
1998 THESIS ABSTRACTS

AN EVALUATION OF MARKOV CHAIN MODELING FOR F/A-18 AIRCRAFT READINESS

Leigh P. Ackart-Lieutenant Commander, Supply Corps, United States Navy

B.S., Southern Illinois University, 1987

Master of Science in Operations Research-September 1998

Advisor: Lyn R. Whitaker, Department of Operations Research

Second Reader: Kevin J. Maher, Department of Operations Research

During its 1998 deployment the USS INDEPENDENCE (CV 62) and Carrier Air Wing Five operated under the control of Commander, Task Force 50 (CTF-50). To balance resources and readiness, CTF-50 asked the following question: "How many days can the USS INDEPENDENCE go without 'off ship' logistics support before the number of Mission Capable aircraft can be expected to fall below Chief of Naval Operations (CNO) readiness goals?" This thesis develops a Markov chain model to answer this question. Explanatory variables for this model include sorties flown, cannibalization rate and frequency of "off ship" logistics support. Using data from the USS INDEPENDENCE this thesis analyzes the readiness by estimating the number of F/A-18 aircraft capable of performing at least one of its intended missions.

Both non-linear Markov models and Generalized Linear Models are employed to estimate the effect of the operating environment on the number of mission capable aircraft available. The analysis demonstrates how the Markov approach captures the cyclic nature of aircraft operations and maintenance. Specifically, it is shown that the USS INDEPENDENCE can expect to operate 5 – 8 days without "off ship" logistics support before F/A MC rates fall below CNO readiness goals. Recommendations for further studies are included.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Aviation Readiness, Markov Chain Models, Logistics Support, Carrier Onboard Delivery (COD)

AN OPTIMIZATION-BASED DECISION SUPPORT MODEL FOR THE NAVY H-60 HELICOPTER PREVENTIVE MAINTENANCE PROGRAM

Michael H. Albright-Commander, United States Navy

B.S., Florida State University, 1980

Master of Science in Operations Research-September 1998

Advisor: Gerald G. Brown, Department of Operations Research

Second Reader: Ronald L. Brown, Department of Operations Research

For Naval aircraft, the largest portion of Operating and Support (O&S) costs is consumed by maintenance. The effort to reduce O&S costs is part of a Naval Air Systems Command initiative termed Affordable Readiness. Innovative programs are being implemented under Affordable Readiness to maintain safety, sustain readiness, and reduce costs.

One program, Integrated Maintenance Concept (IMC), is being developed for the Navy H-60 helicopter. IMC calls for depot-level artisans to be collocated at each squadron facility rather than at a central facility. Integrating appropriate organizational level maintenance tasks with germane subsets of the depot level tasks is the essence of the H-60 IMC. Reduced aircraft maintenance costs and out-of-service time are the major benefits of IMC.

As part of the transition to IMC, current organizational, intermediate and depot maintenance requirements are being reviewed for applicability and effectiveness. The result of this review will be a new listing of justified preventive maintenance tasks. The tasks then are grouped in an optimal manner that minimizes total aircraft out-of-service time.

This thesis explores the potential synergism inherent to certain preventive maintenance task groupings that can lead to an overall reduction in aircraft out-of-service time. A prototypic optimization-based decision support model is developed. The solution presented is evaluated in terms of total cost in hours to perform all required tasks over a given time horizon. Additionally, the optimal task groupings are identified. Together, these results are insightful for developing a preventive maintenance program.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREA: Other (Logistics)

KEYWORDS: Maintenance, Aviation, Optimization, Modeling, Logistics

**OPTIMIZING AMMUNITION MOVEMENT IN SUPPORT OF
THE U.S. PACIFIC FLEET'S POSITIONING PLAN**

**Eric B. Anderson-Lieutenant Commander, United States Navy
B.S., University of North Carolina, 1987**

Master of Science in Operations Research-September 1998

Advisor: John F. Raffensperger, National Research Council Post-Doctoral Associate

Second Reader: Douglas J. MacKinnon, Department of Operations Research

To support United States national and military strategy, the United States Navy must position ammunition at bases located in regions of potential conflict. The Commanders in Chief, U.S. Pacific Fleet (CINCPACFLT), U.S. Atlantic Fleet (CINCLANTFLT), and U.S. Naval Forces Europe (CINCUSNAVEUR) are responsible for developing positioning plans, in consultation with the Naval Ordnance Center (NAVORDCEN), to strategically position appropriate types and quantities of ordnance to support the warfighter and to meet both peacetime and wartime requirements. This thesis examines ammunition positioning in the Western Pacific. Changes to the positioning plan change the mix of ammunition types required to be stored at various bases. In order to satisfy the new requirements, ammunition must be relocated. There is not presently enough ammunition available to satisfy all requirements, so the relocation of available assets must be prioritized. This thesis discusses a model developed to optimize the ordnance positioning and transportation options. The model is used to better locate current stocks of ammunition in order to satisfy the CINCPACFLT Ammunition Positioning Plan.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Ordnance, Ammunition, Transportation, Optimization, Modeling, Logistics

SOFTWARE COMPONENTS FOR AIR DEFENSE PLANNING

Arent Arntzen-Royal Norwegian Air Force

Master of Science in Operations Research-September 1998

Advisor: Arnold H. Buss, Department of Operations Research

Second Reader: Gordon H. Bradley, Department of Operations Research

Modern offensive weapon technologies such as stealth and precision guided munitions have rendered Integrated Air Defense Systems increasingly vulnerable and ineffective. Stealth effectively reduces the performance of radar, but does not have the same impact on passive systems. Sensors have been the most important and vulnerable part of air defense systems throughout the history of air warfare. Research into passive sensors has been encouraging, but before passive sensor systems are produced, procured and deployed, analysis and planning must be conducted to quantify potential benefit and determine feasible system configurations. As this type of analysis encompasses extremely complex system behavior, developing reusable and flexible simulation models becomes important. This thesis develops a prototype software component architecture and component library for building simulation models for air defense analysis. Sensor and airborne weapon simulation components are demonstrated and used in an exploratory analysis of the impact of a network of Infrared Search and Track sensors. The analysis is based on a modern air defense system deployed in a realistic scenario. The component architecture and documentation methodology supports reuse, and provides model configuration flexibility with potential for growth in successive stages of analysis.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Air Defense Planning, Simulation, Software Components

