HOLISTIC ship design optimisation

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ABSTRACT: The present paper describes the HOLISHIP–Holistic Optimisation of Ship Design and Operation for Life Cycle project approach to ship design and operation and demonstrates a subset of its functionality on the basis of a case study. This refers to a RoPAX ferry optimisation for minimum powering requirements and maximum life-cycle economic performance in realistic operating conditions by use of concurrent engineering tools from different project partners operating in collaboration on a common design software platform. The impact of alternative operating/speed scenarios on case study ship’s efficiency and safety is presented and discussed.

This typically results in less favourable selections of optimised sub-systems or components while the optimal ship would have been the result of a holistic optimisation of the entire ship system. It should be noted that the system ship is actually a component of the wider transport system, thus a holistic approach to ship design should actually also consider aspects of fleet composition and transport/mission scenario optimisation, which are not addressed in this paper. For a systems approach to ship design see, e.g. (Hagen et al., 2010) and (Guégan, A. et al., 2017) in the HOLISHIP project.

The approach chosen in the HOLISHIP project (www.holiship.eu) acknowledges the fact that, in practice, surrogate models need to be employed for several sub-systems and components to reduce computational/processing time and the complexity of the overall optimisation problem; also, the often conflicting constraints and requirements of the optimisation, which in turn result from contradicting interests of the various stake holders in the maritime transport chain, need to be optimally balanced. The volatility of market conditions and associated transport demand, the variability of the operational conditions over a ship’s life-cycle, the cost of raw materials as well as energy cost during operation all need to be considered in compliance with continuously changing regulatory requirements.

1 INTRODUCTION

Today’s shipping industry operates in a complex environment with numerous economic, environmental and even social restrictions. Energy efficiency, safety and environmental protection are key requirements for a sustainable shipping industry and the means of transportation need to be adapted accordingly. This calls for significant changes in the traditional ship design process, which is a complex, multi-disciplinary and multi-objective task of both technical and non-technical nature. Likewise multifaceted is ship operation. A system approach to ship design and operation considers the ship as a complex system, integrating a variety of subsystems and their components, e.g. for energy/power generation and ship propulsion, for cargo storage and handling, accommodation of crew/passengers and ship navigation. Any state of the art design process inherently involves optimisation, namely the selection of the best solution (trade-off) out of many feasible ones for a given target function or transport task, depending on vessel type. Today, this trade-off or formalised optimisation increasingly involves life-cycle considerations and objective functions.

In practice often only parts of the ship design and even less of the ship’s life-cycle are integrated in a common database and software platform.