MASTER OF SCIENCE
IN
OPERATIONS RESEARCH

ESTIMATING INTER-DEPLOYMENT TRAINING CYCLE PERFORMANCES
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The objective of this thesis is to estimate Inter-Deployment Training Cycle (IDTC) performances of the U.S. Pacific Fleet surface ships, which are evaluated at the end of the Basic Training Phase, by using Command Metrics Tool (COMET) metrics. The basic objective was primarily to decide whether the COMET database can be used to estimate performances of ships, and to build regression models to estimate Final Evaluation Problem (FEP) performances of ships.

This study develops multivariate logit regression models to examine and explore the structure of the data sets. Most of the models developed according to statistical criteria include only the intercept, indicating that there is no real relationship between the COMET metrics and IDTC performances. The assessments made at the end of FEP are not good Measure of Performances (MOPs) by which to assess ships' IDTC performances.

KEYWORDS: Inter-Deployment Training Cycle, Final Evaluation Problem, Command Metrics Tool, COMET, Logistic Regression

ANALYSIS OF STRYKER BRIGADE COMBAT TEAM STRATEGIC SEALIFT DEPLOYMENT OPTIONS
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Projecting a credible land combat power to a potential conflict area in a timely manner requires rapid strategic sealift mobility with high capacity. A highly deployable, light, yet sufficiently lethal force capable of deterrence or sustaining combat is necessary to accomplish this objective.

The Army's initial steps towards transformation seek to establish that ability. This transformation requires having lighter forces with quicker deployment times, thereby turning the Army from the Legacy Force, made up of both well-equipped heavy war fighting forces, which are difficult to deploy strategically, and rapidly responding light forces, which lack staying power against heavy mechanized forces, into an Interim Force of Stryker Brigade Combat Teams (SBCT). The SBCT combines the capacity for rapid deployment with survivability and tactical mobility. The Army's objective is to deploy the Stryker Brigade Combat Team, a brigade-sized force equipped with medium weight armored vehicles, anywhere in the world within 96 hours (Vick, 2002).

This thesis determines the mix of sealift assets best suited for different scenarios that differ by distance and port accessibility, and analyzes the implications of these findings on Army deployment doctrine. This is accomplished in two ways. First, two specific scenarios are used to develop the initial requirements and best mix of assets for SBCT deployment based on a fictional Kosovo campaign. Additionally, a preliminary analysis is conducted of the three feasible configuration options. The options are: (1) TSVs only, (2) LMSRs only, or (3) a combination of the two. These three options are compared using fixed cargo requirements and their performance versus cost is analyzed based on the Kosovo campaign distances.

KEYWORDS: Stryker, Sealift, Stryker Brigade Combat Teams, SBCT, Rapid Deployment

ANALYSIS OF EFFECTIVENESS OF COOPERATIVE ENGAGEMENT CAPABILITY USING SCHUTZER'S C^2 THEORY

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Information superiority can be obtained by enhancement of the command and control system. While weapon systems may have been developed to a point of decreasing returns regarding firepower, command and control (C^2) systems can be developed further. The force that has superior C^2 may win the fight in the future by information superiority.

Currently, there is no appropriate methodology to assess the contribution from the C^2 system to improved combat outcomes. This thesis develops a methodology to address Cooperative Engagement Capability (CEC) by modifying the C^2 theory developed by D.M. Schutzer. The author addresses the time line that Schutzer suggested as the key to addressing C^2 improvements concretely and modifies the MOE he designed. Based on this modified MOE, developed through simulation analysis of an air defense scenario, the improvement in command and control systems by the CEC system is quantified.

KEYWORDS: CEC, NCW, MOE, C^2 System, D.M. Schutzer, Simulation, Polynomial Regression, Metamodel, Information Superiority

DEFENSE OF THE SEA BASE -- AN ANALYTICAL MODEL

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The purpose of this analysis is to develop an analytical model that describes defense for the Sea Base. Although models have been developed for defense of a carrier battle group (CVBG) with one High Value Unit (HVU) against air, surface, and subsurface attacks, there are unique aspects of the Sea Base that are not specifically addressed in CVBG defense models. First, the defense of the sea base is different in that there are multiple HVUs (Expeditionary Warships – EXWAR Ships) expected in the Sea Base. In addition, there is a credible threat of being overwhelmed by High Density Threats (HDTs) in close proximity to enemy shores, where the enemy need not have a large navy or long range air force to launch an assault. This model specifically addresses the issue of defending multiple HVUs against HDTs.