1998 THESIS ABSTRACTS

OPTIMAL LONG-TERM AIRCRAFT CARRIER DEPLOYMENT PLANNING WITH SYNCHRONOUS DEPOT LEVEL MAINTENANCE SCHEDULING

**Mehmet Ayik-Lieutenant, Turkish Navy
B.S., Turkish Naval Academy, 1992**

Master of Science in Operations Research-March 1998

Advisor: Gerald G. Brown, Department of Operations Research

Second Reader: Ronald L. Brown, Department of Operations Research

Forward deployment of Navy aircraft carrier battle groups is a primary means for the United States to achieve overseas interests. The Navy maintains the forward presence of aircraft carriers in three major Areas of Responsibility (AORs): the Mediterranean Sea, the Persian Gulf, and the Western Pacific. Considering the cost of carrier operations and the desire to maximize coverage of the AORs, planning deployments for the carriers not only significantly affects the achievement of U.S. defense strategy, but also impacts the Navy financially. Previous studies have maximized the deployment of aircraft carriers to the AORs while strictly adhering to the fixed, long-range maintenance schedules published by the Planning and Engineering for Repairs and Alterations Activity for Aircraft Carriers (PERA CV). This thesis optimizes aircraft carrier deployment planning while shifting the pre-scheduled maintenance availabilities well within limits allowed by the Chief of Naval Operations (CNO). This synchronous planning of deployments and major maintenance yields at least 15% more planned coverage in the AORs with the existing carrier fleet. Such an increase had heretofore been thought to require three additional aircraft carriers.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Surface/Undersurface Vehicles – Ships and Watercraft, Modeling and Simulation, Other (Optimization)

KEYWORDS: Aircraft Carriers, Deployment Planning, Depot Level Maintenance, Crisis Response Times, Coverage of Areas of Responsibility, Optimization

CLIMATE SURVEY ANALYSIS FOR AVIATION MAINTENANCE SAFETY

**Robert H. Baker-Captain, United States Marine Corps
B.S., United States Naval Academy, 1991**

Master of Science in Operations Research-September 1998

Advisors: Robert R. Read, Department of Operations Research

CDR John K. Schmidt, School of Aviation Safety

Second Reader: Lyn R. Whitaker, Department of Operations Research

Naval Aviation has been challenged to cut its 1996 human factors related Class A flight mishap rate in half by the year 2000. Investigations show that human caused flight mishaps have not declined as rapidly as mechanical ones. From fiscal year 1990 through 1997, maintenance was a causal factor in 17 percent of Class A flight mishaps. Presently, there is an ongoing effort to identify factors contributing to human error in aviation maintenance. One major component is the development of an instrument to assess safety climate and posture in maintenance operations. This thesis is the climate safety assessment portion of this effort. It utilizes and adapts an existing Model of Organizational Safety Effectiveness (MOSE) to achieve an understanding of the possible influences of organizational factors on aviation maintenance. This thesis develops and administers a prototype Maintenance Climate Assessment Survey (MCAS) that provides a tool for assessing safety in maintenance operations. The study has 268 participants from three Reserve squadrons that represent the spectrum of aviation communities. The prototype MCAS is comprised of 67 questions developed from 155 candidate questions. Each question uses a Likert type rating scale, which allows participants to express opinions for each item presented. Cluster and Factor analysis is used to identify redundancies between items and how items clustered according to the MOSE components. The product of this study is a finalized MCAS with 35 questions that can be used by the Squadron command and Aviation Safety Officer to assess their unit's safety posture in conducting scheduled/unscheduled maintenance operations.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREAS: Manpower, Personnel and, Training; Other (Human Factors)

KEYWORDS: Model of Organizational Safety Effectiveness, Human Factors, Cluster Analysis, Factor Analysis, Aviation Maintenance, Maintenance Climate Assessment Survey

**ON THE QUASIMONOTONICITY OF A SQUARE LINEAR OPERATOR
WITH RESPECT TO A NONNEGATIVE CONE**

Philip Beaver-Major, United States Army

B.S., United States Military Academy, 1983

M.S., Naval Postgraduate School, 1991

Doctor of Philosophy in Applied Mathematics-June 1998

Advisor: David Canright, Department of Mathematics

Committee: Christopher L. Frenzen, Department of Mathematics

Robert F. Dell, Department of Operations Research

Clyde L. Scandrett, Department of Mathematics

Maurice D. Weir, Department of Mathematics

The question of when a square, linear operator is quasimonotone nondecreasing with respect to a nonnegative cone was posed for the application of vector Lyapunov functions in 1974. Necessary conditions were given in 1980, which were based on the spectrum and the first eigenvector. This dissertation gives necessary and sufficient conditions for the case of the real spectrum when the first eigenvector is in the nonnegative orthant, and when the first eigenvector is in the boundary of the nonnegative orthant, it gives conditions based on the reducibility of the matrix. For the complex spectrum, in the presence of a positive first eigenvector the problem is shown to be equivalent to the irreducible nonnegative inverse eigenvalue problem.

DoD KEY TECHNOLOGY AREA: Other (Applied Mathematics)

KEYWORDS: Quasimonotonicity, Nonnegative Cone

CONCEPT FOR A SPECIAL OPERATIONS PLANNING AND ANALYSIS SYSTEM

Allan L. Bilyeu-Captain, United States Army

B.S., United States Military Academy, 1987

Master of Science in Operations Research-June 1998

Advisor: Gordon H. Bradley, Department of Operations Research

Second Reader: Charles H. Shaw, III, Department of Operations Research

This thesis designed and partially implemented a platform independent mission planning and analysis system for the United States Special Operations Command (US SOCOM). The ability to move to platform independent technologies is particularly important for the special operations community since it cannot expect standardized computer planning and analysis systems for their joint, multi-national, and inter-agency operations. This thesis also investigates the ability to integrate legacy systems using an open architecture on an object web. In addition, this thesis incorporates operations research methods into this system to show their importance in planning and analysis. The system is developed in the Java programming language using loosely coupled components. The system involves an image component that contains a map with overlays. The use of common object request broker architecture (CORBA) for integrating legacy systems is discussed. To show the relevance of this system, a scenario involving joint and coalition forces is developed. The scenario demonstrates the usefulness and need for platform independent planning and analysis systems. Finally, this thesis recommends an architecture that USSOCOM should investigate for its future mission planning, analysis, rehearsal, and execution (MPARE) system.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREA: Command, Control, and Communications

KEYWORDS: Special Operations, Map-Based Planning, Java, Platform Independent, MPARE, Loosely Coupled Components

