dTHOR – Digital Ship Structural Health Monitoring

dTHOR

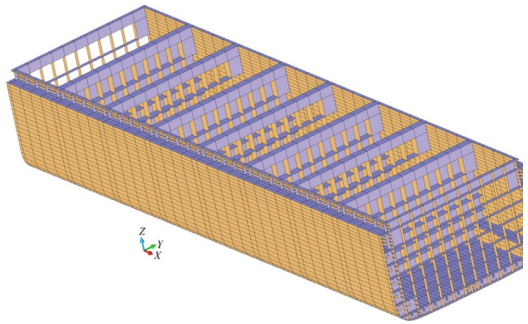
OBJECTIVES:

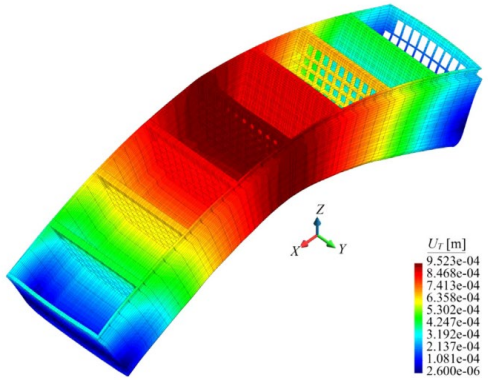
- Develop Digital Twin Models that are interoperable with ship structural elements so that one can accurately monitor and predict the ship structural behaviour and accurately plan real condition-based maintenance

- Develop a digital tool offering predictive assessments of hull health during the whole ship's life cycle and allowing simulation of future upgrades in digital twin and structural possible modifications

- Develop predictive tools that can fully and securely support the integration of the ship's health and maintenance monitoring.

CONTACTS:
claudio.sbarufatti@polimi.it
dario.poloni@polimi.it
marco.giglio@polimi.it



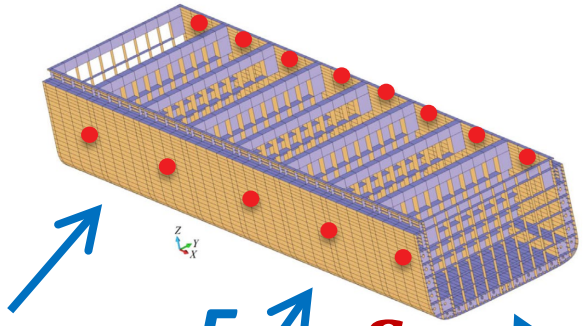


Collaboration: EU consortium (Fincantieri, etc., more than 20 partners)

dTHOR – Digital Ship Structural Health Monitoring

Method: the inverse FEM (iFEM)

