EUROPEAN DEFENCE AGENCY

EDA NEXTPROP PROJECT – NEXT GENERATION OF PROPELLERS

Participating Members

Consortia/Organization

FFI, FiReCo, Light Structures, SINTEF Ocean
CNR-INM, CETENA, Politecnico di Milano
Polish Naval Academy

Modern naval propeller design involves a wide range of aspects, including, among others, efficiency, weight, durability, cost and signature. An important factor in the development process is the experimental testing of the propeller, using a scale model or a full-size prototype. However, experimental testing is cost and time intensive. The importance of and possibilities for numerical simulations and modelling have increased due to high-performance computer resources.

A model of the acoustic field generated by the propeller motion is a complex task, which typically involves: 1) the flow field around the hull and rudders, complete with turbulent boundary layers and possibly separation; 2) fluid-structure interaction at the propeller blades, causing deformations in the structure and structural vibrations that generate sound; and 3) the interaction between hull wake and propeller. This defines a multi-physics and multi-scale problem that must be simplified, or at least separated into different components, in a computational model.

In addition to the more advanced models and computer resources, the emerging field of composite propellers has the potential to improve several of the design aspects, especially weight and signature. In addition to providing more tailor-made properties, such materials also open up new possibilities for integrating sensors inside the structure of the propeller for structural health monitoring – from the production of the propeller and throughout the propeller's lifetime. Such sensors will be essential in a condition-based maintenance programme, which will reduce the cost and time for repair and overhaul, as well as increase the overall operability of the naval platform.

Objectives

The main objective of the project is to develop and establish the required hydro-elastic software and design tools for the modelling of next generation low noise naval propellers. Advanced models for new and modern materials, such as composite materials, will be integrated in the numerical tools, to aid the design of composite propellers. The work should include computational fluid dynamics, finite element analysis, fluid-structure interaction, and theoretical models. The models will be validated through controlled prototype experiments on a generic foil and a typical propeller.

In addition to the main objective, several secondary goals are set:

- Improve the current understanding of the primary mechanisms for sound generation/propagation from naval propellers
- Improve the competence on composite propellers
- Study integration of sensors as a first step towards a condition-based maintenance program
- Improve test methods and the experimental set-up for modern propellers

The project runs from December 2020 to December 2023.

Work Strands

The project is currently in the first phase, which involves literature studies to determine state-of-the-art in the fields of computational fluid dynamics for foil and propeller, composite materials technology for foils and propellers – including fabrication methods, fluid-structure interaction for hydro-elastic applications and noise produced by non-cavitating propellers. Methods and solution strategies will be chosen based on these studies.

An experimental programme will be designed for studies of both single foils and propellers in fluid flow, with measurements of the resulting flow field and the response of the solid objects. The chosen foils and propellers will be manufactured as part of the project, facilitating sensor integration and control of the material properties.

The computer simulations go in parallel with, and possibly beyond, the experiments, and the goal is to achieve the main objective of the projects through the combination of computational and experimental results.

Way Ahead

Composite propellers offer several advantages compared to metal propellers in terms of weight/inertia reduction that will impact bearing loads and shaft/bearing dimensions, allowing for bigger propeller diameters with increased efficiency. Other clear reasons are advantages in terms of non-acoustic signature and not having to consider corrosion protection anymore. The latter is advantageous in terms of maintenance cost and reduced signature. Moreover, composite propellers offer the possibility to design a structure with controlled flexibility resulting in cavitation reduction and increased cavitation inception speed.

In order to ensure an accurate and effective composite propeller design, several capabilities will be developed during the present project, such as the fluid-structure coupling (i.e. how the blade deforms under hydrodynamic load, and how in turn the flow field changes due to blade deformation) and a deeper understanding of the material properties. Moreover, the project will gain capabilities regarding numerical and analytical prediction tools for noise generation and propagation.

The cross-sectoral approach to the development of new propeller designs proposed in the project, and based on the application of both hydro-acoustic and structure and material methods, will promote the synergy among different skills, as well as the creation of new ones. Merging these skills will enhance the competitiveness of the European industrial partners and their business.

Link to TBBs, other CapTechs, and other links

- Materials – OSRA_TBB87: Camouflage and signature management technologies
- Materials – OSRA_TBB89: Materials, structures & concepts for platform monitoring
- Materials – OSRA_TBB90: New manufacturing, joining and repair processes
- Materials – OSRA_TBB93: Computational design and materials modelling
- Maritime –OSRA TBB 96: Platform survivability and operability in challenging conditions
- Maritime –OSRA TBB 97: Energy and propulsion

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