PARTIAL-ENUMERATION FOR PLANAR NETWORK INTERDICTION PROBLEMS

Michael R. Boyle-Lieutenant, United States Navy

B.S., University of Illinois, 1988

Master of Science in Operations Research-March 1998

Advisor: R. Kevin Wood, Department of Operations Research

Second Reader: Gerald G. Brown, Department of Operations Research

In the network interdiction problem, an interdictor destroys a set of arcs in a capacitated network through which an adversary will maximize flow. The interdictor's primary objective is to use his limited resources to minimize that maximum flow, but other objectives may be important. Therefore, we describe algorithms for enumerating near-optimal interdiction sets in planar networks so that these sets may be evaluated with respect to secondary criteria, e.g., safety of attacking forces, collateral damage, etc. The algorithms are based on enumerating near-shortest paths or cycles in the dual of a planar network; they find a single optimal interdiction set in pseudo-polynomial time. One algorithm was implemented applicable to s - t planar networks (s and t must lie on the perimeter of the network) and solve problems with up to 512 nodes and 791 arcs. An example of computational results on that largest network is that the algorithm enumerates all 959 solutions that are within 10% of optimal in 3.46 seconds on a 133 MHz Pentium PC. It was also proposed, but not implemented, at a somewhat less efficient extension of this algorithm to solve problems on general planar networks.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Network Interdiction, Dijkstra's Algorithm

A RELIABILITY AND AVAILABILITY ANALYSIS OF NOTIONAL JOINT STRIKE FIGHTER AIRCRAFT DESIGNS

Daniel E. Boyles-Lieutenant Commander, United States Navy

B.S., University of Illinois, 1986

Master of Science in Operations Research-September 1998

Advisor: Robert R. Read, Department of Operations Research

Second Reader: Lyn R. Whitaker, Department of Operations Research

This thesis investigates the reliability and availability differences of notional Aircraft Carrier Takeoff and Landing (CVTOL) and Short Takeoff and Vertical Landing (STOVL) versions of the Joint Strike Fighter (JSF) aircraft using basic Reliability Block Diagrams (RBD), survivor functions, and stochastic methods. The models used in this thesis can be developed for forecasting the reliability and availability of any notional aircraft. The aircraft component data were extracted from the Naval Aviation Logistics Data Analysis (NALDA) database. Stochastic model sensitivity analysis of critical notional aircraft components and comparison of aircraft survivor function calculations indicate the STOVL JSF has a higher attrition rate and a significantly lower availability than the CVTOL JSF.

DoD KEY TECHNOLOGY AREAS: Aerospace Propulsion and Power, Air Vehicles

KEYWORDS: Joint Strike Fighter, JSF, Reliability, Availability, STOVL

1998 THESIS ABSTRACTS

AN ALGORITHM FOR CLASSIFYING PUBLIC SWITCHED TELEPHONE NETWORKS (PSTN) SWITCHING STATIONS

**John F. Brandeau-Commander, United States Navy
B.S., Duke University, 1980**

Master of Science in Operations Research-September 1998

Advisor: Robert F. Dell, Department of Operations Research

Second Reader: Norman D. Curet, National Security Agency

The National Security Agency (NSA) collects and processes signals intelligence information for national security purposes. As part of this mission, NSA predicts message routing over public switched telephone networks (PSTNs). The hierarchical switching level (or classification) of PSTN switching stations must be determined before making routing predictions. This thesis develops a fast graph-theoretic algorithm for accomplishing this classification. An undirected connected graph models a target PSTN; switching stations are nodes and logical connections between the switching stations are unit-length arcs. We develop bounds for the minimum number of switching levels and implicitly enumerate all possible classifications for each PSTN. The algorithm is implemented in Java and PSTNs are classified using a personal computer. Solutions are obtained in under one second for nine real-world PSTNs, and large notional networks of over 300 nodes and 900 arcs are classified in under one minute. This research improves existing node classification software.

DoD KEY TECHNOLOGY AREA: Command, Control, and Communications

KEYWORDS: Public Switched Telephone Network, PSTN, Hierarchical PSTN, Telecommunications, Java, Graph Theory, National Security

A PROCESS SIMULATION DESIGN TO ASSESS PROMISING TECHNOLOGIES RELEVANT TO F/A-18 AIRCREW TARGET RECOGNITION

**Eric V. Bryant-Major, United States Marine Corps
B.S., San Diego State University, 1985**

Master of Science in Information Technology Management-September 1998

Advisors: William K. Krebs, Department of Operations Research

Terrance C. Brady, Department of Systems Management

F/A-18 aircrew visual target recognition during air-to-ground weapons employment is accomplished by the integration of sensors, systems, and information processing by the aircrew. The aircrew's ability to rapidly obtain target recognition from the cockpit display of the target scene is critical to accurate weapons delivery.

Using system engineering principles, a process simulation design was devised consistent with DoD acquisition reform regulations, that simulates how aircrew perform visual search and target recognition in attack aircraft, and it provides measures of performance (MOP) for decision-makers to assess the effectiveness of promising technologies. Two assessments were performed. The first experiment measures for effect in aircrew target recognition reaction time and accuracy using two different sensors – visible and infrared. An analysis of variance (ANOVA) of the measured reaction times data showed that aircrew using a visible sensor were significantly faster than aircrew using an infrared sensor. The second assessment involves aircrew cognitive model building during pre-mission planning using Mission Rehearsal Simulation (MRS) software. An ANOVA of the measured data revealed that aircrew who used the MRS software was significantly faster than aircrew who did not. An optimum aircrew training methodology using MRS software was devised and it is currently being integrated into F/A-18 fleet replacement squadron training.

DoD KEY TECHNOLOGY AREAS: Human Systems Interface, Sensors, Modeling and Simulation, Other (Defense Acquisition, Systems Engineering)

KEYWORDS: Target Recognition, Human Factors, Simulation, Process Decomposition

1998 THESIS ABSTRACTS

COORDINATED INLAND AREA SEARCH AND RESCUE (SAR) PLANNING AND EXECUTION TOOL

**Timothy S. Castle-Lieutenant, United States Coast Guard
B.S., United States Coast Guard Academy, 1991**

Master of Science in Operations Research-September 1998

Advisors: Gordon Bradley, Department of Operations Research

Alan Washburn, Department of Operations Research

Second Reader: James Eagle, Undersea Warfare Academic Group

This thesis designs and implements the Coordinated Inland Area Search and Rescue (SAR) System (COINSS). This system provides several important features not provided by current inland SAR computer systems. First is the ability to model movement of the target. Second is modeling the effect terrain has on the movement of the target. Third is the visual presentation of a probability map, a color display showing the probability that the target is located at various geographic positions. COINSS is developed in the Java programming language. It is designed to be implemented with a map-based planning system using loosely coupled components. COINSS provides the initialization, movement, and search algorithms which are used by the planning system to support the search operation. The initialization algorithms define the search area where the SAR operation will occur. Initial areas are defined for the target. COINSS models the movement of the target as a discrete time Markov chain. Bayes theorem is used to update the probability map when negative search information is provided. This thesis will improve inland SAR operations by providing the first model with an interactive graphical user interface and a model of target movement.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Search and Rescue, Java, Loosely Coupled Components, Map Based Planning

MAP USAGE IN VIRTUAL ENVIRONMENTS

Helsin Cevik-Lieutenant Junior Grade, Turkish Navy

B.S., Turkish Naval Academy, 1992

Master of Science in Computer Science-September 1998

Advisors: Rudolph Darken, Department of Computer Science

John Falby, Department of Computer Science

Second Reader: Dylan Schmorow, Department of Operations Research

It is neither practical nor efficient to represent virtual maps as we do for paper maps in the real world due to major differences in hardware and software capabilities and requirements. Instead, the parameters can be determined that affect virtual map representation and that help to construct a mental map, and then manipulate these parameters in order to increase the effectiveness of map representation as an aid in performing navigation tasks.

