Aalto University
School of Engineering

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Towards cost-efficient and environmental friendly support vessels for the development of Arctic offshore fields

Title of the dissertation	Goal-based optimization in Arctic offshore support vessel design and fleet composition
Contents of the dissertation	The modern industry of ship design and shipbuilding is very competitive. A vessel is a complex product of broad cooperation – research institutions, design bureaus, and shipyards aim to provide high-quality outcomes. Any suboptimal solution affects the following stages of ship production, making the conceptual ship design a phase with the most impact on ship performance. An Arctic offshore support vessel is a sophisticated and expensive tradeoff between a traditional offshore vessel for open water and an icebreaker. An Arctic navigation imposes specific vessel design requirements to operate in ice safely. However, advanced icebreaking capabilities often negatively affect other ship qualities, such as open water seakeeping performance and cost-efficiency. Meanwhile, Arctic offshore support vessels must be eco-efficient to minimize ship emissions into the fragile Arctic environment. Holistic multi-objective optimization of ships is an effective approach to providing competitive design concepts, which considers a ship a complex system in a specific external operational context. In contrast to the single-objective optimization that finds only one optimal solution corresponding to a particular objective, the multi-objective optimization results in a set of solutions – tradeoffs between the different optimization objectives (e.g., cost-efficiency and environmental friendliness). The dissertation proposes a framework for holistic multi-objective optimization of Arctic offshore support vessels and fleets, including a parametric design model of an Arctic offshore support vessel, performance assessment models for independently operating and icebreaker-assisted Arctic offshore support vessels, and the Artificial Bee Colony optimization algorithm. The framework scans the feasible design space to find a set of competitive solutions, representing tradeoffs between cost- and eco-efficiency of an Arctic offshore support vessel.
Field of the dissertation	Mechanical Engineering
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