Resource Constrained Scheduling Problem
at U.S. Naval Shipyards

by

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ABSTRACT

Submarine repair schedules are some of the most complex schedules seen in project management. Repairs of a nuclear U.S. submarine are resource constrained since resources are divided among approximately thirty shops (e.g. electricians, welders, and pipefitters). The system complexity, the tight spaces, the operational nuclear reactor, the challenges inherent in repair, and resource competition all contribute to a dense integrated schedule. Minimizing the overall length of each project, the "makespan," is the primary objective function of this thesis. This thesis uses a commercially available simulation package, @Risk, to analyze a realistic submarine repair schedule. Simulation is used to analyze uncertainty in the task durations and identify crucial tasks that highly impact the makespan. Finally, a genetic algorithm is tested to assign resources to minimize the makespan. The submarine repair data was based on a schedule with 4038 tasks and 7723 constraints or ties. A simulation assigned all 4038 tasks a triangle probability distribution with the duration set at plus or minus 10 percent of the original duration estimate. Sensitivity analysis of the simulation identified key task nodes having significant impact on the overall duration. These top ten crucial tasks were then given similar probability distributions and another simulation was run keeping the remaining 4028 tasks as deterministic durations. Minimizing the makespan could only be executed on a small subset of data, 25 tasks, due to limiting assumptions on reducing task durations by assigning more resources. An overall improvement of 5.5-15.6 % was achieved; this gives an indication of the approximate makespan optimization potential in current U.S. submarine repair, maintenance and overhaul operations.

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