The approach taken was first to determine and then investigate the parameters that affect virtual map representation through an experiment designed specifically for this thesis. The experiment examined users of an urban and open ocean virtual environment executing a set of navigation tasks with a virtual map with different orientation schemas.

The results of this study showed that, a forward-up map orientation is preferable to a north-up map orientation for egocentric tasks and a north-up map orientation is preferable to a forward-up map orientation for geocentric tasks. Under almost every possible condition, individuals with high spatial abilities will be able to use either a north-up map or a forward-up map better than individuals with low spatial abilities. Furthermore, it was found that these principles apply across types of environment with vastly different spatial characteristics, but sparse environments seem to exhibit less of a performance difference than dense environments.

DoD KEY TECHNOLOGY AREAS: Human Systems Interface, Modeling and Simulation

KEYWORDS: Virtual Environments, Wayfinding, Navigation, Virtual Maps, Spatial Visualization, Spatial Orientation, Cognitive Maps, Mental Rotation

1998 THESIS ABSTRACTS

MINIMIZING ARMY CADET TEMPORARY DUTY

Clay S. Chilson-Lieutenant, United States Navy

B.S., United States Naval Academy, 1992

Master of Science in Operations Research-March 1998

Advisor: Robert F. Dell, Department of Operation Research

Second Reader: LTC Charles H. Shaw, Department of Operations Research

Every newly-commissioned Army officer from a Reserve Officer Training Corps (ROTC) commissioning source joins one of 19 different basic branches (e.g., infantry, armor) and undergoes initial training to develop fundamental skills at an Officer Basic Course (OBC). Each basic branch has a separate training program and offers multiple OBC classes every year. The Army grants commissions to approximately 3,000 ROTC cadets annually and, under the current system, manually schedules each cadet to attend an OBC class. In addition, the Army schedules approximately 850 of these cadets to fill one of two temporary duty (TDY) assignments en route to their OBC class. This thesis develops a mixed integer linear program called Minimizing Cadet Temporary Duty (MCTDY) to reduce the time needed to schedule cadets and reduce the TDY costs as well as pay and allowances incurred by all second lieutenants prior to their OBC class. For 2,828 cadets receiving commissions in 1998, MCTDY produces face-valid, cost-effective results. Direct comparisons between MCTDY and manual schedules are not made but experiments with MCTDY indicate a difference in TDY costs of up to \$15 million is possible.

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: Personnel Scheduling, Army ROTC, Officer Basic Course, Mixed Integer Linear Programming

A COMPARISON OF THE FORCE DEPLOYMENT ESTIMATOR (FDE) AND NAVAL POSTGRADUATE SCHOOL / RAND MOBILITY OPTIMIZER (NRMO) AS TOOLS FOR MOBILITY ANALYSIS

Eric M. Damm-Major, United States Marine Corps

B.S., Pennsylvania State University, 1984

Master of Science in Operations Research-September 1998

Advisors: Richard E. Rosenthal, Department of Operations Research

Laura M. Williams, Department of Operations Research

Second Reader: Lt Col Kirk Yost, Department of Operations Research

Over the past decade, changes in the global power structure have driven the United States into a major reassessment of its force structure and global force projection requirements. There is a resulting need for force deployment models that offer quick, accurate analysis of force projection options and proposed force structure changes. One model, the Force Deployment Estimator (FDE), a combination discrete event simulation and goal program, is currently used by the J8, Warfighting Analysis Division (J8/WAD). A second model with similar capabilities, the Naval Postgraduate School/RAND Mobility Optimizer (NRMO), is a linear program that was written for the Air Force Studies and Analysis Agency. In order to compare the two models and give J8/WAD the option of a second model for use in analysis, NRMOAS (NRMO Air/Sea) was created by adding a sealift component to NRMO. NRMOAS creates both an air and sea network and can be run with the user designating the unit's mode of travel, the model determining the same or a combination of both. This thesis compares the results of several different scenarios run through FDE and NRMOAS. In all cases, NRMOAS out performed FDE in terms of timely delivery of personnel and cargo. Additionally, NRMOAS allows a far higher level of resolution in network structure. The recommendation is that NRMOAS be used by J8/WAD for detailed mobility analysis. Also recommended are changes to FDE.

DoD KEY TECHNOLOGY AREAS: Modeling and Simulation, Other (Optimization)

KEYWORDS: Mobility, Optimization, Force Deployment

1998 THESIS ABSTRACTS

SUBMARINE PERISCOPE DEPTH COURSE SELECTION TACTICAL DECISION AID

D.J. Danko-Lieutenant, United States Navy

B.S.E., University of Washington, 1990

Master of Science in Operations Research-December 1997

Advisor: Alan R. Washburn, Department of Operations Research

Second Reader: James N. Eagle, Undersea Warfare Academic Group

Coming to periscope depth is one of the most intensive of the routine submarine operations. Errors in fire control and sonar system information serve to produce uncertain contact solutions that complicate the decision of selecting a safe course. The model developed in this thesis simulates a specified number of trials on each possible course, with the measure of effectiveness for each course being the probability of the course being acceptable with respect to specified minimum range criteria. The model outputs a geographic display and a graph of the measures of effectiveness versus course.

