ANNUAL REPORT 20/21

SFI· AUTOSHIP

Autonomous ships for safe and sustainable operations

The Research Council of Norway

SFI· AUTOSHIP

NTNU | Norwegian University of Science and Technology

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INDUSTRY PARTNERS

MARITIME ROBOTICS idletechs equinor DNV G2 OCEAN

GRIEG STAR EMBRON massterly a Kongsberg Wilhelmsen joint venture MACGREGOR

Telia KONGSBERG ncl North Sea Container Line TORGHATTEN gard

PUBLIC AND GOVERNMENTAL PARTNERS

Sjøfartsdirektoratet Norwegian Maritime Authority Trondheim Havn TRONDHEIM KOMMUNE KYSTVERKET

Grafisk design og produksjon: NTNU Grafisk senter

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VISION

Our vision is to leverage the competencies of the complete Norwegian maritime cluster and consolidate Norway as a leading global actor within autonomous ships

OBJECTIVE

The Centre for Research-based Innovation within Autonomous Ships will develop and manage technologies, systems and operations for safe, sustainable, secure and cost-effective autonomous sea transport operations.

The focus areas include:

- Enabling technologies like situational awareness, artificial intelligence, autonomous control and digital infrastructure.
- New business models and operational concepts like the adaptation of remote operation senters (ROC) and the development of cost-efficient logistical concepts and port solutions.
- Methods and models for monitoring risk and the clarification of the legal aspects of liability when a captain is not on board.

Photo: Geir Mogen/NTNU

Centre Director

I am both honored and proud to be able to present the first annual report for SFI AutoShip, the new Centre for research-based innovation (SFI). We have now onboarded an eight-year long journey, where academia, research institutes, industry and public partners are joining forces to accelerate the level of innovations within autonomous shipping. The long-term horizon gives us the opportunity to target some of the most challenging gaps in technologies and at the same time work systematically to transfer results as they arise.

The Centre had its official startup on December 1st 2020, but the preparation started earlier including a full day workshop on September 1st. Many researchers will be engaged in the Centre, including those being educated through PhD and Post Doc scholarships. We are involving many disciplines, and the Centre will use this opportunity to stimulate new collaborations. The multi-disciplinary insight, along with in-depth specializations, are skills we believe are required for the future. As a female Director of the Centre, I would like to see more women being recruited to jobs in the maritime sector.

I hope you will enjoy reading more about our activities, ambitions and plans, despite our short time in operation.

I am grateful to all of you that have contributed to the establishment of this Centre, and for your contributions ahead. It gives us what we need to sail into new waters.

Professor Mary Ann Lundteigen
Centre Director SFI AutoShip

Photo: Mikael Sætereid / Ocean Autonomy Cluster

Chairman of the Board

I am very pleased and honoured to be appointed as Chairman of the Board for SFI AutoShip for the next two years!

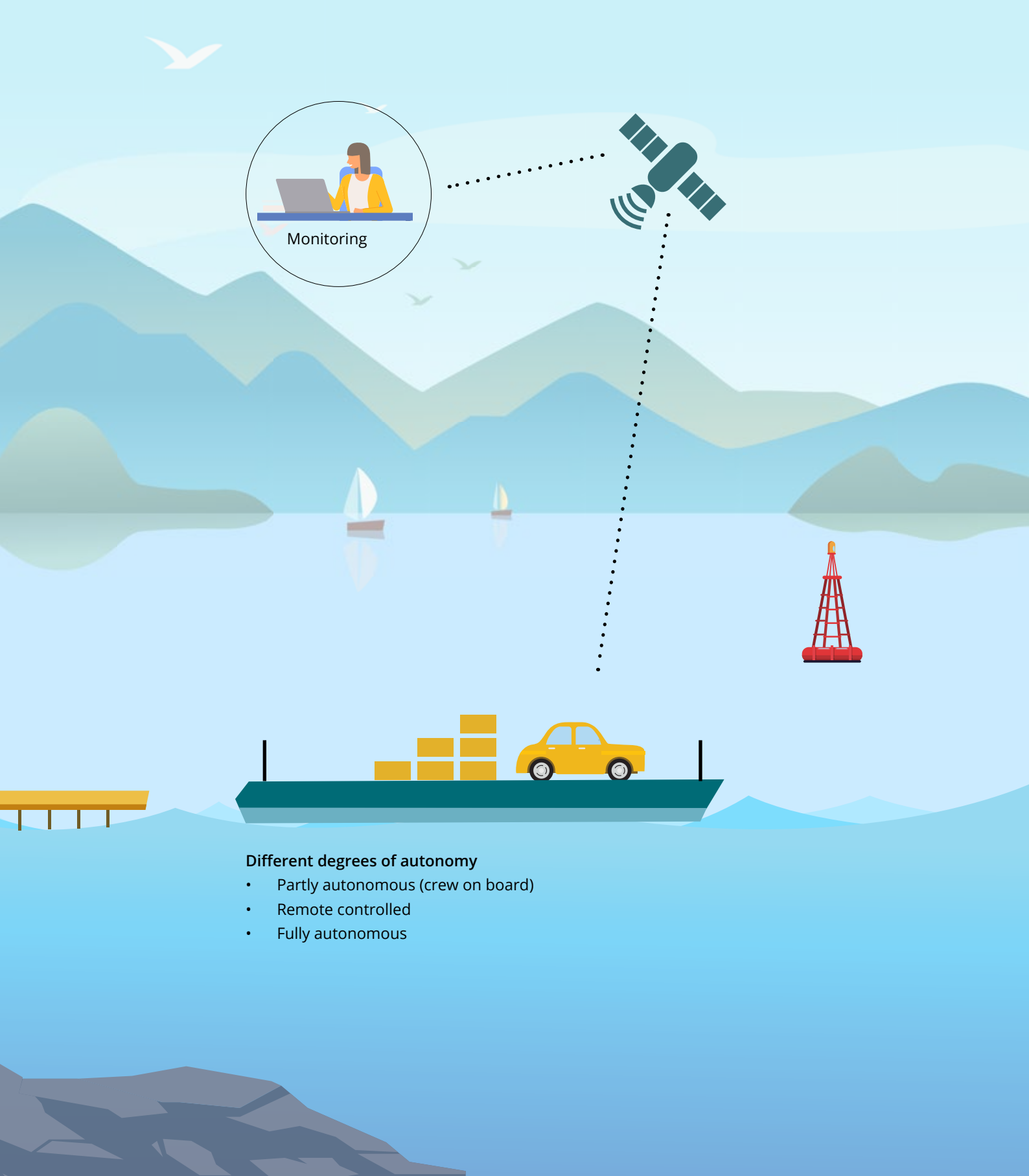
SFI AutoShip will play an important role in the development of autonomous ship technology. New methods and knowledge will be developed and applied to establish and verify key enabling technologies for autonomous ship applications. Demonstration of these new methods and technologies will be assured through a variety of relevant use cases where industry partners will play an important role.

