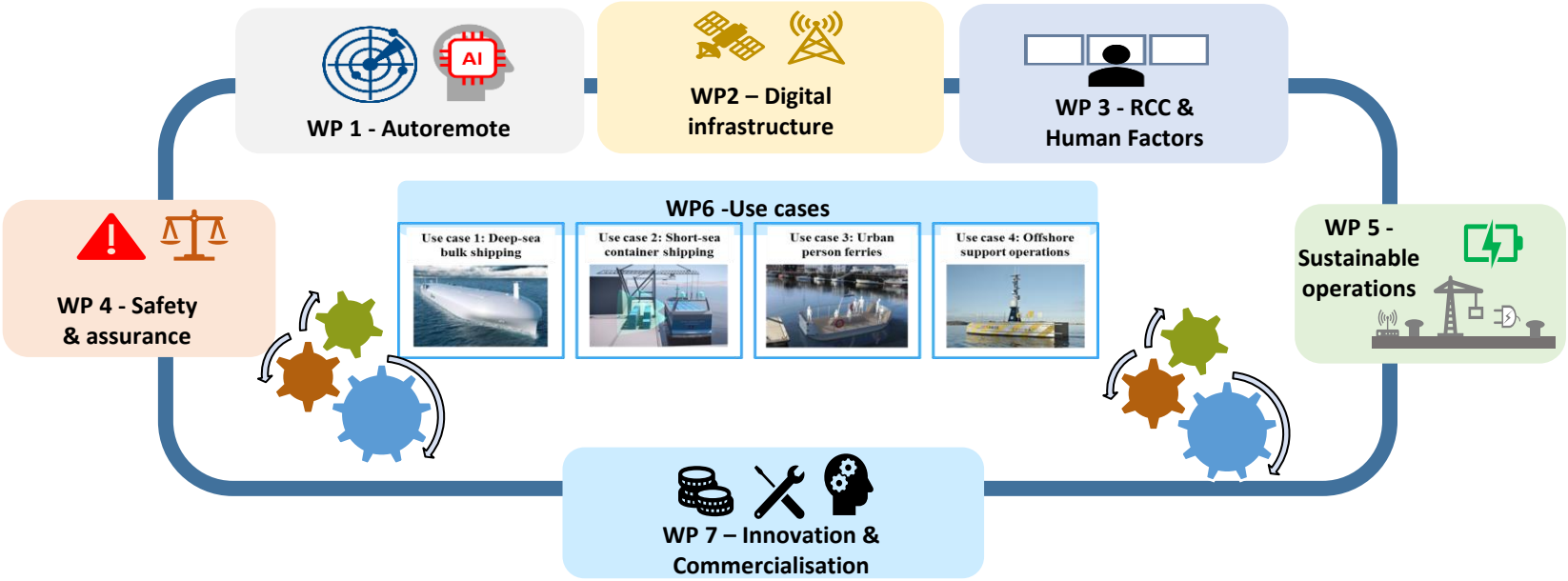
KONGSBERG (Kongsberg Maritime) · equinor · TORGHATTEN · MARITIME ROBOTICS · DNV·GL · gard · ncl · GRIEG STAR · G2 OCEAN · MACGREGOR · massterly · Telia · EMBRON · idletechs

Public and governmental partners:

Trondheim Havn · TRONDHEIM KOMMUNE · KYSTVERKET · Sjøfartsdirektoratet Norwegian Maritime Authority

Scope and way of working

Research partners
Industry partners
Public partners



WP1: AutoRemote

Research objective: develop **perception and decision-making systems** that will enable MASS to accomplish their mission, including fall-backs for extraordinary events.