KEYWORDS: Submarine Periscope Depth Operations, Course Selection, Tactical Decision Aid, Simulations Using Visual Basic Programming

DoD KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles-Ships and Watercraft Ground Vehicles

THE ARSENAL SHIP CONCEPT: VULNERABILITIES TO SPECIAL OPERATIONS

Christian A. Dunbar-Lieutenant, United States Navy

B.S., University of Notre Dame, 1993

Master of Science in Defense Analysis-June 1998

and

Dino Pietrantonio-Lieutenant, United States Navy

B.S., United States Naval Academy, 1991

Master of Science in Defense Analysis-December 1997

Advisor: Wayne P. Hughes Jr., Department of Operations Research

Second Reader: Gordon H. McCormick, Special Operations/Low Intensity Conflict Curriculum Committee

The United States Navy has solicited proposals for a revolutionary class of ship, the Arsenal Ship. Despite reduced funding for the project, the concept is still viable for future development. We show how the development of a new unparalleled weapon system or platform will evoke a response by potential adversaries, based on capabilities and asset investment, by unconventional means. The Arsenal Ship is a target across the spectrum of conflict. This thesis will describe threats that are usually overlooked and examine the Arsenal Ship's vulnerability to them. In addition, we will show how these vulnerabilities arise as the Arsenal Ship operates through the range of geographic areas. Further, this thesis describes possible strategic and tactical defensive actions to enable the Arsenal Ship to counter these unconventional threats. Each recommended action has a direct implication upon the engineered design and the proposed Concept of Operations (CONOP). In addition, the recommendations will influence the strategy for employing any further platform based on the Arsenal Ship concept, anywhere in the world

DoD KEY TECHNOLOGY AREAS: Battlespace Environments, Command, and Control Communications, Conventional Weapons, Surface/Under Surface Vehicles-Ships and Watercraft

KEYWORDS: Arsenal Ship, ARSHIP, Maritime Special Operations, and Special Operations, Combat Swimmer, VBSS, Visit Board Search and Seize, Unconventional Warfare

1998 THESIS ABSTRACTS

SOPITE SYNDROME IN OPERATIONAL FLIGHT TRAINING
David E. Flaherty-Lieutenant Commander, United States Naval Reserve
B.S., Massachusetts Maritime Academy, 1985
Master of Science in Operations Research-September 1998
Advisors: CDR John K. Schmidt, School of Aviation Safety
Robert R. Read, Department of Operations Research
Second Reader: Samuel E. Buttrey, Department of Operations Research

Sopite Syndrome is a poorly understood response to motion characterized by drowsiness, fatigue, sleep disturbances, and mood changes. It is distinct from “regular” motion sickness or common fatigue, and may affect the performance of motor vehicle as well as aircraft operators. The potential impact Sopite Syndrome may have on military aviation is relatively unknown. Recently, research in situations relevant to aviation training and flight operations has been initiated. The present study is part of that effort. Its goal is to determine the incidence, severity, and association of Sopite Syndrome characteristics in a population of Student Naval Flight Officers (SNFOs). Seventy-eight SNFOs assigned to Training Squadrons Four and Ten located at the Naval Air Station Pensacola, Florida completed a questionnaire designed to capture evidence/incidence of fatigue, motion sickness, drowsiness, and sleep disturbances during days when SNFOs flew versus non-flying days.

The questionnaire data was coded/tabulated for entry on a spreadsheet for subsequent analysis. Descriptive and non-parametric statistical techniques were used to analyze the data set obtained. The results show sufficient evidence between the levels of symptomology and their relationships when comparing conditions that support the existence of Sopite Syndrome in operational flight training.

DoD KEY TECHNOLOGY AREA: Other (Human Factors)

KEYWORDS: Sopite Syndrome, Motion Sickness

**THE EFFECTS OF SOPITE SYNDROME ON SELF-PACED
AIRSICKNESS DESENSITIZATION PROGRAM**
Michelle A. Flaherty-Lieutenant, United States Navy
B.S., Auburn University, 1988
M.A., National University, 1994
Master of Science in Operations Research-September 1998
Advisors: CDR John K. Schmidt, School of Aviation Safety
Robert R. Read, Department of Operations Research
Second Reader: Samuel E. Buttrey, Department of Operations Research

The U.S. Navy implemented the Self-Paced Airsickness Desensitization (SPAD) program in 1989 for aviation students whose incidence of airsickness was not easily resolved. Some participants may have also experienced symptoms that are not typically recognized as motion sickness, including prolonged drowsiness and/or mood changes. These effects are part of a poorly understood response to motion termed “Sopite Syndrome.” This thesis explores the effects of Sopite Syndrome on student aviators diagnosed with motion sickness. Sixty SPAD program participants completed a survey comprised of scales, which estimate motion sickness, drowsiness, fatigue, and sleep disturbances during SPAD treatment days. Results indicate: (1) symptoms consistent of Sopite Syndrome were reported by 45% of the participants and (2) the presence of Sopite Syndrome in a SPAD participant was not an accurate predictor for successful treatment and return to flight status.

DoD KEY TECHNOLOGY AREA: Other (Human Factors)

KEYWORDS: Sopite Syndrome, Motion Sickness, Airsickness, Airsickness Rehabilitation Programs

1998 THESIS ABSTRACTS

NAVAL SPECIAL WARFARE LOGISTIC PLANNING SYSTEM

Michael F. Giancatarino-Commander, United States Navy

B.S., United States Naval Academy, 1981

M.S., Boston University, 1994

Master of Science in Operations Research-September 1998

Advisor: David A. Schrady, Department of Operations Research

Second Reader: LTC Charles H. Shaw, Department of Operations Research

In today's world, small-scale contingencies and operations-other-than-war have replaced major theater war as the driving United States (U.S.) military scenario and account for approximately 80% of operational tempo. Special Operations Forces play the key role in these limited actions. Similarly, the number of possible locations and levels of conflict have also increased. With the drawdown of permanent U.S. military bases throughout the world, the resulting reduction in logistic support has evolved as a major problem. Logistic support of naval special operations forces has not kept pace with this changing environment. An accurate and timely logistic planning aid is needed to assist in mission planning. Such a planning aid must utilize logistic planning factors for all classes of supply derived from conventional military sources, as well as, naval special warfare sources. These logistic planning factors are the input for the subsequent EXCEL, spreadsheet program designed to serve as a stand-alone, logistic requirement planning aid. This program can be used by naval special warfare staff, joint staff, and other mission planners to quickly calculate logistic supply and service requirements for a multitude of naval special warfare missions, area of operations, and threats.