SFI AutoShip is necessary for several reasons. There are common challenges for the industry that need to be addressed to enable safe and efficient operation of autonomous ships in complex environments with other ships and infrastructure. New versions of the existing traffic rules at sea (COLREGS) and extended digital communication protocols are some examples of this. In addition to solving the technological challenges, aspects related to human machine interactions, ethics and liability also need to be addressed. Adoption and scaling up of this industry needs new rules and regulations to be established and the Centre can help drive these processes forward. The Centre is also facilitating close cooperation between research institutions and industry partners in the forefront of the development of autonomous ship technology and applications.

The industry related to autonomous ship applications needs education of young talents that can drive the development and secure competitiveness of the Norwegian industrial companies into the future. SFI AutoShip will play an important role in this through master and PhD projects. Good cooperation between educational institutions and the industry will assure relevance in the topics proposed to the students and help in the recruitment of the best talents.

Combining forces of top education institutions, research organisations, SMEs and large companies to solve common challenges and to establish networks will help the Norwegian industry stay in the forefront of the development of autonomous ship applications, which in addition to creating interesting new jobs and value for the society will play an important role in meeting the UN Sustainability Development Goals.

Sverre Rye Torben
Key Technology Owner
Emerging Project department of Kongsberg Maritime
Chairman of the Board of SFI Autoship



Different degrees of autonomy

- Partly autonomous (crew on board)
- Remote controlled
- Fully autonomous


See, interpret and navigate safely in all weather conditions and environments.

WORDS FROM OUR PARTNERS

Each year we will ask a few of our partners to reflect on the importance of maritime autonomy and their ambitions through SFI AutoShip

Equinor ASA v/ Kjetil Skaugset

Kjetil Skaugset is a senior advisor within Technology Management at Equinor. He is also the leader of SFI AutoShip's Innovation and Commercialization Advisory Committee.

What are your company's current activity and ambitions in the area of autonomous ships?
We have already used unmanned and autonomous surface vessels in our operations. This is mostly connected to survey and inspection tasks placed at various steps on the autonomy ladder. In the future I believe we will do that even more so. Increased level of autonomy is an integral part of future operations across business areas.

Equinor is an active partner in several research initiatives supporting increased level of autonomy in the ocean space, e.g. Centre of Excellence NTNU AMOS (Autonomous Marine Operations and Systems). SFI Autoship is a natural continuation of this focusing on autonomous ships.

Where/how do you see that the industry and society will benefit from the utilization of autonomous ships and related infrastructure?
Automated and autonomous systems are important in reducing human exposure to risk in operations. It can also be a component in a larger system, e.g. Remotely Operated Factory (ROF™), contributing to further gains on the safety side.

Autonomous ships bring value in a variety of industry segments, e.g. offshore oil & gas, renewables, shipping and mobility as such. Optimalization of vessel size and tasks involves reduction in vessel cost while simultaneously increasing the scope or nature of the tasks performed. Such efficient resource use increase value, and at the same time involve lower emissions from the operations.

Hence, I do expect significant benefits for industry and society along the three dimensions aligned with Equinor's strategy "Always Safe, High Value, Low Carbon".

What has been the main motivation for joining SFI AutoShip?
It is important to contribute to the progress of research, development, and innovation within this field. For us, innovation is defined as "Creating something new, that is valuable and implemented". It is important to stress that there is no innovation without implementation. In this context we are aiming not only a single first use, but rather wide implementation of results.

Further, it is important for us to bring the end user perspectives into the SFI. This includes setting direction where we believe potential to be the greatest. Leveraging the wide operational experience within Equinor will add value to SFI Autoship.

What expectations do you have for the Centre?
I expect SFI Autoship to attract and develop world leading students and researchers, and for them to undertake world leading research for future value creation. SFI Autoship results successfully tested in full scale in our operations would be what we consider a success from this partnership.

SFI Autoship is set up for teamwork. Accomplishing the full potential of use cases, both existing and the ones we will define during the SFI, requires a real team effort from all participants in the SFI.

I expect a good and open collaboration between partners, excellent research, and rapid path from idea to realization. This will enable us to implement SFI results in our operations. SFI Autoship should capitalize on the ability to perform early testing of ideas, to confirm assumptions or adjust the course of action. This will increase relevance for the research done, as well as creating a dynamic and inspiring place to work.

Equinor is a broad energy company with more than 21,000 employees, present in more than 30 countries worldwide. Equinor develops oil, gas, wind, solar energy and low carbon solutions. The headquarters are in Stavanger, Norway. Equinor is an active partner in research projects supporting increased level of autonomy in several areas.

DNV v/ Øystein Engelhardtsen

Øystein Engelhardtsen is the Group Leader for Ship Autonomy in DNV and represents an active partner in SFI AutoShip.

What are your company's current activity and ambitions in the area of autonomous ships?
DNV's ambition is to be in the forefront of assuring safety for autonomous ship functions. From the sensors on board, the reliability of machinery in an unmanned vessel, to the software which must be stable and cyber-secure, to national and international rules and regulations. DNV is working with all of the stakeholders in this new field to build a robust set of standards that will enable these new systems and technologies to reach the market and ensure that they are safely implemented.

Where and how do you see that the industry and society will benefit from the utilization of autonomous ships and related infrastructure?
DNV believes that increased automation and potentially unmanned ships is a trend that may eventually lead to safer and more efficient transport and operations at sea. However, this development depends on safe operation being assured, an aspect which is at the core of DNV's classification services.

What has been the main motivation for joining SFI AutoShip?
SFI AutoShip gathers many of the leading actors in the Norwegian maritime cluster and we see it as essential to join forces in order to tackle the wide range of challenges in enabling safe implementation of autonomous and remotely operated systems in the Maritime sector.

What expectations do you have for the Centre?
We hope to see that SFI AutoShip can constitute a platform for industry-wide collaboration on development of safe and predictable technology for ship autonomy. We also expect the SFI to provide answers to some of the key research questions within development and assurance of such technologies.

DNV is the world's leading classification society and a recognized advisor for the maritime industry. We enhance safety, quality, energy efficiency and environmental performance of the global shipping industry – across all vessel types and offshore structures. We invest heavily in research and development to find solutions, together with the industry, that address strategic, operational or regulatory challenges.

NCL v/ Kenneth Johanson

Kenneth Johanson is the Digital manager at North Sea Container Line (NCL) and a valuble partner in the SFI. Kenneth Johansen is a Board member of SFI AutoShip and we asked about his visions on autonomous ships.

