A Systems Engineering approach to ship design

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Abstract  In the recent years, ships have experienced an unprecedented growth in complexity prompted by automation, embedded software and increasingly stringent regulation and customer expectations. Systems Engineering approaches have been designed by industries like aerospace or automotive that were facing similar challenges. Shipyards and academic partners initiated the HOLISHIP project in 2016 to develop integrated methods and tools dedicated to ship design. The constraint is to devise approaches that can be implemented in existing shipyards quickly and at limited costs – including limited training costs for experimented ship designers. This paper describes an attempt, based on SysML, to bridge the gap between established systems engineering methods and naval architecture standards. SysML is used as a starting point and then adapted to fit the needs of the shipbuilding industry. The resulting systems engineering approach focuses on the physical description of the ship system. It combines system architecture diagrams that are a cross between traditional Product Breakdown Structures and SysML Internal Block Diagrams; standard SysML State Machines; and “operational scenarios” that are used to make a link between these diagrams. The bottom-line concepts of systems engineering are preserved yet the extremely reduced semantics render the approach easy to learn for ship designers, making it a promising step towards Systems Engineering tools and methods for ship design.

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1 - INTRODUCTION

The developing maritime economy is facing increasingly complex operations at sea, including technically complex new tasks (e.g., deep oil recovery), intense traffic in coastal areas, increased interaction between assets of various types and sizes (ships large and small, aircrafts, drones, satellites, etc). Ships are designed to achieve a balance between all the resulting constraints: a ship is a collection of systems of many different types, combined to operate in a harsh, complex environment while ensuring safe operation at sea.