DoD KEY TECHNOLOGY AREA: Other (Logistics)

KEYWORDS: Naval Special Warfare Forces, Logistic Planning Factors, Logistic Planning Requirements

SPATIAL KNOWLEDGE ACQUISITION AND TRANSFER FROM VIRTUAL TO NATURAL ENVIRONMENTS FOR DISMOUNTED LAND NAVIGATION

Simon R. Goerger-Captain, United States Army

B.S., United States Military Academy, 1988

Master of Science in Computer Science-September 1998

Advisors: Rudolph Darken, Department of Computer Science

Dylan Schmorow, Department of Operations Research

Navigation and terrain familiarity are critical for mission success in the military. Virtual environments (VEs) have often been suggested as a useful tool in addressing these issues. This thesis research addresses the utility of VEs to improve spatial knowledge of and navigation performance through natural terrain compared to traditional methods. In this experiment, fifteen subjects were assigned to one of three training conditions. The map group studied the environment using only an orienteering map. The real world group studied the environment using the map and explored the actual terrain. The VE group studied the terrain using both the map and a real-time VE. Measures were taken of both route and configuration knowledge. The results suggest four conclusions. First, training conditions have no statistically significant effect on an individual's ability to obtain and demonstrate spatial knowledge of a natural environment. Second, spatial ability plays a significant role in navigation performance. Third, exposure to the actual terrain or to a virtual representation of the terrain seems to eliminate ambiguities in an individual's mental map by providing dynamic imagery to clarify propositional knowledge gained from maps. However, this factor has not been shown to improve performance by the measures used here. Fourth, a high resolution 1:5,000 orienteering map provides extensive detail and consequently, navigation performance in this experiment is not likely to be indicative of performance using a conventional 1:24,000 map.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Spatial Knowledge, Virtual Environments, Navigation, Orienteering, Geographic Information Systems, Terrain Visualization, Modeling and Simulation

1998 THESIS ABSTRACTS

**PATRIOT PAC-3 MULTI-FUNCTION SIMULATION ANALYSIS:
A TIME SERIES APPROACH TO A DETERMINISTIC MODEL (U)**

**Omar F. Gutierrez-Captain, United States Army
B.S., United States Military Academy, 1989**

Master of Science in Operations Research-September 1998

Advisor: George Conner, Department of Operations Research

Second Reader: Samuel Parry, Department of Operations Research

Defenses against tactical ballistic missile attacks are a primary national security need. The last line of defense against missiles in terminal phase is the next-generation PATRIOT (PAC-3) air defense system. A PAC-3 radar simulation called Multi-function Simulation (MFSIM) is undergoing the Army Verification, Validation and Accreditation Process. This model builds on a previous Patriot simulation.

This thesis identified unusual model behavior in MFSIM. Missile intercept altitudes did not occur as expected under stressful scenarios. One possible cause, radar dwell times under stress, was found not to be the source of the unusual behavior.

DoD KEY TECHNOLOGY AREAS: Conventional Weapons, Modeling and Simulation

KEYWORDS: MFSIM, PATRIOT, PAC-3, Tactical Ballistic Missile, TBM, Ballistic Missile Defense Organization, BMDO, Theater Missile Defense, TMD

**MODELING SEA-BASED SUSTAINMENT OF MARINE EXPEDITIONARY UNIT (SPECIAL OPERATIONS
CAPABLE) (MEU(SOC)) OPERATIONS ASHORE**

**Robert M. Hagan-Captain, United States Marine Corps
B.S., United States Naval Academy, 1989**

Master of Science in Operations Research-September 1998

Advisor: David A. Schrady, Department of Operations Research

Second Reader: Ronald L. Brown, Department of Operations Research

The Marine Corps has embraced the concepts of Operational Maneuver From The Sea (OMFTS) and Ship-to-Objective Maneuver (STOM) as the next progression in the evolution of amphibious warfare. These related concepts envision harnessing emerging technologies to allow the projection of naval power ashore faster and from greater distances than in the past. Additionally, both concepts identify the ability to conduct sea-based logistics (SBL) as a key requirement for successful implementation. Sea-based logistics involves executing a wide range of logistical functions from a sea-base rather than from sites traditionally established ashore. Acknowledged enhancements are required to realize a complete SBL capability; however, the ability to provide some measure of sea-based sustainment exists today. This thesis models the sea-based sustainment of Marine Expeditionary Unit (Special Operations Capable) (MEU(SOC)) forces deployed from Amphibious Ready Group (ARG) ships. Missions are developed for analysis; each is coupled with an appropriate force package of personnel and equipment density. Sustainment requirements and available transportation capacities are then determined and compared for each mission. This comparison along with several excursions provides insight into the nature of sea-based sustainment feasibility. It also gauges potential limitations for sea-based sustainment.

DoD KEY TECHNOLOGY AREA: Other (Logistics)

KEYWORDS: Sustainment, Operational Maneuver From The Sea (OMFTS), Ship-to-Objective Maneuver (STOM), Sea-Based Logistics, Sea-Based Sustainment

1998 THESIS ABSTRACTS

PATIENT SATISFACTION: A VISUAL ANALYSIS USING TRELLIS GRAPHICS

Tonya A. Hall-Lieutenant, United States Navy

B.S., West Virginia State College, 1991

M.S., Public Administration, 1994

Master of Science in Operations Research-September 1998

Advisor: Samuel E. Buttrey, Department of Operations Research

Second Reader: James Scaramozzino, Institute for Defense Education and Analysis

During times of peace, health care is one of the foremost quality of life issues to active duty members, their families and retirees. Patient satisfaction surveys are used to determine how patients perceive salient aspects of their medical care. There has been substantial anecdotal evidence to suggest that patients are unhappy with their care, but past analysis of the DoD Annual Surveys using simple frequencies of responses indicated that, overall, patients were satisfied. This thesis, using a powerful new technique called Trellis Graphics that allows more than three variables to be visualized simultaneously, has uncovered startling results that go beyond previous analysis, provide evidence to support the anecdotal claims, and show that overall satisfaction is not a reliable measurement for determining patient satisfaction. The seven factors defined by the National Committee on Quality Assurance are each individually, and together as a group, more reliable measures. The inability to choose a provider was clearly rated by every beneficiary group as the single greatest source of dissatisfaction. There are also differences in satisfaction between the sexes, and among the different groups. Active duty members, who are the primary customers of military treatment facilities, are the most dissatisfied, and women tend to be less happy than men.

DoD KEY TECHNOLOGY AREA: Other (Health Care, Statistics)

KEYWORDS: Patient Satisfaction, Military Health Care, Survey, Trellis Graphics

SURFACE SHIP SENSOR EMPLOYMENT AGAINST DIESEL SUBMARINES

Matthew Jordan Harrison-Lieutenant, United States Navy

B.S., United States Naval Academy, 1992

Master of Science in Operations Research-March 1998

Advisors: Wayne P. Hughes, Department of Operations Research

Don Brutzman, Undersea Warfare Academic Group

Second Reader: RADM John J. Ekelund Jr., USN (Ret)

This thesis provides tactical guidance for employment of surface ship sensors against torpedo-armed diesel submarines during littoral operations. Advantageous utilization of antisubmarine sensor systems in the littoral environment incorporates a blend of competent tactical experience and innovative thought processes and reflects environmental conditions, threat status, and mission priorities. Through extensive use of a modeling and simulation program, this thesis determines the preferred sensor employment configurations based on surface ship and submarine detection and counter-detection ranges and vulnerabilities to torpedo attack. Preference is based on a measure of effectiveness that minimizes the risk faced by surface ships from a diesel submarine threat, and provides tactical recommendations that are readily implementable as sensor employment policies.