What are your company's current activity and ambitions in the area of autonomous ships?
We are currently not that autonomous, which in turn drives us to investigate this area even more as we advance. We have turned our organization around digitally the last two years to be able to gather and use our data. This will hopefully get us the insight we would need for the future.

Where and how do you see that the industry and society will benefit from the utilization of autonomous ships and related infrastructure?
Since we operate an extensive service with both ocean-going vessels and land going transport, we see the best benefit in the intersections between partners. If we could automate information flow and data, we could, as a next step, automate a lot of other tasks. We also visualize this as a first step where automation will move on to other areas as we progress.

What has been the main motivation for joining SFI AutoShip?
We want to be in front of the research. If we figure out something that could bring us a significant benefit, we will steer our organization towards this fast and early. SFI Autoship can give us the necessary insight.

What expectations do you have for the Centre?
We expect a healthy sharing of information between a lot of exciting parties. We also hope and wish that our hands-on contribution of experience and data can give researchers a broader insight.

NCL is an integrated container logistics company with an extensive and well-connected network in Europe and Norway. We offer containerized transport solutions from door to door, from all around Europe to the West Coast of Norway.

NCL cooperates with a broad network of agents in Norway, the Netherlands, Germany, and the UK, and serves major European hubs in France, Belgium, and Italy, to mention a few.

