DNV·GL

MARITIME

ROMAS – Remote Operations of Machinery and Automation Systems – experiences from pilot testing

HFC Conference Trondheim Oct 23rd 2019

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23 October 2019

Outline

- The ROMAS Project
- The pilot test campaign
  - Setup and equipment
  - Test scope
  - Test experiences
  - Conclusions
- Way ahead

The ROMAS project – an introduction

Project Partners: DNV·GL Fjord1 høglund MARINE AUTOMATION Sjøfartsdirektoratet Norwegian Maritime Authority

The ROMAS project

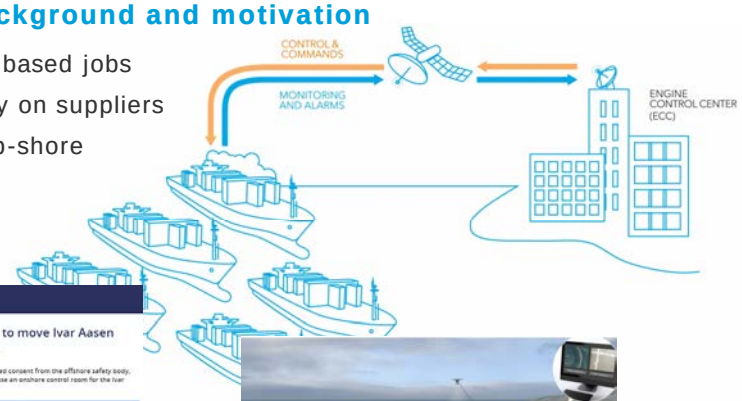
- **ROMAS: Remote Operation of Machinery and Automation Systems**
  - NFR application granted Dec 2016
  - Research project 2017-2019
  - Total budget 9,5 MNOK
  - 50% support from NFR (Maroff)

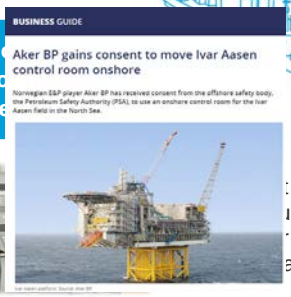
Forskningsrådet
The Research Council of Norway

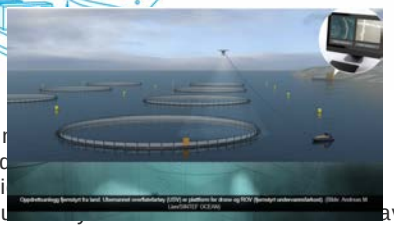
- **Partners:** DNV·GL Fjord1 høglund MARINE AUTOMATION
- **Reference partner:** Sjøfartsdirektoratet Norwegian Maritime Authority

Remote machinery operation: Background and motivation

- Young engineering talents prefer shore-based jobs
- Increasingly complex ships, dependency on suppliers
- Increased digitalisation & improved ship-shore connectivity
- Automation and remote operations is increasingly adopted in other industries







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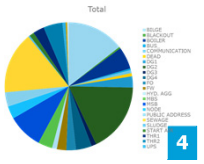
Close to completion

The ROMAS project work packages & phases

Objective: Establish a framework of regulations, rules and verification methods for remote (shore-based) operations of ship machinery and automation systems, enabling improved operations and cost-efficiency, without compromising safety of ship operations.



1 Business & User Requirements (fjord1)

2 Risk & Reliability (DNV·GL)

3 Operational Data Analysis (DNV·GL)

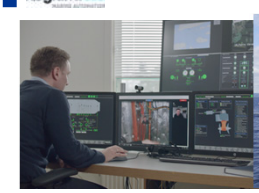
4 Rules & Regulations (DNV·GL)

5 Verification & Approval (DNV·GL)

6 Implementation (høglund)

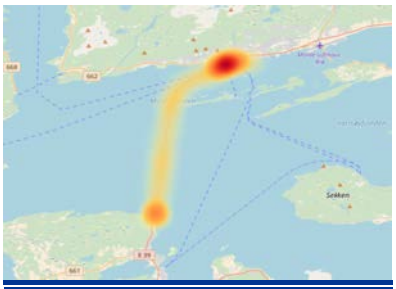
7 Piloting & Demo (DNV·GL)

8 PM & Dissemination (DNV·GL)

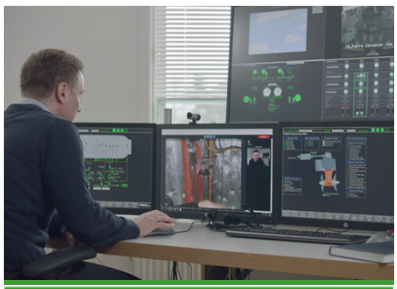


The pilot test campaign

The pilot test setup



- Route: Molde – Vestnes (35 mins)
- Pilot test vessel: *MF Fannefjord*, operated by Fjord1
- Equipped with
  - Enhanced IAS-system
  - Redundant ship-shore communications



- ECC in Molde (Fjord1)
- One chief engineer operating three vessels from a shore-based Engine Control Centre.
- Responsibilities: Machinery operation, alarm handling and communication with crew and shore-parties