DoD KEY TECHNOLOGY AREA: Electronic Warfare, Sensors, Surface/Under Surface Vehicles – Ships and Watercraft, Modeling and Simulation

KEYWORDS: Antisubmarine Tactics, Simulation, Sensor Employment, Antisubmarine Warfare

1998 THESIS ABSTRACTS

A SIMULATION ANALYSIS OF A SUPPRESSION OF ENEMY AIR DEFENSE (SEAD) OPERATION

**Nils K. Haugen-Lieutenant Commander, Royal Norwegian Navy
Master of Science in Operations Research-September 1998**

**Advisors: Donald P. Gaver, Department of Operations Research
Patricia A. Jacobs, Department of Operations Research**

Second Reader: Arnold H. Buss, Department of Operations Research

Traditional SEAD operations rely on Wild Weasel aircraft equipped with Anti-Radiation missiles. This combination of real-time target acquisition capability with high precision weaponry has rendered surface-based radar systems vulnerable and ineffective. As a result, SEAD operations are decoupled from the slow and error-prone intelligence gathering and evaluation process proceeding conventional air-to-ground targeting. However, new technology allows modern air defense systems to combine increased mobility with a minimal use of radar, reducing the number of targets available to Wild Weasel aircraft. Consequently, more of the operational load is shifted over to conventional air-to-ground assets, making the SEAD operation more sensitive to the typical error and delay sources in the conventional targeting process.

This thesis uses a low-resolution simulation model to evaluate the impact of information delay on a SEAD operation. The results show that the effectiveness of a SEAD operation is sensitive to information delay, but not to the anticipated degree. Not surprisingly, the dominating variable for the success of the SEAD operation is the number of allocated SEAD aircraft. Next, but an order of magnitude less influential, is the delay in the SEAD intelligence cycle. Finally, the frequency of movement of the air defense units seems to play a minor role.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Suppression of Enemy Air Defense, Intelligence Cycle, Simulation

AN AGENT-BASED APPROACH TO ANALYZING INFORMATION AND COORDINATION IN COMBAT

**Richard B. Hencke-Lieutenant, United States Navy
B.S., California State Polytechnic University, Pomona, 1990
Master of Science in Systems Engineering-September 1998**

**Advisors: Donald P. Gaver, Department of Operations Research
Carl R. Jones, Information Systems Academic Group**

The quality and quantity of information flows is a critical factor in the command and control of forces in battle. Many current simulations do not adequately show the interactive effects of information on the battlefield. Agent-based simulation is a promising technique that can provide insight into these effects.

The purpose of this thesis is to develop an agent-based simulation to analyze the relationship between information and command structure. (SinBaD) Simulation of Information in Battlefield Decisions is the agent-based simulation developed specifically for this thesis. Although SInBad is only an abstract model of combat, it is believed that this approach can provide much insight into the mechanisms that affect the effectiveness of information in battle.

Several combat scenarios are simulated using different control rules. These simulations suggest that there exists scenarios where information is essential to mission success and some cases where its role is less instrumental or even detrimental. Other insights generated from this research suggest that agent-based simulation may help define metrics useful in aiding decision-makers during the planning and execution of a large and complex campaign.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Agent-Based Simulation, Complexity Theory, Complex Adaptive Systems

1998 THESIS ABSTRACTS

FIRST TERM ATTRITION OF FUNDAMENTAL APPLIED SKILLS TRAINING (FAST) STUDENTS

Jeffrey W. Hickox-Lieutenant, United States Navy

B.S., United States Naval Academy, 1990

Master of Science in Operations Research-March 1998

Advisor: Samuel E. Buttrey, Department of Operations Research

Second Reader: Robert R. Read, Department of Operations Research

Fundamental Applied Skills Training (FAST) provides assistance to recruits with literacy skills deficiencies that could prevent them from successfully completing the recruit training cycle at Recruit Training Command, Great Lakes, Illinois. Short-term success of the program is known, but the long-term effects of this training are not known. In response to a Navy Training Requirements Review action item, this thesis examined the first term attrition of FAST students from Fiscal years 1993 and 1994 at yearly intervals. Analysis determined that FAST students have significantly lower attrition rate throughout the first term and a significantly higher reenlistment rate for a second term than sailors of similar abilities. Attrition of FAST students was similar to that of sailors of the upper mental group during the first term. The thesis includes a general overview of FAST research and a concise history of FAST development.

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: FAST, Attrition, Naval Training, Navy Personnel, Skills

AN ANALYTICAL APPROACH TO OPTIMAL AIMING FOR THE ARMY TACTICAL MISSILE SYSTEM

Joseph S. Horab-Captain, United States Army

B.S., State University of New York at Buffalo, 1989

Master of Science in Operations Research-June 1998

Advisor: Alan R. Washburn, Department of Operations Research

Second Reader: LTC Charles H. Shaw, III, Department of Operations Research

After Desert Storm the Army Tactical Missile System's (ATACMS) range was increased from 165km to 300km. The increase in range was gained by reducing the total number of submunitions. To offset the loss of effectiveness, a global positioning system was added to the guidance unit to increase accuracy of the missile.

Further increases to the missile's effectiveness can be gained by optimizing the aimpoints at which the missile is fired. This can be accomplished by using an analytical function that predicts the probability of kill based on several parameters that are dependent on the type of target and missile. This function, through the use of a model such as the OpAimer model developed in this thesis, can then assure at least a locally optimal solution for the aimpoints. The parameters of the model include the target's location error, the accuracy of the missile and the shape of the distribution of a missile's bomblets about its center of impact.

Optimization methods such as the OpAimer model must become part of the current fire direction systems. Their inclusion will ensure that the ATACMS missile is used effectively and limited assets are not unnecessarily wasted.