Research tasks will focus on:

- **SITAW and sensor fusion** to enhancement of autonomous decision-making processes.
- Maritime **SLAM** and extended **object tracking**
- **Integration** of SITAW information in automatic control systems.
- **Reliable and resilient** autonomous decision making, **combining** optimal control, AI framework and low-level control algorithms

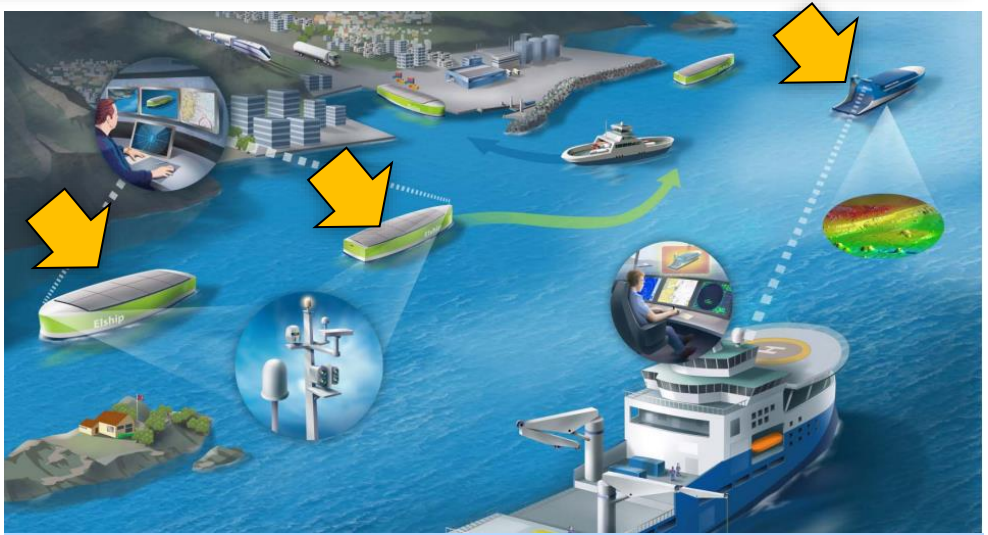


Illustration: NTNU/Bjarne Stenberg

WP2: Digital Infrastructure

Research objective: develop **reliable and secure data transfer** among the ship, the ROC and other marine traffic, allocated according to operational needs.

Research tasks will focus on:

- **Communication** between autonomous ships, their ROC and other maritime traffic.
- **Radio and radar technology** to be used in cooperative, massive MIMO and sensor fusion strategies.
- **Protocols and prototypes** for the processing of cooperative or system-provided information
- **Protection against cyber-physical attacks** such as bitstream manipulation, spoofing, meaconing and jamming.

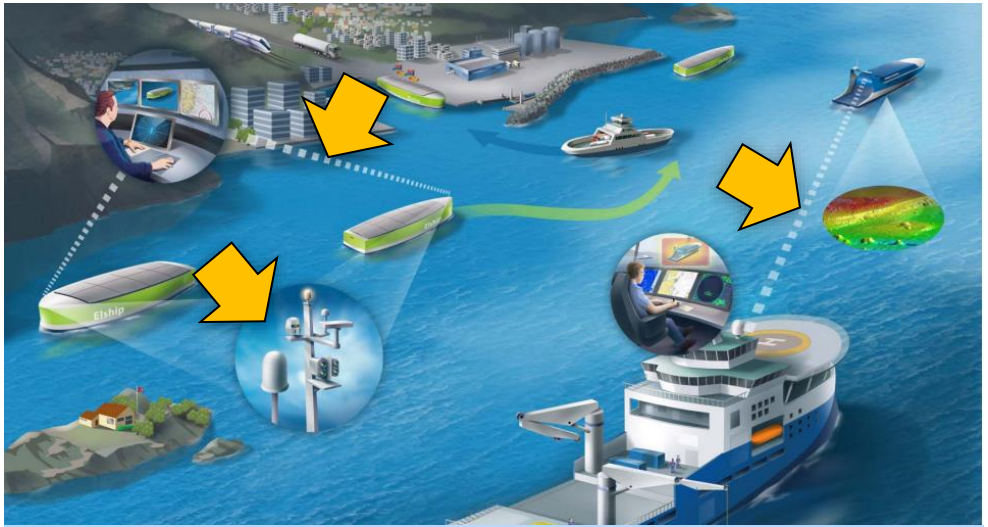


Illustration: NTNU/Bjarne Stenberg

WP3: ROC and Human factors

Research objective: develop **safe and efficien**t human-machine interfaces and interaction for remote operation centres (ROCs).