- Multi-skilled seafarer supporting the chief engineer and doing manual operations.
- Safety manning: unchanged.
- Technical solutions and procedures supporting the concept

Implications on Human Factors

The ROMAS concept implies physically moving the Chief Engineer from the ferry to ECC (on shore)
Some consequences:

- Chief Engineer is not able to physically observe (see, smell, hear) the equipment he or she is responsible for monitoring and controlling.
- Communication between the Chief Engineer and other crew members or officers is limited to what is possible with communication equipment.
- Socializing and more informal interactions with crew and officers on the ferry will be limited.
- A position called 'Combiman' is introduced. He/she will not have all the same qualifications as the Chief Engineer and is therefore required to execute some tasks under remote supervision of the Chief Engineer. This implies that the Chief Engineer will perform fewer manual tasks but also perform more supervision and guidance of the Combiman. This require new interpersonal skillsets (teamwork, communication).

ECR on MF Fannefjord

ECC Equipment in Fjord1's office in Molde

1x Large screen (Wall)

Fleet map (AIS) CCTV feed

IAS monitor Fleet status

4 OS monitors (desk)

IAS screen/Internet

Maintenance system

Fleet Status view on the Big Screen

Input for test setup: 30 mitigations identified in HazID analysis

Training(2)

- Machinery training (Combiman)
- Safety training (Combiman)

Design(13)

- UPS for IAS & Comms
- Descriptive Battery Alarm
- Alarm limits adjusted for remote operations
- Alarms with priority/criticality
- Sufficient IAS integration
- Additional ICE modem
- Comms outage alarm
- Walkthrough of all essential sensors
- Visual surveillance (CCTV) at ECC
- Redundancy of comms modems
- VHF at ECC
- Sufficient UPS, broadband and security at ECC
- Additional sensors or inspection tools for gas system

Procedures(15)

- Avoid simultaneous overhaul of two engines/generators
- Procedure for ECC-Bridge communication
- Procedure for handling comms loss
- Procedure for spare ferry to be put into operations
- Procedure for ECC handling for simultaneous problems on two ferries
- Procedures/criteria for taking the ferry out of service
- Procedure for transferring command from ECC to Bridge
- Procedure for ECC support in severe weather conditions
- Updated procedures for remote/ECC-operations
- Procedure for handling water ingress
- Procedure for fire handling
- Procedure for bilge handling
- CBM (Condition Based Maintenance)
- Updated procedure for gas system
- Updated procedure for battery system

Mitigations implemented for pilot testing (implemented, partly implemented)

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+ new features identified in pilot planning (implemented, partly implemented)

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- IAS Command transfer functionality
- IAS alarm history "resynchronisation"
- Shiplog integration (ticket/adm system)
- Voice communication ECC-Bridge
- Comms system health monitoring
- Digital engine log book
- Big Screen Fleet view in ECC
- ESS/battery integration
- Fire system integration
- AR Smart glasses for remote support

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Test setup: Including POB (# persons onboard) from Shiplog in Fleet Status

- POB = Persons On Board
  - Automatically updated from Shiplog (adm/ticket system)
  - Can easily be expanded with other info e.g. dangerous cargo
  - Time saver during emergencies

Test scope

Planned test scope

- Normal operations
- Abnormal cases and failure scenarios
- Functional tests
  - Alarm handling
  - Ship-to-shore communication
  - New ECC & IAS functionality

In practice

- Focused on failures & functional tests
- 3 test sessions of 1-2 days
  - Jan 23rd, March 1st , March 26-27th
  - Induced failures & simulated scenarios
  - Out of service => "aggressive" tests
  - Between tests: summarize & update

Operation	ECC Operater responsibility	Combiman responsibility
Control & monitoring	Attend and follow-up	
Planned Maintenance & Repair	Plan + Support	Execute (*)
Planned Inspection & testing	Plan + Support	Execute
Unplanned Inspection & testing	Plan + Support	Detect + Execute
Startup machinery	Plan/Instruct	Detect + Execute
Shutdown machinery	Plan/Instruct	Detect + Execute
Reconfigure el.power generation or distribution.	Plan+ Execute	
Communication ship-based parties	Key contact	On Request
Communication shore-based parties	Key contact	
LNG Bunkering	Support	Detect + Execute
General surveillance	Support	Detect + Execute

Nr	Test type	Scenario
1	Abnormal	Putting spare ferry into operation
2	Abnormal	Operational problems on two ferries simultaneously
3	Abnormal	DG auto-stop
4	Abnormal	Unplanned Maintenance & Repair
5	Abnormal	Black-out.
6	Abnormal	Loss of ship-shore communications
7	Abnormal	ECC unavailable.
8	Abnormal	Loss of propulsion or manoeuvring capability.
9	Abnormal	Extreme weather
10	Abnormal	Evacuation
11	Abnormal	Mob boat operation
12	Abnormal	Water ingress / Loss of stability.
13	Abnormal	Fire alarm / fire incident.
14	Abnormal	Equipment down for maintenance

