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Optimized Transit Tool & Easy Reference (OTTER) Improved Data Analysis

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NPS NRP Executive Summary
Title: Optimized Transit Tool & Easy Reference (OTTER) Improved Data Analysis
Report Date: 12/03/19 Project Number: NPS-19-N123-A
Naval Postgraduate School / Energy Academic Group

NAVAL RESEARCH PROGRAM
NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

OPTIMIZED TRANSIT TOOL & EASY REFERENCE (OTTER) IMPROVED DATA ANALYSIS

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EXECUTIVE SUMMARY

Project Summary

The Optimized Transit Tool & Easy Reference (OTTER) program is a simple Excel tool designed to help United States Navy (USN) surface ships reduce their fuel consumption during transits, while still adhering to mission and operational requirements. Possible fuel savings are a function of not only a ship's mission, but also the base case transit speeds and operational behaviors to which the optimized transit solution is being compared, and the operational constraints that limit the potential optimizations such as keeping multiple engines online for enhanced maneuverability. This research expands on previous efforts by considering a wider range of possible transit scenarios for cruisers and destroyers. Our methods included modeling transits with an average speed ranging from 8 to 27 kts, with up to four hours per day dedicated to running drill sets, where operational conditions included unconstrained engine modes and, at minimum, ships maintaining split plant. In all cases, OTTER improved fuel efficiency compared to the base cases, but the improvements ranged from significant to negligible depending on specific operating and transit conditions.

This effort also solicited feedback on the OTTER's interfaces and training materials via interviews with Navy Surface Warfare Officers (SWOs) at the Naval Postgraduate School (NPS). Interview results revealed ways the OTTER interface can be improved to alleviate confusion, and how to make the training materials more effective. Input from these SWOs will be used to improve the effectiveness of future versions of OTTER and its related materials once it reaches the users.

Keywords: fuel, logistics, Optimized Transit Tool & Easy Reference, OTTER, transit, surface fleet, refuel, TFP, transit fuel planner, BOSC, Battlegroup Optimum Speed Calculator, SECAT, Ship Energy Conservation Assistance Training, DFM, diesel marine fuel, engine mode, plant configuration, optimization, tools

Background

OTTER is a tool originally developed by LCDR Warren Blackburn and Mr. Brandon Naylor (Blackburn, 2016) to help ships save fuel, using the mixed-mode fuel optimization method (US Patent No US8050849B1). Past Naval Research Program-funded research efforts into this topic (Howard & Naylor, 2017, Howard & Naylor 2018) produced promising results, but did not have the benefit of working with actual ship transit records. This study intended to fill the gaps in the previous research efforts and theses in part by addressing the inconsistencies in the original transit data, and also model a wider variety of realistic transit conditions by working with students with operational experience who provided real-world "lessons learned." This study was also designed to reveal how OTTER might be made more effective and how user error of the tool might be reduced. While it was expected that OTTER would provide fuel savings, and this would always be an improvement on the base case transit behaviors, it was also assumed the fuel savings would vary greatly depending on operational conditions.

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Process and Methodology

This study was conducted by modeling a wide variety of transit conditions in OTTER with various operational constraints and requirements, in order to determine how much fuel could be saved by using OTTER transit solutions versus base case transit behavior. Over 650 transits were modeled for cruisers and destroyers with Plan of Intended Movement (PIM) window speeds ranging from 8 to 27 kts, with up to four hours per day diverted for training exercises. These operating conditions allowed and prevented the use of the trail shaft engine configurations; ships using high speeds to maintain position at the front of the PIM window were modeled as base case conditions.

Additionally, we recruited SWO volunteers from the NPS community to gauge the effectiveness of the training materials and determine how the interface might be improved. These volunteers were given a copy of OTTER with the included instructions, and asked to try to model several transits and comment on their experience. Through their feedback and observing the experience of a new user, we learned how the training materials can be improved, noted changes which could make the user interface more intuitive, and discovered a bug in the interface.

Findings and Conclusions

This study found that OTTER's optimized transit solutions could produce significant fuel savings for cruisers and destroyers, even in cases where operational conditions required significant diversions or restricted engine configuration. Typical OTTER fuel savings were around 10% for unrestricted transits and 8% for transits that did not allow use of the trail shaft configuration. While the vast majority of transit conditions would likely produce fuel savings ranging from 3% to 15%, in extreme cases, OTTER could produce savings as high as 20% or conversely, offer negligible advantage over the base case.

While OTTER was well-received by the volunteer SWOs who tested the program, their feedback made it clear that the OTTER tool and training materials can be improved. Suggestions included making the instructions and training materials more consistent with the rest of their training; in addition, the SWOs also uncovered a bug in the interface that allowed the user to edit a protected value. Their feedback will be incorporated in future versions of OTTER.

Recommendations for Further Research

This study has demonstrated that adopting OTTER across the fleet could result in significant fuel savings. However, further study is needed to facilitate this adoption, and to assess the impact OTTER's fuel savings could have on logistics and operational readiness. Once the recommended improvements from this study are made to OTTER and its training materials, further work will also be required to test OTTER in an operational environment, compare actual fuel savings against the model, and verify that the improved training materials are effective. This work will support the eventual adoption of the OTTER tool and represents a possibility for huge cost savings and increased operational capability.

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Acronyms

Naval Postgraduate School	NPS
Optimized Transit Tool & Easy Reference	OTTER
Plan of Intended Movement	PIM
Surface Warfare Officer	SWO