Photo: Geir Mogen/NTNU

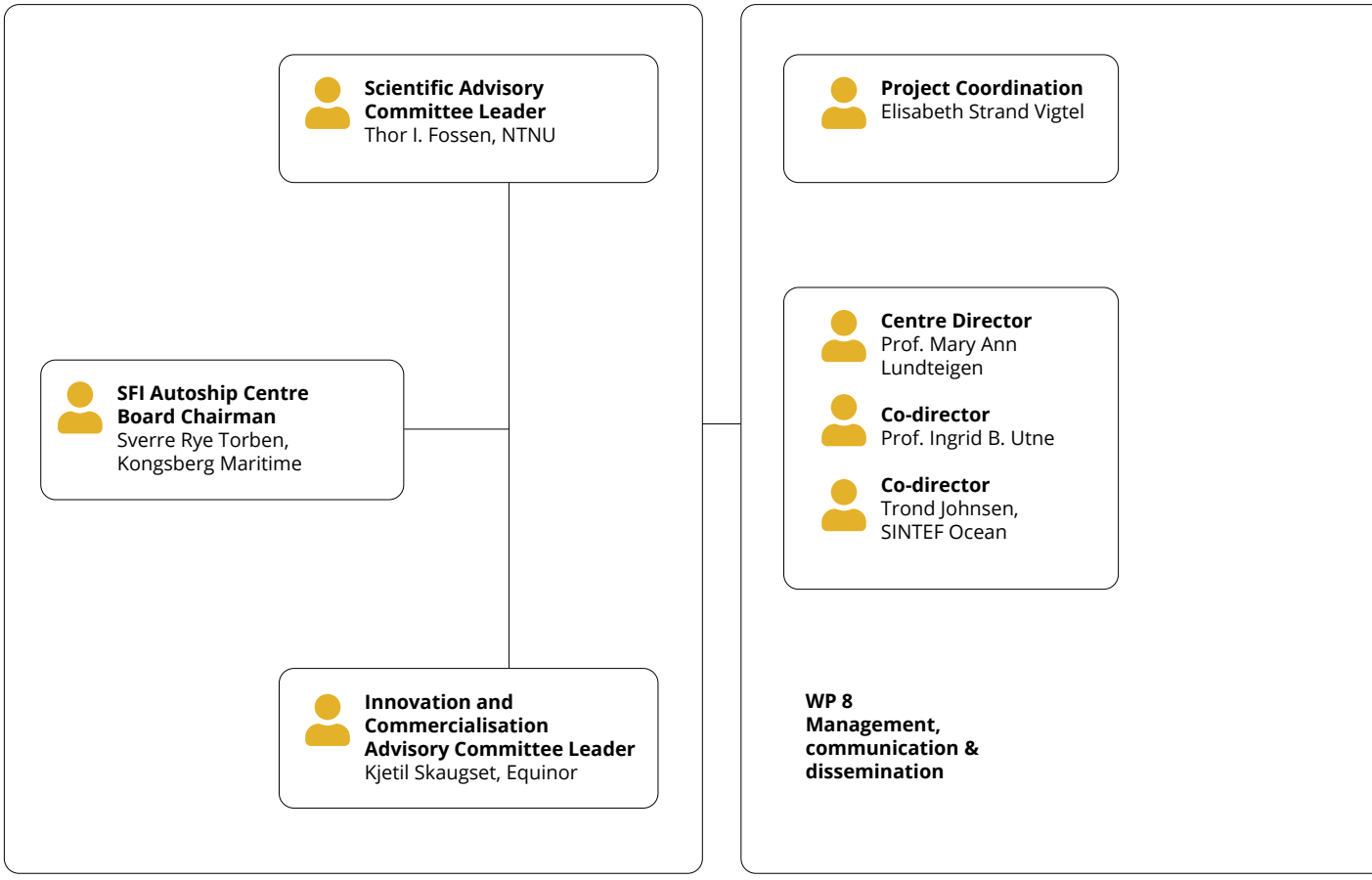
Organisation

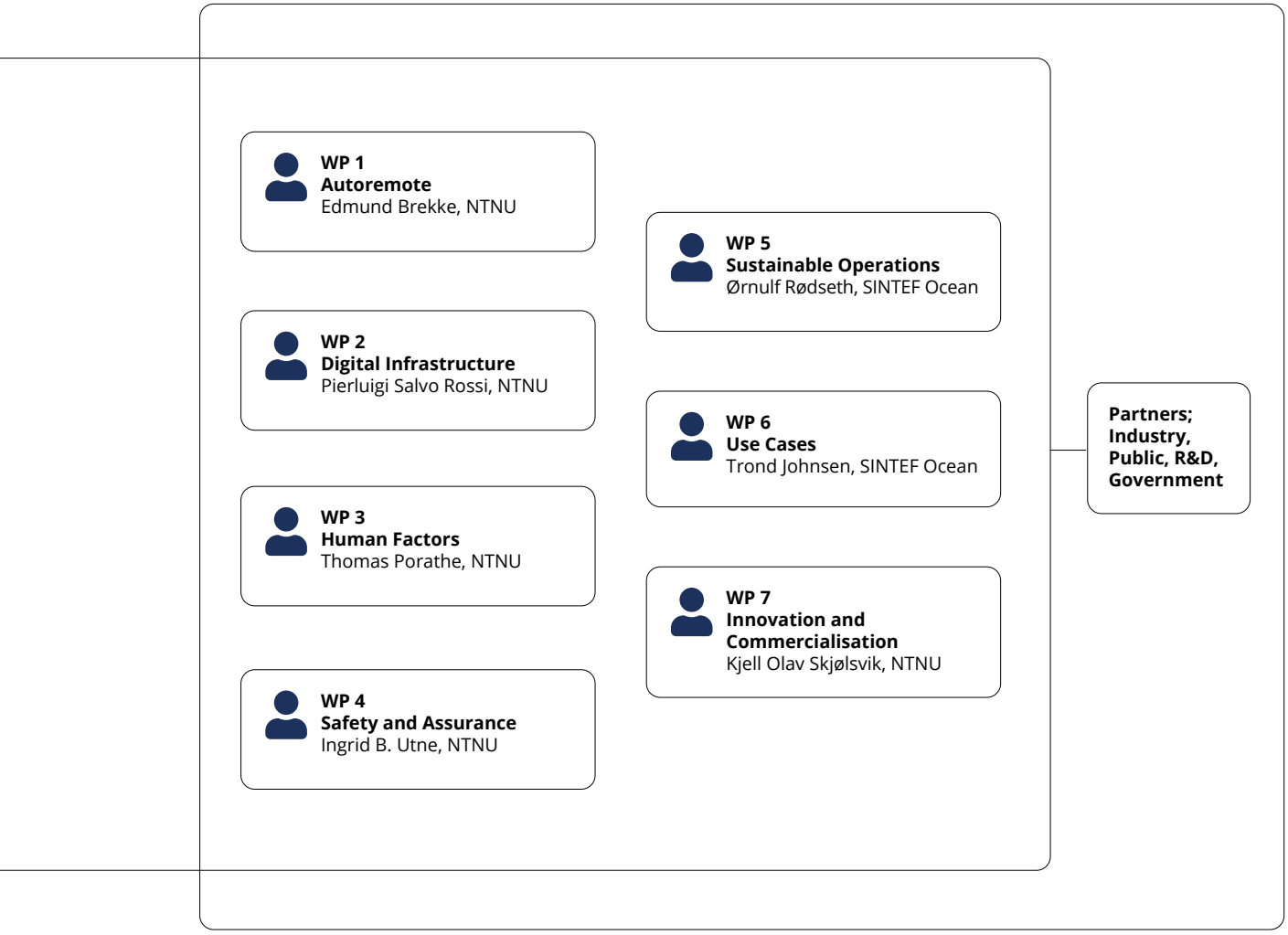
The Centre is hosted by the Department of Engineering Cybernetics (ITK) at the Faculty of Information Technology and Electrical Engineering (IE), NTNU.

The Centre organisation includes the Centre board, Centre management, eight Work Packages (WPs), and two advisory committees. In total, NTNU involves six Departments in three Faculties: IE faculty: ITK, Department of Electronic Systems (IES), and Department of ICT and Natural Sciences (IIR). Faculty of Engineering (IV): Department of Marine Technology (IMT) and Department of Ocean Operations and Civil Engineering (IHB). Faculty of Architecture and Design (AD): Department of Design (ID).

The other research partners are SINTEF Ocean, SINTEF Digital, Institute for Energy Technology (IFE), and the University of Oslo (UiO).

Organisation of the Centre




WP 1
Autoremote
Edmund Brekke, NTNU
WP 2
Digital Infrastructure
Pierluigi Salvo Rossi, NTNU
WP 3
Human Factors
Thomas Porathe, NTNU
WP 4
Safety and Assurance
Ingrid B. Utne, NTNU
WP 5
Sustainable Operations
Ørnulf Rødseth, SINTEF Ocean
WP 6
Use Cases
Trond Johnsen, SINTEF Ocean
WP 7
Innovation and Commercialisation
Kjell Olav Skjølsvik, NTNU
Partners; Industry, Public, R&D, Government

CENTRE MANAGEMENT		
Name	**Dept. of Engineering Cybernetics, NTNU**	**Centre director**
Mary Ann Lundteigen	Dept. of Engineering Cybernetics, NTNU	Centre director
Ingrid Bouwer Utne	Dept. of Marine Technology, NTNU	Co-director
Trond Johnsen	SINTEF Ocean	Co-director
Elisabeth Strand Vigtel	Dept. of Engineering Cybernetics, NTNU	Administrative Coordinator
Work packages 1-7	NTNU and SINTEF	Work package leaders

CENTRE BOARD		
Name	**Institution**	**Function**
Sverre Rye Torben	Kongsberg Maritime	Chairman of the Board
Kjell Røang	Forskningsrådet	Observer
Ingelin Steinsland	NTNU	Board member
Trond Solvang	UiO	Board member
Trond Runar Hagen	SINTEF AS	Board member
Arne Fredheim	SINTEF Ocean	Board member
Bjørn Axel Gran	IFE	Board member
Hans Anton Tvete	DNV	Board member
Trygve Christian Moe	Embron	Board member
Kjetil Skaugset	Equinor	Board member
Leif Arne Strømmen	G2 Ocean	Board member
Lars Lislegard-Bækken	Gard	Board member
John Gabriel Østling	Grieg Star	Board member
Andreas Simskar Wulvik	Idletechs	Board member
Eivind Gimming Stensland	MacGregor	Board member
Vegard Evjen Hovstein	Maritime Robotics	Board member
Tom Eystø	Massterly	Board member
Kenneth Johanson	NCL	Board member
Henning Huuse	Telia	Board member
Stein Andre Herigstad-Olsen	Torghatten	Board member
Trond Langemyr	Kystverket	Board member
Svein David Mehaug	Sjøfartsdirektoratet	Board member
Terje Meisler	Trondheim Havn	Board member
Kjell-Inge Stellander	Trondheim kommune	Board member

INNOVATION AND COMMERCIALISATION ADVISORY COMMITTEE		
Representing the partner institutions	**Institution**	**Function**
Kjetil Skaugset	Equinor	Leader 2021-2022
Are Jørgensen	DNV	Permanent member
Oda Ellingsen	Kongsberg Maritime	Permanent member
Vegard Evjen Hovstein	Maritime Robotics	Permanent member
Trond Johnsen	SINTEF Ocean	Permanent member
Kjell Olav Skjølsvik	NTNU	Permanent member
Bjørn Martin Worsøe	Telia	Member 2021-2022
Joachim Ofstad Næss	Torghatten	Member 2021-2022

SCIENTIFIC ADVISORY COMMITTEE		
Name	**Institution**	**Function**
Thor I. Fossen	Dept. of Engineering Cybernetics, NTNU	Leader
Other members to be announced		

From the allocation of the center. Photo: Kai T. Dragland/NTNU

Illustration: Bjarne Stenberg/ NTNU

Research and Work Packages

Based on the Centre's objectives two overarching research questions have been identified:

- How can the society benefit from autonomous shipping, in terms of reduced environmental footprint, economy, safety and sustainability?
- How can new standards, methods, regulations, digital twins and digital infrastructure be used to assure the required safety and security for autonomous shipping?

