

Design of Tool for the Optimization of Deck Area Assignments with Integration into Existing Naval Ship Design Programs

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Many tasks in the early stages of ship design are manual and repetitive processes. One such task is in the realm of deck area arrangements. The allocation and assignment of areas in early stage ship design involves tracking the difference of total ship area envelope and all required areas to be placed for habitability, mission support, and propulsion capability among many. The problem becomes more complex with the addition of constraints involving required separation zones between other areas, affinities for certain areas or deck levels, and compartment subdivision. The Leading Edge Architecture for Prototyping Systems (LEAPS) database structure output from the Advanced Ship and Submarine Evaluation Tool (ASSET) provides a ship envelope and a list of areas requiring assignment. However, with over a hundred different area categories to place in a subdivided ship hull of a large number of compartments each with their own preferences and constraints, this problem is categorized as Non-deterministic Polynomial-time hard(NP). Essentially meaning that finding the optimal solution in the design space is not realistically feasible as the problem scales upwards in size.

Fortunately, this type of problem, known as Bin Packing, is well understood in academic research. Meta-heuristic methods of obtaining near optimal solutions in a finite timeframe exist that are reasonable enough for use. This thesis presents the framework for a ship design tool that pairs two of these meta-heuristic methods with naval ship architecture and LEAPS based projects. The framework is divided into three major steps: a ship volume balance, a ship area balance, and an area layout of the ship footprint. The output of the tool is the general arrangements drawings in a universal CAD format that would be the starting point into more detailed arrangements.

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