The model also gives a commander insight into the optimal placement of defenders with respect to parameters such as threat sector, minimum detection range, attacker and defender velocity, and defender weapon ranges. The model can also be used for Operational Requirements (ORs) development by Sea Base system designers. By inputting parameters associated with certain scenarios, system developers can see how performance of a specific parameter, such as weapons range, probability of kill, and radar detection range, can affect the quality of Sea Base defense with respect to the effective area of defender coverage and the number of defenders required to achieve a certain level of protection. Additionally, if given a probability of success requirement for a defender against a certain number of attackers, the model determines the number of shots/salvos which yields that probability and in turn, gives insight into what range of parameters play critical roles in achieving it.

KEYWORDS: Missile Defense, High Density Threat, HDT, Sea Base, Firing Policy, Sector Coverage

OPTIMIZING A MILITARY SUPPLY CHAIN IN THE PRESENCE OF RANDOM, NON-STATIONARY DEMANDS

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Demand for supplies, such as ammunition, during a military operation is a scenario-dependent random variable that may be subject to high variance. The challenge is to design an efficient military logistics supply chain that satisfies uncertain, non-stationary demands, while taking into account the volatility and singularity of military operations. This research focuses on the development of a modeling framework that determines the optimal deployment of transportation assets and supplies at the operational level, with possible interdiction by enemy forces. This model is termed Optimal Military Logistics Supply Chain (OPTiMiLSC). This is a two-level, multiple time period, scenario-based stochastic model. OPTiMiLSC uses a combination of optimization, scenario-based simulation, and statistical analysis. A "scenario tree" method is used to generate the demand scenarios. The results show a positive correlation between the number of demand scenarios and the probability that a random demand scenario is satisfied. OPTiMiLSC is compared with two deterministic optimization approaches. The first approach is where demands are fixed at the 90^{th} percentile, which tends to over-supply when compared to OPTiMiLSC. The mean value approach, on the other hand, tends to under-supply. OPTiMiLSC enables military planners to establish a robust logistic plan that responds more adequately to an intra-theater operation.

KEYWORDS: Military Logistic Supply Chain, Mathematical Programming, Optimization, Simulation, Random and Non-Stationary Demand, Supply, Transportation, Stochastic Programming, Scenarios Tree Generation, Statistic Analysis

AN ENHANCED GRAPHICAL USER INTERFACE FOR ANALYZING THE VULNERABILITY OF ELECTRICAL POWER SYSTEMS TO TERRORIST ATTACKS

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This thesis develops a Graphical User Interface (GUI) to represent electric power grids subject to interdiction (attack) by terrorists. The work enhances the prototypic One-line Diagram (OD) representations of electric power networks in the VEGA 1.0 decision-support system (Vulnerability of Electrical Power Grids Analysis, version 1.0). Conforming to Windows standards, the new OD GUI incorporates advanced graphical features, which help the user visualize the model and understand the consequences of interdiction. The new ODs also capture the details of system restoration over time following an attack. The enhanced OD GUI has been incorporated into the updated version of the system, VEGA 2.0.

KEYWORDS: Graphical User Interface, Electrical Power Systems, Visual Basic

A MODEL FOR PREDICTING THE REPAIR COSTS OF U.S. NAVY INVENTORY ITEMS

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This research was initiated due to a report claiming that the U.S. Navy significantly overestimated repair prices in a Performance Based Logistics (PBL) reward to a contractor. The purpose of this thesis is to

develop a model for improving the prediction of repair price for U.S. Navy inventory items. The thesis examines several prediction methodologies, including a ratio-estimator prediction method that is a modification of the methodology currently in use, as well as regression analysis. In contrast to the ratio-estimator approach, regression is able to utilize a wide range of predictor variables, several of which are evaluated in the thesis research. Results of this analysis reveal that a regression model with logarithmic transformations yields more accurate predictions of repair prices than the current methodology. This improvement is seen especially for items that have the highest replacement price. One feature of the proposed regression-based methodology is that predicted repair prices for the most expensive items are substantially lower than with the current methodology. In the case which prompted this thesis research, the overstatement of benefit from the PBL would have been reduced by about 30 million under the proposed methodology.

KEYWORDS: Cost Estimation, Repair Price, Data Analysis, Naval Inventory Items, Operations Research, Regression Analysis