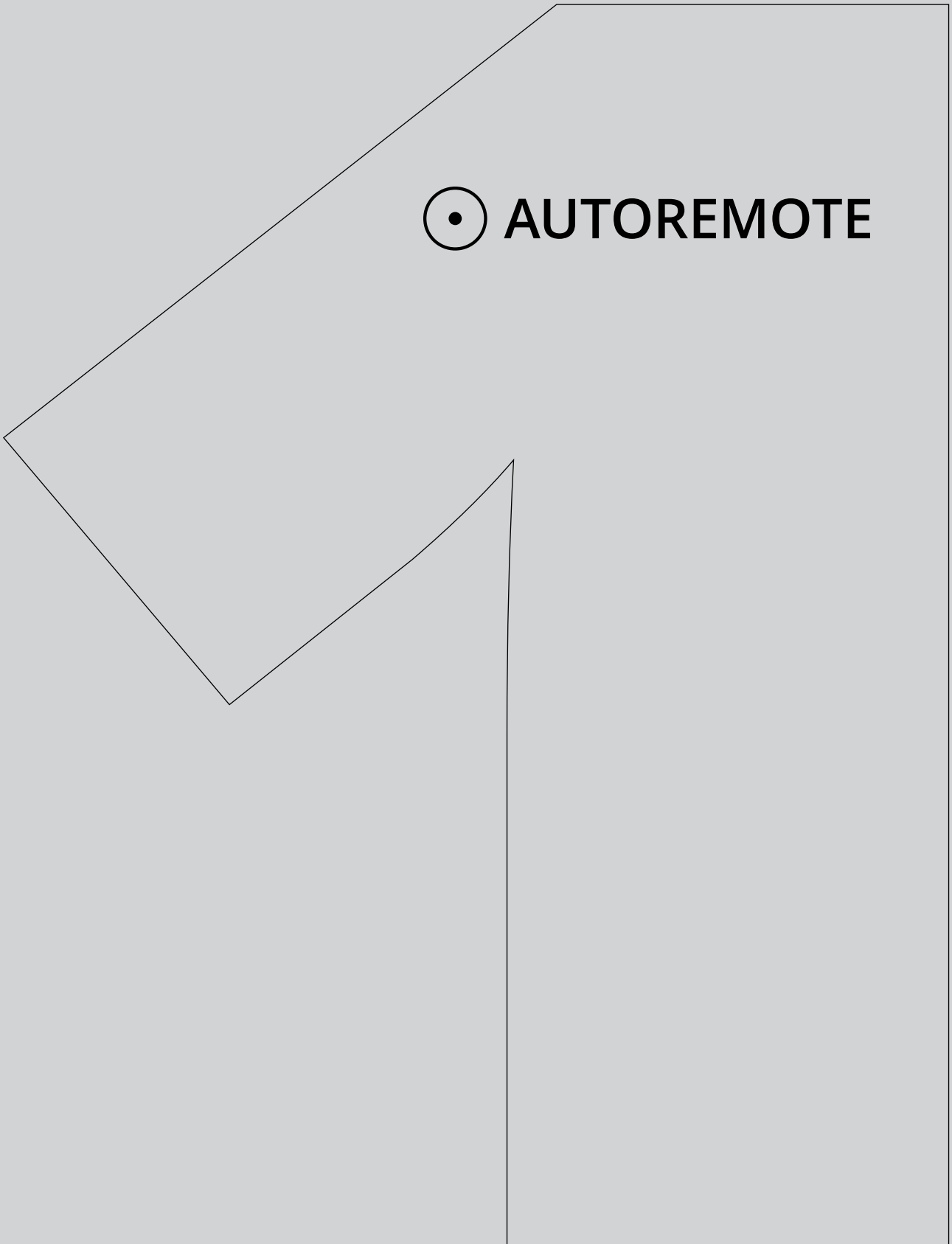
Answering these questions relies on a multi-disciplinary effort, multiple perspectives from different autonomy concepts, industrial and commercial applications, and the Centre stakeholders' interests, theory development, and experimental testing. This is best approached by framing and aligning Centre research according to use cases, where each use case represents a relevant context for autonomous ships.

To further explore these research questions and how to succeed with multi-disciplinary efforts, SFI AutoShip conducted a workshop on September 1st, 2020 which included more than 50 participants. The objective of the workshop was to

- Actively engage industry and public partners to provide input to the framing and execution of activities in the Centre
- Anchor the goals of the Centre and work packages with partners own internal strategies
- Ensure that the plans for research and innovation meet partners` expectations

All the work packages held presentations followed by digital breakout sessions. The participants could visit the different sessions digitally to partake in the discussions.

In order to facilitate innovation and ensure exploitation of research outcomes and utilization of these, an Innovation and Commercialization Advisory Committee has been established. The Committee consists of members from our partners and they are in the final stages of developing an innovation strategy for the SFI.


AUTOREMOTE

WP leader: Associate Professor

Edmund Førland Brekke

Department of Engineering Cybernetics

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

This WP will solve open problems in the development of technology for solutions to the use cases and will provide benchmarking solutions and data sets. The work in WP1 can be divided into two main tasks, covering the perception side and the actuation/decision-making side of Maritime autonomous surface ships (MASS) technology.

The main research tasks are:

Task 1.1, which covers situational awareness (SITAW) and sensor fusion and will provide the autonomous decision-making processes with information that is largely absent in current systems. A long-term research focus is maritime SLAM (simultaenous localization and mapping) and extended object tracking which currently are at low technology readiness level (TRL).

Task 1.2, which provides integration of SITAW information in automatic control systems. A long-term research focus is autonomous decision making, developed in an optimal control and AI framework and supported by low-level control algorithms with the reliability and resilience required in MASS technology.

DIGITAL INFRASTRUCTURE

WP leader: Professor

Pierluigi Salvo Rossi, NTNU

Department of Electronic Systems

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

The digital infrastructure behind autonomous maritime systems is an IoT system, where nodes are sensors on ships or on-land centres, each with different partial view, different equipment, asymmetric links, and operating in non-stationary local and global conditions. Understanding and comparing effective ways to collect and combine the information and provide a coherent scenario is challenging.

The main research tasks are:

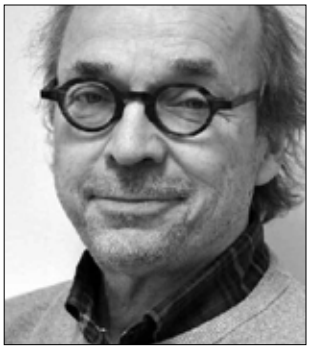
Task 2.1, which focuses on consolidating knowledge about the possible technological solutions for communication between autonomous ships, their ROC and other maritime traffic.