Research tasks will focus on**:**

- **Reliable decision-support** system for the ROC based on **sensor fusion** of available real-time environmental data and simulation models of the ship.
- **Usable Human-centre** designed based HMI for the ROC, incorporating situation awareness, workload, communicate with conventional ships.
- **Procedures, manning and competence** needs for ROC.
- **Division of roles** between automation and operators.

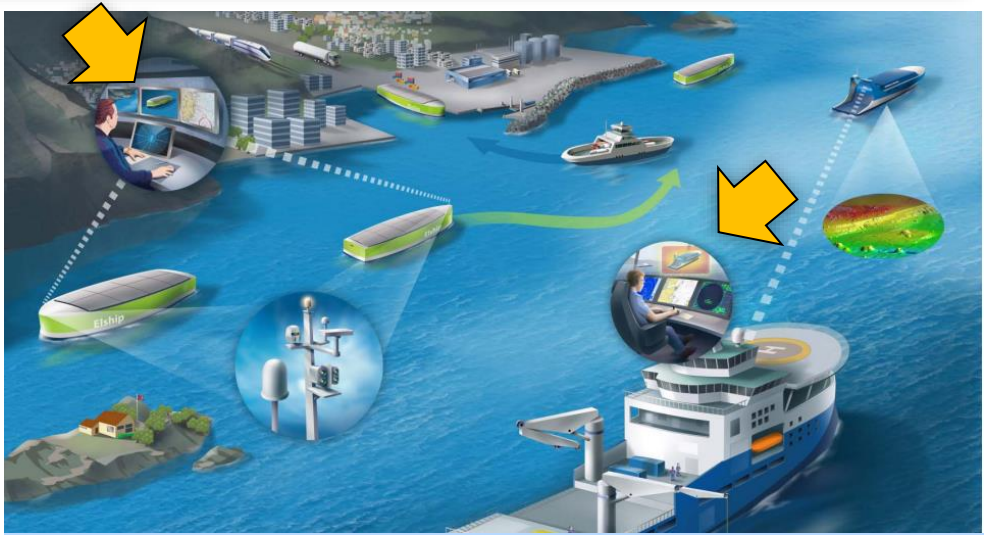


Illustration: NTNU/Bjarne Stenberg

WP4: Safety and Assurance

Research objective: research and develop novel methods, models and tools for risk management and safe design and operations of autonomous ships.

Research tasks will focus on**:**

- **Risk management in operation**, and the need to monitor system condition, act upon, and mitigate consequences of hazardous events.
- **Integration** of **safety in design** phases and fail-safe solutions.
- **System verification** and **simulation**, including cost-efficient approaches to testing and simulations.
- **Implication and risk acceptance** in the context of **liability and maritime laws**.

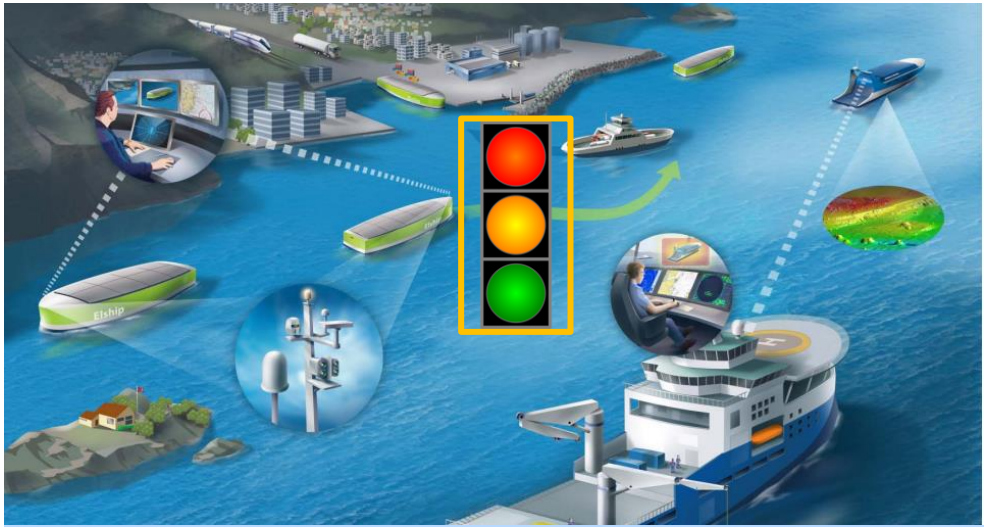


Illustration: NTNU/Bjarne Stenberg

WP5: Sustainable operations

Research objective: develop the next generation **cost-effective and environmentally-friendly** sea transport system.