dTHOR



- Node coordinates
- Element connectivity and geometry
- Boundary conditions

- Material properties
- Loads

FEM

Nodal displacements + Strains

Measured strains in discrete positions

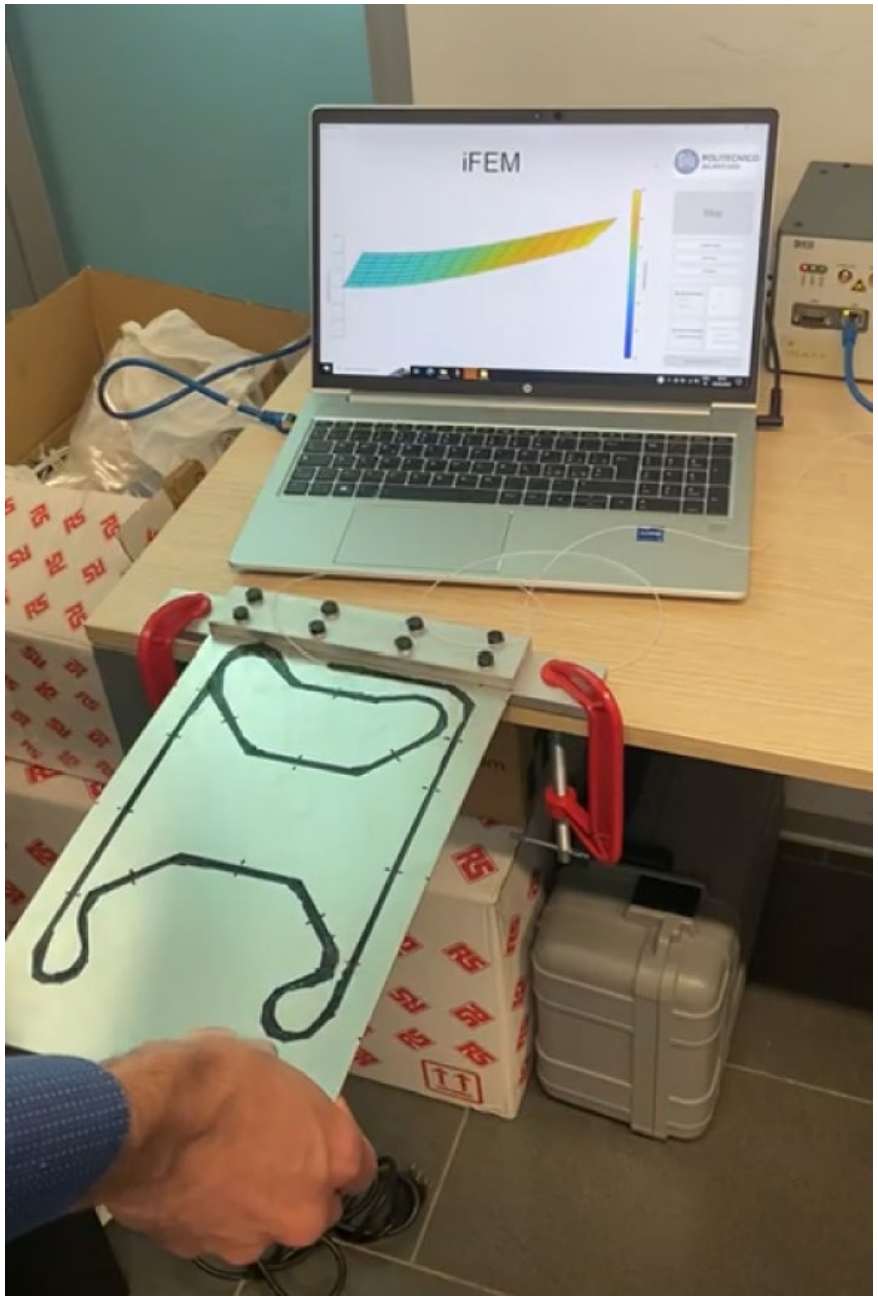
iFEM

Independent from loads and material properties

dTHOR – Digital Ship Structural Health Monitoring

Method: the inverse FEM (iFEM)

- Fiber optic strain gauges are acquired in real time through Matlab and a Labview software
- Strains are processed in real-time by a iFEM code to reproduce the full-field displacement of the structure
- The full-field strain and stress can be also reconstructed



One step forward…

Method: the inverse FEM (iFEM)

Project: dTHOR

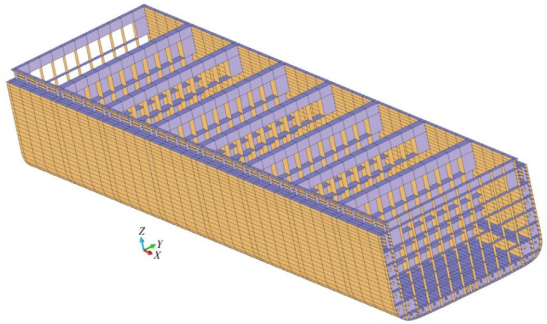
Title: iFEM-based hull shape sensing for damage identification

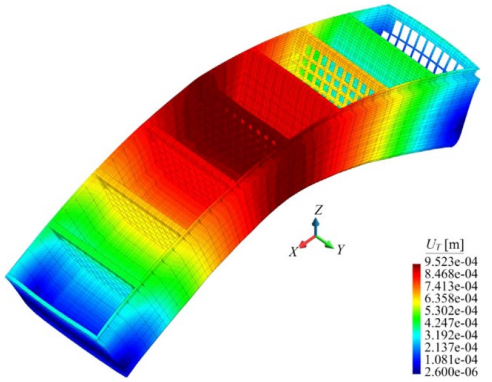
dTHOR

RESEARCH BACKGROUND:
The Inverse Finite Element method (iFEM) employing a network of strain sensors reconstructs the full-field displacement on beam or shell structures, independently of the loading conditions and of the material properties. The iFEM is thus suitable to monitor and keep track of the structural condition throughout the lifespan of the structure, enabling conditions-based maintenance policies.