Task 2.2, which focuses on radio and radar technology to be used in cooperative, massive multiple -input and multiple-output (MIMO) and sensor fusion strategies.

Task 2.3, which focuses on development of protocols and prototypes for the processing of cooperative or system-provided information.

Task 2.4, which focuses on contributing to making the developments of Tasks 2.1-2.3 protected against cyber-physical attacks such as bitstream manipulation, spoofing, meaconing and jamming.

REMOTE OPERATION CENTRES (ROC) AND HUMAN FACTORS



WP leader: Professor

Thomas Porathe

Department of Design

Our objective is to develop safe and efficient human-machine interfaces and interaction for remote operation centres (ROCs).

MASS will for the foreseeable future be dependent on a land-based remote operation - centre (ROC). The role of the ROC will be to monitor the status of the ship, and to intervene if the automation fails. The location, removed from the context of the vessel, will be a great challenge in order to give adequate situation awareness to the ROC operators. The interaction among MASS-ROC and conventional ships will depend heavily on sensor and automatic identification system (AIS) information, as well as cooperation with the vessel traffic service (VTS).

The main research tasks are:

Task 3.1, which will research a reliable decision-support system for the ROC based on sensor fusion of available real-time environmental data and simulation models of the ship ("digital twin").

Task 3.2, which will research a usable Human-centre designed based HMI for the ROC. With situation awareness and workload in mind, develop the interface humans and automation onboard and in the ROC, and means of communicate intentions to conventional ships.

Task 3.3, which will focus on research, procedures, manning and competence needs for ROC Research the needed competence for the new "mariners" in the ROC and also work procedures and division of labour between operators and automation.

Task 3.4, which will focus on iteratively, to verify usability and validate performance in the ROC in simulators and at sea. The prototypes developed will be tested with end users at the NTNU simulator centre in Ålesund and on the research vessel Gunnerus.

4

SAFETY AND ASSURANCE

WP Leader: Professor

Ingrid Bouwer Utne

Department of Marine Technology, NTNU

Our objective is to research and develop novel methods, models and tools for risk management and safe design and operations of autonomous ships.

This work package will focus on risk reduction, mitigation strategies, and safe solutions for the design and operation of autonomous ships. This achievement relies on the ability to identify the new risks and incorporate necessary (technical, software, security, human and organisational) measures into the systems, the operation, and the associated infrastructure.

The main research tasks are:

Task 4.1, which focuses on risk management in operation, and the need to monitor system condition, act upon, and mitigate consequences of hazardous events.

Task 4.2, which targets the integration of safety in design phases and fail-safe solutions.

Tasks 4.3, which focuses on system verification and simulation, including cost-efficient approaches to testing and simulations.

Task 4.4, which evaluates the implication of autonomous operations and risk acceptance in the context of liability and maritime laws, as well as how assurance tools, standards, and rules can cover the new aspects of autonomous operations.

SUSTAINABLE OPERATIONS

WP leader: Senior researcher

Ørnulf Jan Rødseth

SINTEF Ocean

Our objective is to develop the next generation cost-effective and environmentally friendly sea transport system.

Autonomous ships can dramatically change transport systems, e.g. by introducing smaller and more flexible vessels. This may be a key factor in reaching IMO's (International Maritime Organisation) 50% goal for emission reductions as well as other sustainable development goals. The sustainability of an autonomous ship system will depend on efficient utilization and integration of all technologies developed in the Centre. The future auto-remote solutions must be aligned with the human capabilities of any remote operators and other mariners; automated berthing, cargo handling and power supplies in port must be efficiently integrated with shipboard automation; and the combination of operational strategies, automation and transport work undertaken must be optimised to be cost-effective and environmentally sound.

WP5 will provide the integration among the technologies developed in WPs 1-4 with the transport operations undertaken, physical port automation systems and economic and environmental optimisation. The WP will provide quantified evidence that the use cases developed in SFI AutoShip will be cost-effective as well as environmentally significantly better than alternatives used today.

The main research tasks are:

Task 5.1 covers logistic system cost-benefit analyses, which includes development of an integrated framework for economic, environmental and risk assessment. Development of KPIs, models and simulation tools for the mentioned that allows an integrated assessment of the autonomous ship system's operational cost, environmental footprint and risks.

Task 5.2 on green ship operations, which focuses on the identification and assessment of technology and solutions for environmentally friendly operation of uncrewed, or periodically uncrewed, ships.

Task 5.3 on automated mechanical ship-port, which includes the optimisation of automatic control of mooring and cargo-handling systems to automate port operations, while also utilizing the ship's actuator systems, including ballast.

USE CASE

6

WP leader: Research manager

Trond Johnsen

SINTEF Ocean

Our objective is to demonstrate the applicability and value-adding potential of research and innovation results from the centre, and disclose new problems for further research.

Each use case will involve at least one end user, product and service providers, research institutes, universities and authorities, which represent the entire research innovation chain as well as competence at all technology readiness levels (TRLs). At the start of the Centre, four use cases have been identified as most promising from the industry-partners' perspective. In collaboration with WP7, the use cases will be run as innovation projects with a typical duration of 2-3 years, and with steering and heavy involvement from industry partners. When a use case has reached a sufficiently high TRL, it will be handed over to the industry partners for further development internally and/or through new and dedicated research and innovation projects. More use cases will be introduced during the lifetime of the centre, based on updated market and technology developments.

The main research tasks are:

Task 6.1 on use case identification and specification, which covers the specification of objectives, deliverables and need for research results from WP 1-5.

Task 6.2 on case-data management, which includes the gather and manage use case data provided by industry partners (e.g. data from ships in operation). Ensure access to relevant data for researchers and students.

Task 6.3 on the integration of research results, which is about the integration of relevant results from WP 1-5 into holistic use case deliverables, i.e. complete technological and operational concepts.

Task 6.4 on the demonstration, which includes the verification and documentation of the performance of the concept deliverables through simulator, model-scale and/or full-scale demonstrators.

INNOVATION AND COMMERCIALISATION

WP Leader: Innovation manager

Kjell Olav Skjølsvik

Department of Marine Technology, NTNU

Our objective is to foster innovation culture and outcomes throughout the Centre.

To facilitate innovation and ensure exploitation of research outcomes, an open mindset and mechanisms stimulating innovation will be implemented. The WP will provide new business opportunities through utilization of the research outcomes in development of new products, services, procedures, guidelines, standards, and technology. Training of young researchers, facilitating ideation, and monitoring potential for exploitation of research outcome will be elements in the innovation management within the SFI.