Research tasks will include**:**

- **Logistic system cost-benefit analyses** and development of KPIs, models and simulation tools
- **Green ship operations** covering technology and solutions for environmentally-friendly operation of unmanned, or periodically unmanned, ships.
- **Automated mechanical ship-port** covering automatic control of mooring and cargo-handling systems.

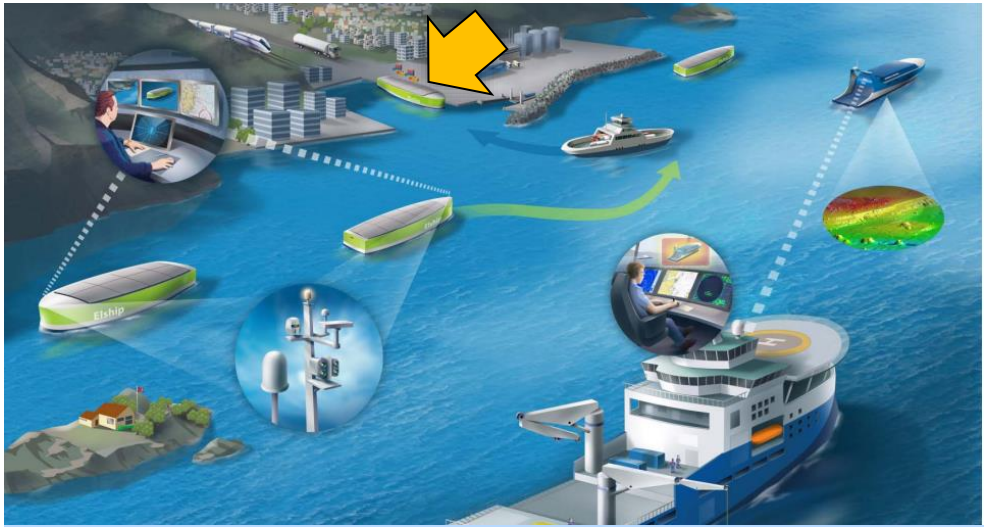


Illustration: NTNU/Bjarne Stenberg

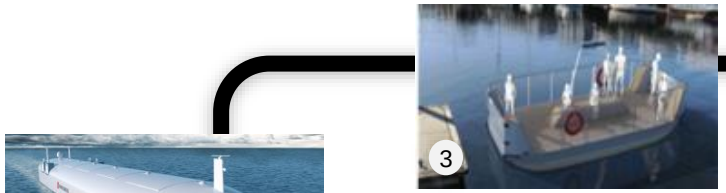
WP6: Use Cases

Research objective: demonstrate the **applicability and value-adding** potential of research and innovation results from the centre, and disclose new problems for further research.

Tasks will include**:**

- **Use case** identification and specification.
- **Integration of research results** into design and operational concepts.
- **Demonstration** through simulator, model-scale and/or full-scale demonstrators

Use case 3: Urban person ferries



Use case 1: Deep sea bulk shipping

Use case 4: Offshore support operations

Use case 2: Short sea container shipping

Illustrations: 1&2: Kongsberg.com,3: NTNU, 4: Equinor.com

Thanks for your attention

Questions?

www.ntnu.edu/sfi-autoship

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Abbreviations used

- TRL: Technology readiness level
- KPI: Key performance indicators
- MASS: Maritime autonomous surface ship
- MIMO: multiple-input multiple-output
- ROC: Remote Operation Centre
- SFF: Centre for research excellence
- SFI: Center for reseach based innovation
- SITAW: Situational awareness
- SLAM: Simultaneous localization and map building
- NFAS: Norwegian forum for autonomous ships