RESEARCH ACTIVITIES:

- Develop an iFEM model of the hull of a naval unit
- Apply Anomaly Detection and Damage identification techniques
- Possibly validate the undamaged model with experimental data





METHODOLOGY: numerical – possibly experimental

DURATION: 9 months

CONTACTS:
claudio.sbarufatti@polimi.it
dario.poloni@polimi.it
marco.giglio@polimi.it

Project: dTHOR

Title: Development of a Discrete Event Digital-Twin of a Naval Fleet for Condition-Based maintenance

dTHOR

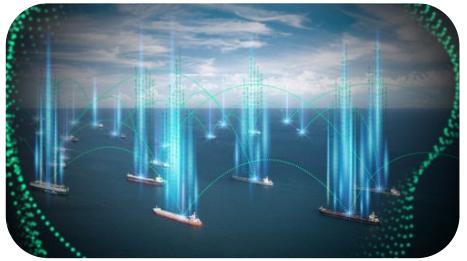
RESEARCH BACKGROUND:
Discrete-Event Digital Twins can be used to optmize the assets performance, and to evaluate the cost-effectiveness of different maintenance policies, enabling the shift from programmed maintenance to condition-based maintenance, in an industry 4.0 framework.

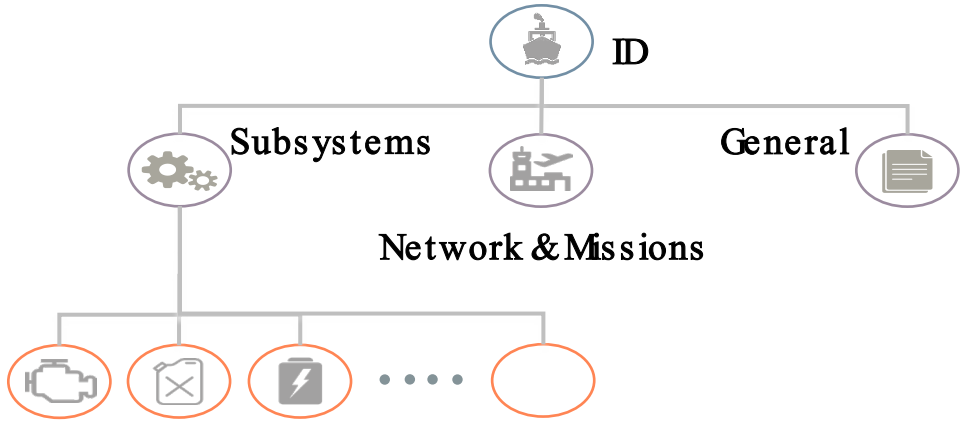
RESEARCH ACTIVITIES:

- Development of a model to describe the hull life-cycle
- Development of a fleet management system for the hull in MATLAB-SimEvents
- Fleet Life-Cycle Analysis by means of Monte Carlo Simulations

METHODOLOGY: numerical – analytical

DURATION: 9 months





CONTACTS:
claudio.sbarufatti@polimi.it
dario.poloni@polimi.it
marco.giglio@polimi.it

Project: dTHOR

Title: Evolutionary algorithms for maintenance policies optimization from AI-based decision-making

dTHOR

RESEARCH BACKGROUND:
Optimizing maintenance policies is a complex multi-objective task, at the core of the industry 4.0 framework, which aims to shift from programmed maintenance to condition-based maintenance. Artificial Intelligence coupled with evolutionary algorithms is set to be the new folder

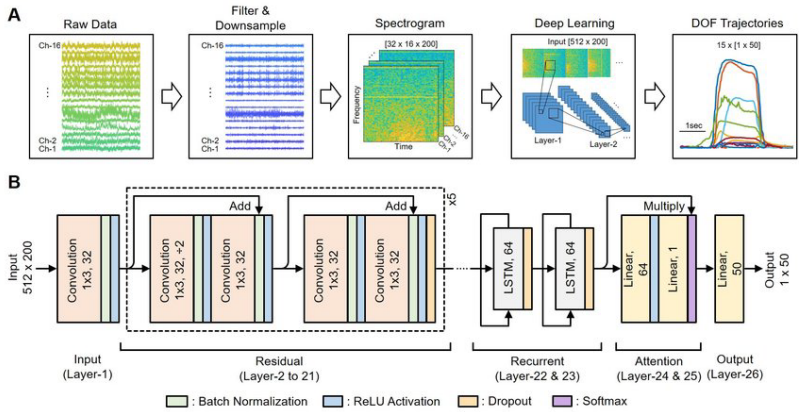
RESEARCH ACTIVITIES:

- Definition of the requirements for the maintenance policies
- Development of the AI model and coupling with evolutionary algorithms
- Comparison of AI + evolutionary algorithms with state of the art algorithms

METHODOLOGY: numerical – analytical

DURATION: 9 months

CONTACTS:
claudio.sbarufatti@polimi.it
dario.poloni@polimi.it
marco.giglio@polimi.it



Project: dTHOR

Title: Damage progression assessment and structural prognosis

dTHOR

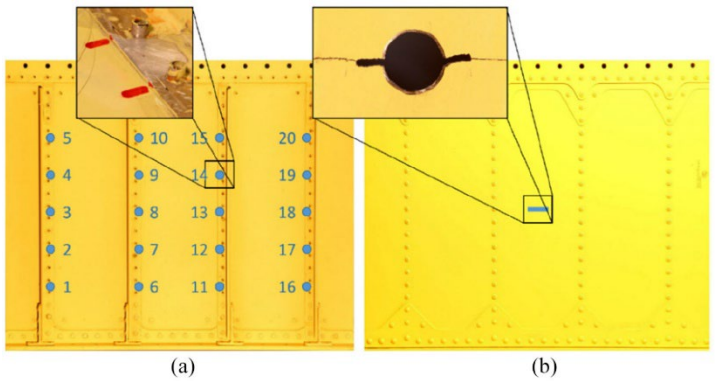
RESEARCH BACKGROUND:
Assuming potential damage is assessed either by human perception or inspection or based on the processing of sensor data, the assessment of the residual strength of a damaged component and the prognosis of potential damage progression are two challenging but crucial tasks to transition from programmed maintenance to condition-based paradigms.

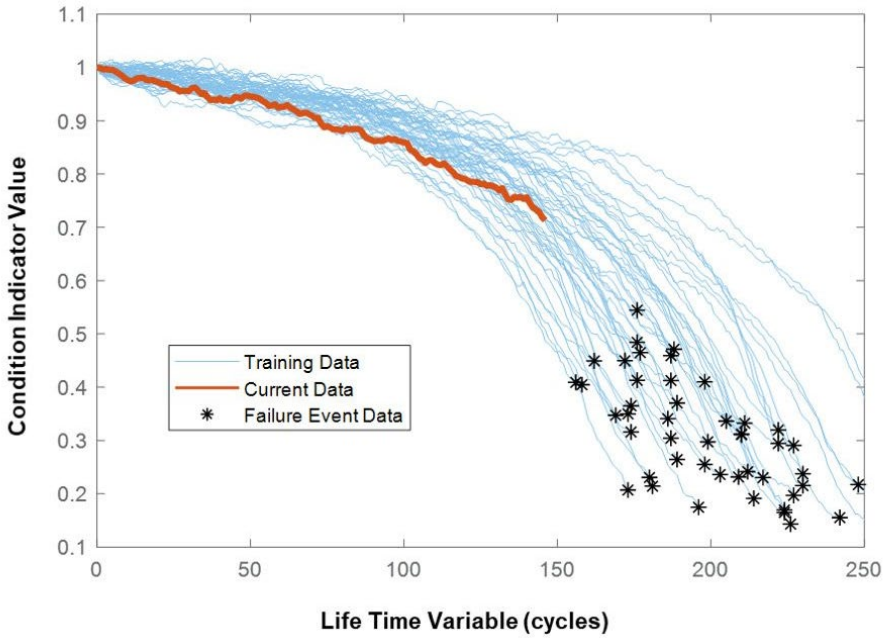
RESEARCH ACTIVITIES:

- Perform damage progression assessment using Finite Element Analysis
- Possibly surrogate the damage progression path with ANNs
- Application of predictive stochastic algorithms to predict the Residual Useful Life of the components

METHODOLOGY: numerical – analytical

DURATION: 9 months





CONTACTS:
claudio.sbarufatti@polimi.it
dario.poloni@polimi.it
marco.giglio@polimi.it