Use case solutions and new business opportunities will be developed up to a limited maturity within the framework of the SFI. Strategies will be established for further maturation and implementation of the use cases and individual business opportunities through alternative and appropriate pathways to impact. This may be alternative types of spin-off associated projects or spin-off companies. Examples of associated projects may be new, limited, and application-oriented partnership R&D projects, EU pathfinder projects, and pilot- and demonstration projects.

The main research tasks are:

Task 7.1, which focuses on creating and maintaining innovation culture and innovation capability

Task 7.2 on IP (intellectual property) management

Task 7.3 on Technology/knowledge transfer and innovation projects

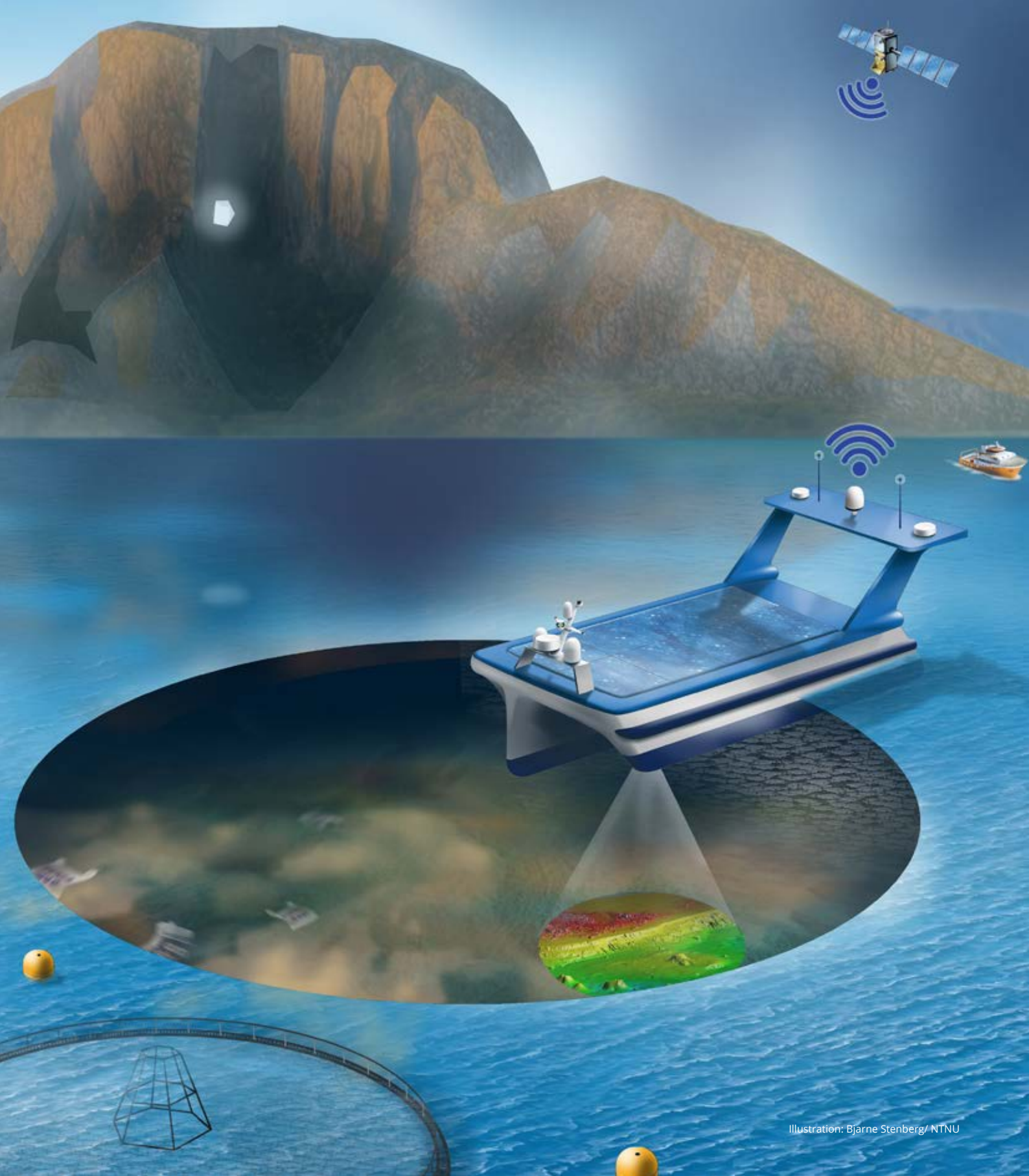


Illustration: Bjarne Stenberg/ NTNU

International Collaboration

There is great potential for fruitful international collaboration in SFI AutoShip. One of our main research partners; SINTEF Ocean, is the secretariat for the International Network for Autonomous Ships (INAS). Through this network, MoUs with the Technology Centre for Offshore and Marine, Singapore (TCOMS) and the Smart Ship Coalition of The Great Lakes-St. Lawrence have been established. In addition, the network reaches a long range of associations all over the world. INAS and NFAS also organise the International Conference on Maritime Autonomous Surface Ships (ICMASS) and the International Ship Autonomy and Sustainability Summit. These MoUs and events are today the centre-point of international autonomous ship research and a meeting point for leading experts from all corners of the world. It is also an alternative forum for regulators outside the International Maritime Organization (IMO) where new guidelines for autonomous ship use and trials are being discussed. Thus, the network also plays a very important role in allowing these new ship types to sail.

The Centre will pursue collaboration with top researchers from all over the world due to the many disciplines involved in developing autonomous ships, and the rapid advances within several of those disciplines over the last years.

OUR TOP INTERNATIONAL RESEARCH PARTNERS


Prof. Rudy Negenborn
Delft university
Prof. Jose Neira
University of Zaragoza
Assoc. Prof. Tim Miller
University of Melbourne

Recruitment

SFI AutoShip aims to recruit outstanding candidates for our research positions. In October 2020 we announced the following positions:

Research area	Department NTNU	Planned start
Simultaneous localization and mapping for autonomous ships	Engineering Cybernetics	09/21
Situational Awareness for Autonomous Ships	Engineering Cybernetics	09/21
Docking for autonomous ships	Engineering Cybernetics	09/21
Multi-sensor object detection and classification	Engineering Cybernetics	09/21
Mission analysis and design/Mission planning systems	Engineering Cybernetics	Postponed to 2024
Radio channel measurements and modeling in maritime scenarios	Electronic Systems	09/21
Autonomous ship collision avoidance	Engineering Cybernetics	05/21
Interaction design	Design	09/21
AI decision transparency in autonomous maritime operations	Ocean Operations and Civil Engineering	09/21
Explainable AI for Autonomous Ships	ICT and Natural Sciences	09/21
Online risk modeling of autonomous ships	Marine Technology	09/21
Marine cybernetics and safety for autonomous ships	Marine Technology	09/21
Dynamic and simulation-based risk modeling for operational decision support and verification (Post Doc)	Marine Technology	09/21
Safety demonstration of autonomous control systems using digital twin	Engineering Cybernetics	09/21
Research area	**Department UiO**	**Planned start**
Jurisprudence – SFI Autoship	Scandinavian Institute of Maritime Law, University of Oslo	05/21

Communication

The Centre has begun working on plans for communication activities, including knowledge transfer to user partners and dissemination to the general public via popular science channels. The Centre has established a Twitter account, a LinkedIn account and a website as the most important communication platforms, and news posted at Twitter is automatically shown on the web site. We are also developing a communication plan for our external collaboration, where we aim to formulate a strategy for:

- **Who and how:** Who our most important external stakeholders are and how we should interact with them and through what relevant channels and means?
- **With what:** How we can best focus our main messages to various stakeholders?