Experiences from pilot testing

Alarms

- Volume of alarms must be managable
- Suppression & context awareness
- Descriptive alarms (COMMON alarms must be avoided)
- Criticality levels

ECC / Remote IAS

- Integration: level and quality
- Command transfer
- Fleet view
- Synchronisation between ship and ECC

Ship-to-shore communications

- Reliability
- Redundancy
- Coverage
- IAS integration
- Quality monitoring

Experiences from pilot testing

Other technical measures

- Remote-ready ship components & systems
- Digital engine log
- 2-way voice communication
- AR Glasses
- CCTV

Assurance & Verification

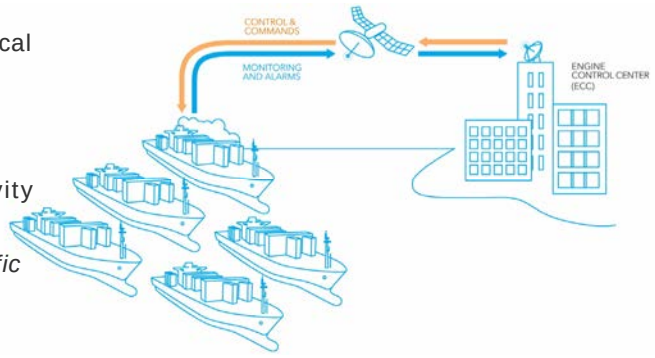
- Product assurance needed
- Structured approach to ECC design (ISO 11064)
- Quality control of SW and data
- Standard protocols and data structures

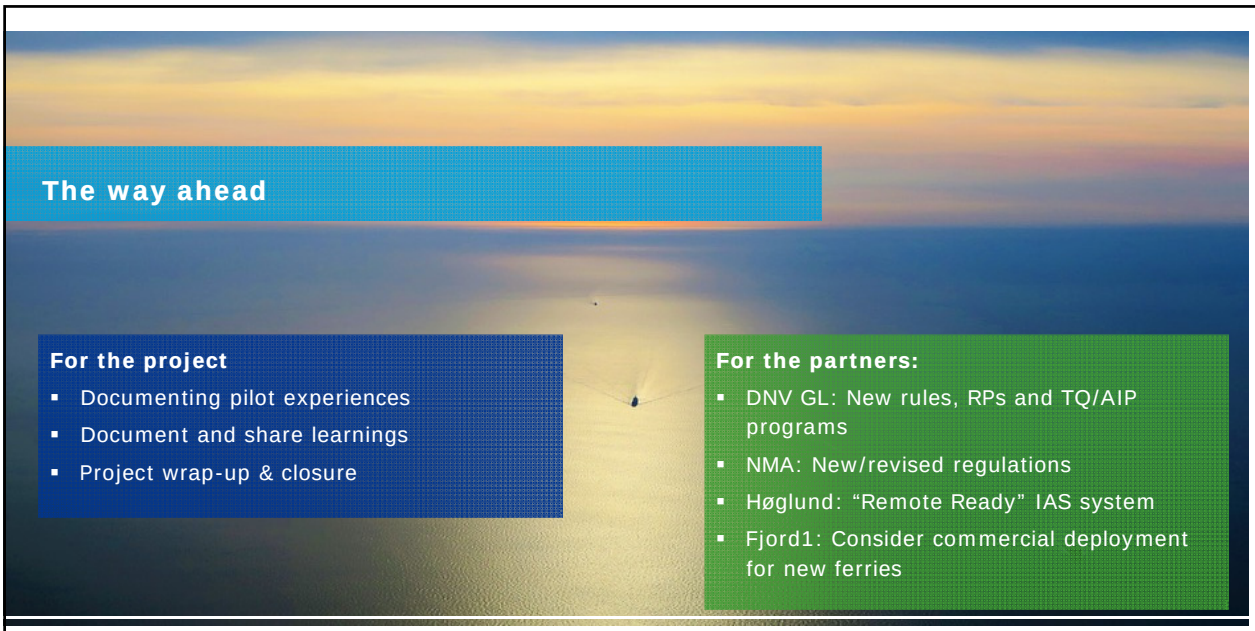
Not focused on in pilot testing … but still important!

- Operational procedures
- Competence & training
- Cyber security

Conclusions

- The remote machinery operations concept is feasible given
  - proper implementation of the relevant technical measures
  - appropriate configuration of operational parameters
- Critical elements: alarms, ship-shore-connectivity and the remote systems.
- There is a need for a risk analysis that is *specific* to segment, operation, ship and remote infrastructure.
- Monitoring and analysing data on shore brings new benefits





The way ahead

For the project

- Documenting pilot experiences
- Document and share learnings
- Project wrap-up & closure

For the partners:

- DNV GL: New rules, RPs and TQ/AIP programs
- NMA: New/revised regulations
- Høglund: "Remote Ready" IAS system
- Fjord1: Consider commercial deployment for new ferries

Thank you for your attention!

DNV·GL Fjord1 høglund MARINE AUTOMATION Sjøfartsdirektoratet Norwegian Maritime Authority

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