MUNIN’s Autonomous Engine Room

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Partners & Tasks

- MarineSoft
- Marintek
- Marorka
- Hochschule Wismar

1. System Analysis and Redesign
2. Information Gathering and Process Management
3. Repair and Maintenance Optimisation for Unmanned Operation
4. Optimal Environmental Performance
Initial Situation & Targets

Initial Situation:

- state-of-the-art Engine room with OUT24
- Two-stroke low speed turbocharged crosshead Diesel engine with a directly coupled fixed pitch propeller (e.g. MAN B&W 6S50ME)

Target:

- An engine can reliably operate for an intercontinental voyage without physical interference from a person in the engine room
Requirements to the autonomous engine room:

- All operating functions that are possible in the engine control room (ECR) must be carried out from Shore Control Centre (SCC).
- Changeover of all necessary heating and pre-heating to electrical operation
- Change to Marine Diesel Oil (MDO) as main engine fuel
- Filling the main engine crankcase with inert gas so that explosions are avoided and the risk of fire is reduced
- Redundant implementation of sensors and monitoring of cable breaks
- High redundancy in electrical power generation, one GenSet must be able to deliver the required electrical power
- Additional automatic filters for fuel oil and lubrication oil of the main engine
- Design of an automatic, redundant system for switching the tanks
- Additional noise, vibration monitoring in the machinery spaces
- Monitoring of the machinery spaces and bilges via infrared cameras and corresponding lighting for normal cameras
- Extended fire alarm
- Extended bilge monitoring
- Extended diagnostic systems of the non-redundant main engine
Possible diagnosis system for the main engine:

- Revolution uniformity, load balance control,
- Leakage measurement system,
- Cylinder pressure and injection pressure monitoring,
- Piston ring monitoring,
- Liner temperature monitoring,
- Torque measurement,
- Performance monitoring,
- Bearing temperature monitoring,
- Bearing distance monitoring system
Information Gathering and Process Management I

- Enhanced data traffic through additional sensors and diagnostic systems
- Limited communication bandwidth to the SCC
  - Offshore data processing needed
  - Offshore decision making is needed for real autonomy

- The Autonomous Ship Controller (ASC) for unmanned ships
  - Autonomous Bridge Controller System
  - Autonomous Engine Monitoring and Control System
Information Gathering and Process Management II

[Diagram showing the flow of information between EAS, Computerized Maintenance Management System (CMMS) / Constant Engine Efficiency Module, Autonomous Ship Controller (ASC), AEMC, Data Set, Information Cluster, Response Management, and Autonomous Bridge Controller (ABS).]

Communication to SCC
Repair and Maintenance Optimisation for Unmanned Operation I

- Operation of a ship without personnel on board requires a new maintenance management concept. There exist both hazards and critical functions related to main engine. How serious is poor maintenance?

- A structured approach has been developed in order to develop the maintenance concept:

IDEA: Unmanned shipping

Step 1: Requirements
Step 2: System selection and definition
Step 3: Analysis of existing concept (AS-IS)
Step 4: Identify gap
Step 5: Develop new concept (TO-BE)
Step 6: Evaluate concept

From a reliability perspective, Failure Modes, Effects, and Criticality Analysis (FMECA) has been performed with 6 steps. Technical issues such as carry water overflow and leakage through piston rings has been identified as critical events. Measures have been proposed in order to accept the concept for the design stage.
Repair and Maintenance Optimisation for Unmanned Operation III

Status: Alarms for the fleet

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Fleet & Map

- Fleet number: 24
- TCI: 93%
- Availability: 92%
- Maint. costs: 200,000 $ / month

Maintenance overview
- Analyse selected event
- Maintenance status & history
- Maintenance planning and scheduling
- Preventive maintenance program
- Maintenance KPIs
- Status reports
- Reliability analysis
Optimal Environmental Performance I

- Highly dependent on a comprehensive monitoring and maintenance system.
- Key performance indicators as part of the maintenance system used to track performance and for preventive maintenance.
- Data collection for tracking performance and reporting to authorities.
- Optimization algorithms to intelligently share the ships electrical load between electrical producers.
Performance indicators react to technical issues such as carry water overflow and leakage through piston rings.

Load sharing algorithm analyses the required electrical load and recommends running conditions for electrical energy producers.

Upon request, shore controllers can request an emission report and/or a performance report for a sailed leg.
Thank you for your attention.