Beyond the industrial, research, and academic stakeholders, we focus on reaching out to master students. In particular and over time, we would like to attract more female students and researchers to the Centre, as we believe that the maritime sector would benefit from having a better gender balance.

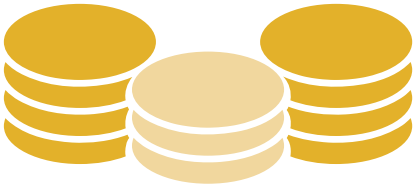
We have also started to prepare the internal communication routines and practices for the Centre in operating procedures and by using a digital platform for exchange of information.

Events where SFI AutoShip has been presented:

Audience	Type	Where	Presented by	When
Norway-Singapore Science week	Conference	Webinar	Mary Ann Lundteigen	05.11.2020
Maritimt forum	Workshop	Webinar	Edmund Brekke	20.10.2020
Trondheim test site	Workshop	Webinar	Mary Ann Lundteigen	19.10.2020
NTNU Ocean day	Workshop	Dokkhuset, Trondheim	Mary Ann Lundteigen	29.09.2020
Ocean Autonomy Cluster	Article/interview	OAC homepage	Mary Ann Lundteigen	21.01.2021
NTNU Evening	Popular presentation	Dokkhuset, Trondheim	Mary Ann Lundteigen	16.03.2021
Ocean Week	Conference presentation	Trondheim	Mary Ann Lundteigen	04.05.2021

Mary Ann Lundteigen (professor at the Dept. of Engineering Cybernetics and Centre director of SFI AutoShip) presented the SFI during “NTNU Evening” at Dokkhuset 16.March 2021. Photo: Elisabeth Strand Vigtel

Annual Accounts for 2020



FUNDING	AMOUNT
The Research Council	622
The Host Institution (NTNU)	121
Research Partners*	77
Enterprise partners	
Public partners	
Total	**820**

COST	AMOUNT
The Host Institution (NTNU)	317
Research Partners*	503
Enterprise partners	
Public partners	
Equipment	
Total	**820**

** Research Partners:*
Sintef Ocean AS
Institutt for Energiteknikk (IFE)

The total budget for SFI AutoShip is NOK 240 million. The financial contribution is from the Research Council of Norway, cash and/or in-kind contributions from the industry partners, NTNU and the research partners.

Key Personnel

CENTRE MANAGEMENT AND ADMINISTRATION

Mary Ann Lundteigen	Centre director
Ingrid Wouwer Utne	Centre co-director and WP 4 leader
Trond Johnsen	Centre co-director and WP 6 leader
Elisabeth Strand Vigtel	Administrative coordinator
Steve Harila Løkkeberg	Finance

KEY RESEARCHES	NTNU	MAIN RESEARCH AREA
Edmund Brekke	Dept. of Engineering Cybernetics	Sensor fusion
Tor Arne Johansen	Dept. of Engineering Cybernetics	Automatic control
Mary Ann Lundteigen	Dept. of Engineering Cybernetics	Safety, reliability and automation systems
Adil Rasheed	Dept. of Engineering Cybernetics	Big Data Cybernetics, Hybrid Analysis and Modelling
Thor I. Fossen	Dept. of Engineering Cybernetics	Cyber security, navigation and control of marine craft
Anastasios Lekkas	Dept. of Engineering Cybernetics	Autonomous systems
Annette Stahl	Dept. of Engineering Cybernetics	Robotic vision
Torbjørn Ekman	Dept. of Electronic Systems	Radio communications, communication theory and signal processing
Ingrid Bouwer Utne	Dept. of Marine Technology	Operational risk in marine and maritime systems
Roger Skjetne	Dept. of Marine Technology	Marine cybernetics
Kjell Olav Skjølsvik	Dept. of Marine Technology	Innovation manager
Egil Eide	Dept. of Electronic Systems	Sensors and autonomous systems
Pierluigi Salvo Rossi	Dept. of Electronic Systems	Signal processing, communication theory, data fusion and machine learing
Thomas Porathe	Dept. of Design	Human factors and remote control centres
Runar Ostnes	Dept. of Ocean Operations and Civil Engineering	Nautical science, navigation systems and nautical operations
Ottar L. Osen	Dept. of ICT and Natural Sciences	Cybernetics and Artificial Intelligence

KEY RESEARCHES	UNIVERSITY OF OSLO (UIO)	MAIN RESEARCH AREA
Trond Solvang	UiO, Scandinavian Institute of Maritime Law	Maritime law, torts law, contract law

KEY RESEARCHES	SINTEF	MAIN RESEARCH AREA
Trond Johnsen	SINTEF Ocean	Maritime transport and logistics
Ørnulf Rødseth	SINTEF Ocean	Maritime digitalization, autonomous control system design
Odd Erik Mørkrid	SINTEF Ocean	Maritime logistics and autonomous shipping
Espen Tangstad	SINTEF Ocean	Autonomous control system design
Lars Andreas Lien Wennersberg	SINTEF Ocean	Methods for design, analysis and approval of merchant autonomous ship systems
Sture Holmstrøm	SINTEF Digital	Safety, risk assessment
Esten Ingar Grøtli	SINTEF Digital	Localization, estimation, path planning
Erlend Solbakk Harbitz	SINTEF Digital	Tracking, localization, marine control systems
Marialena Vagia	SINTEF Digital	Cargo handling, control systems

KEY RESEARCHES	INSTITUTE FOR ENERGY TECHNOLOGY (IFE)	MAIN RESEARCH AREA
Bjørn Axel Gran	IFE	Risk, safety and security
Stine Strand	IFE	Control room and interaction design
Linda Sofie Lunde-Hanssen	IFE	Control room and interaction design
Sashidharan Komandur	IFE	Human-centred digitalization
Stine Aurora Mikkelsplass	IFE	Risk, safety and security

SFI · AUTOSHIP

Autonomous ships