Chapter 13
Load Optimization for Navy Landing Ship Tank

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ABSTRACT

The success of military operations mainly relies on the proper flow of the logistical supplies such as water, food, ammunition, etc. from source to the operation theater on time. There are special types of transportation vessels regarding the feature of supply. However, when transporting special material like ammunition, most navies usually prefer utilizing their own transportation capabilities since they require special treatment. For this reason, such material is carried in special boxes, called containers. To minimize the transportation cost and time, an efficient container stowage plan is necessary in terms of loading and unloading these containers. This chapter aims to develop a solution methodology to the problem with the focus on military logistics planning. For this purpose, the author develops a mathematical model that attempts to minimize the transportation time by creating proper loading and unloading sequence of containers to military cargo ships.

INTRODUCTION

Over the past two decades there has been a continuous increase in demand for cost efficient containerized transportation. To meet this demand, shipping companies have deployed larger container vessels, which can nowadays transport up to 19,000 TEUs (Twenty-Foot Container Equivalent Units). These vessels sail from port to port loading and unloading thousands of containers.

Minimizing the time, a vessel spends at port involves, among other issues, an efficient stowage plan; a plan that describes where each container should be loaded on the vessel. Note that containers are only accessible when they are on the top of other containers. Unloading and loading movements of the same containers in the same port are called shifts. Shifts arise either when planners want to unload containers destined for current port which however are beneath those destined for subsequent ports, or when planners want to reorder the sequence of containers to prevent more shifts in the future. Usually it is called necessary shifts in the former case and voluntary shifts in the latter. Shifts are time-consuming and

DOI: 10.4018/978-1-5225-5513-1.ch013

money-consuming activities, hence the arrangement of containers on board is crucial to achieve effective operations by reducing the number of shifts. The task of determining the arrangement of containers is called, as mentioned before, stowage or load planning.

In the military domain, the logistic supplies are usually delivered by private shipping companies or military cargo ships such as LST (Landing Ship Tank), LCM (Landing Craft Mechanized), LCU (Landing Craft Utility) and other types of ships, depending on the size of the cargo. But some critical military cargo, like ammunition, must be delivered in special boxes or containers with delicate treatment. This may require the utilization of navy cargo ships like LSTs and LCMs. In peace time, transportation of critical military cargo is made through several military ports by unloading filled boxes and loading empty boxes along with other loads. Particularly in the event of crisis or any operation however, these deliveries should be completed in minimum time interval. This can be achieved only by shortening the time spent at any port. In order to shorten this time, the stowage plan must be made in a fashion that there is no or minimum number of shifts. In this paper, the author proposes an algorithm that minimizes the number of shifts that may occur during loading process.

The purpose of this study is to show the close relation between Military Transportation and Container Stowage Plan and to produce an optimal solution for Military Transportation problems in designated time by utilizing CSP algorithms. Since the duration of Military Transportation is crucial to planners in critical times, it is assumed that proposed model will make contributions to the studies in this field.

LITERATURE REVIEW

An early attempt at this problem explained by Sheilds (1984), uses a combination of simulation using Monte-Carlo techniques and human interaction to provide possible vessel plans.

One of the early works on this problem was the one conducted by Imai and Miki (1989) who considered the maximization of GM and the minimization of the loading-related re-handle when loading containers onto one of the ship holds. For simplicity in the solution process, they formulated the problem as a two-objective assignment problem, employing the estimated number of re-handles in the objective function instead of the exact one. The precise number of re-handles is obtained from the resulting solution.

Imai et al. (2001) followed another approach in order for the exact number of re-handles to be considered in the problem. They formulated the stowage problem as a GM objective assignment problem for identifying a non-inferior solution set in terms of the GM and number of re-handles. Multiple solutions of the assignment problem were enumerated, thus computing the exact number of re-handles based on each enumerated solution. This approach, however, generated enormous multiple solutions for nearly the same range of a non-inferior solution set as the method employed in Imai and Miki (1989). Surprisingly, the former took 6000 times longer computation time than the latter. Imai et al. (2002) modified the problem only for finding non-inferior solutions with acceptable GM. The first attempt to derive some rules for determining good container stowage plans is reported in Ambrosino and Sciomachen (1998), where a constraint satisfaction approach is used for defining and characterizing the space of feasible solutions.

Wilson and Roach (1999, 2000) and Wilson et al. (2001) presented a realistic model, considering all technical restrictions in order to implement a commercial usable decision support system. Their approach was based on decomposing the planning process into two phases. In the first phase, called the strategic process, they created a rough stowage plan, based on grouping the containers with the same characteristics in terms of size, destination, etc., and on assigning them to blocks of stowage space in the

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