DoD KEY TECHNOLOGY AREA: Conventional Weapons, Computing and Software

KEYWORDS: Army Tactical Missile System, ATACMS, Optimal Aiming

1998 THESIS ABSTRACTS

ANALYSES OF WEIGHT, BODY-FAT, AND PHYSICAL FITNESS TESTING STANDARDS, FOR ACTIVE DUTY MALE MARINES, WITH PROPOSED ALTERNATIVES

**William J. Inserra-Major, United States Marine Corps
B.S., University of Arizona, 1986**

Master of Science in Operations Research-September 1998

Advisors: Harold J. Larson, Department of Operations Research

LtCol Timothy L. Phillips, United States Marine Corps Representative

Second Reader: William K. Krebs, Department of Operations Research

The Marine Corps utilizes a three-event Physical Fitness Test (PFT) comprised of a 3-mile run, sit-ups, and pull-ups to assess the level of physical fitness of individual Marines. This thesis uses newly collected data from the Marine Corps to analyze the current weight and body-fat standards and compare them with proposed alternatives. The research investigates whether the current standards can be slightly relaxed without resulting in significant decreases in physical fitness performance. Additionally, this thesis investigates the validity of pull-ups as an indicator of muscular strength and endurance. The analysis compares the performance scores for two types of pull-ups (the dead-hang and kip methods) with other physical performance events which require upper body strength and muscular endurance. The thesis also presents proposed scoring alternatives for the pull-up event based on an analytical comparison of performance distributions for the run and sit-up events, in order to level the equality for all three PFT events. Additionally, a new 3-profile PFT alternative comprised of aerobic, muscular, and body composition profiles is presented as an improved measure of assessing the physical fitness of individual Marines.

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: Weight, Body-Fat, Physical Fitness Test, Pull-ups, Physical Fitness, Weight Control Program, Height-Weight Tables, Physical Performance, Muscular Strength, Muscular Endurance, Percent Body-Fat, Maximum Weight Limits, Percent Body-Fat Limits, Upper-Body Strength, Body Composition, Modified Pull-ups

MINIMIZING DRUG RELATED ATTRITION COSTS FOR INCOMING NAVAL RECRUITS

John J. Jacklich-Lieutenant, United States Navy

B.S., Mechanical Engineering, University of Washington, 1991

Master of Science in Operations Research-March 1998

Advisor: Samuel Buttrey, Department of Operations Research

Second Reader: Richard E. Rosenthal, Department of Operations Research

This thesis investigates alternative strategies for enforcing the Navy's zero-tolerance drug use policy among Navy recruits. Current policy relies mainly on the gas chromatography/mass spectrometry (GC/MS) urinalysis for recruits when they arrive at boot camp. GC/MS, a laboratory test, takes at least three days for confirmation. The cost of separating recruits who fail urinalysis or admit to drug use at boot camp is \$2.7 million per year.

Key ideas investigated in the thesis are the administration of drug tests at Military Entrance Processing Stations (MEPS) on the day of shipping to boot camp, and the use of a new "non-instrumented" drug test (NIDT). The NIDT, though not as accurate as GC/MS, requires no laboratory equipment or expertise to administer and furnishes results immediately.

This thesis designs and recommends a new policy which includes NIDT testing for marijuana at the MEPS in addition to GC/MS at RTC. Through the use of detailed statistical, cost and sensitivity analyses, the thesis concludes that the Navy can save well over a \$1 million per year by instituting this policy. These results have been reported to RADM Kevin Green, Commander of NTC, Great Lakes, who has announced his intention to adopt the new policy.

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: Recruit, Drug Testing, Attrition, Optimization, Policy, RTC Separation Costs

1998 THESIS ABSTRACTS

SIMULATING AN ISOCHRONAL SCHEDULED INSPECTION SYSTEM FOR THE P-3 ORION

**Jeffrey A. Jones-Lieutenant, United States Navy
B.S., Wichita State University, 1990**

Master of Science in Operations Research-September 1998

Advisor: George W. Conner, Department of Operations Research

Second Reader: Arnold H. Buss, Department of Operations Research

The purpose of this thesis is to explore potential challenges facing the implementation of an Isochronal Scheduled Inspection System (ISIS) for the United States Navy's P-3 Orion. Implementation of ISIS, which is based solely upon calendar time, has been proposed to replace the present system of scheduled inspections that are based upon both calendar time and flight hours. The United States Customs Service and the Royal Netherlands Navy have successfully fielded the ISIS program and demonstrated that the concept works when implemented on a small scale. It is not known, however, how well the program might work when applied to a larger organization. This thesis obtains insights into potential troubles arising from implementation of the ISIS program by building and analyzing a simulation model. The model's output includes the number of times aircraft induction dates are rescheduled, and the number of days that scheduled aircraft induction dates are changed by. The analysis provides a measure with which to gauge the difficulty of implementing the ISIS program in the U.S. Navy.

DoD KEY TECHNOLOGY AREAS: Air Vehicles, Modeling and Simulation

KEYWORDS: Aviation, Scheduled Maintenance, Simulation, Java, Isochronal

TWO NEW NEAREST NEIGHBOR CLASSIFICATION RULES

Ciril Karo-Major, Australian Army

**B.Sc., University College Australian Defence Force Academy,
University of New South Wales, 1989**

Master of Science in Operations Research-September 1998

Advisor: Samuel E. Buttrey, Department of Operations Research

Second Reader: Harold J. Larson, Department of Operations Research

Nearest-Neighbor (NN) classification is a non-parametric discrimination and classification technique. In NN classification a test item is compared by some similarity measure of its multiple variables (usually a distance metric) with all the items in a training set. The class of the item to which it is most similar can be used as an indication of the class of the test item. In other words, the test item is assigned the class of its nearest neighbor. A key extension is the case when $k > 1$ nearest neighbors (k -NN) are examined with the classification usually being made based on a plurality. NN classification is used in many fields, including for example the field of Pattern Recognition. Applications include tasks like speech recognition by a computer, medical data interpretation and diagnosis, or the interpretation of remote sensing imagery from satellites. Military applications of the technique include any situation where automated recognition is required.

This thesis proposes two new NN rules that are intended to improve classification accuracy. The rules are tested against baseline classification methods in common use with a variety of data sets. One method shows improvement over the baseline methods in most of the data cases examined.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Sensors, Other (Statistics)

KEYWORDS: Nearest Neighbor Classification, Discrimination, Pattern Recognition

1998 THESIS ABSTRACTS

A COMPARISON OF AN ALTERNATIVE INVENTORY CONTROL CONCEPT WITH THE NAVY'S EXISTING WHOLESALE INVENTORY CONTROL PROCEDURES FOR REPAIRABLES

David R. Kless-Lieutenant Commander, United States Navy

B.S., United States Naval Academy, 1987

Master of Science in Operations Research-September 1998

Advisor: Kevin J. Maher, Department of Operations Research

Second Reader: Patricia A. Jacobs, Department of Operations Research

The Director of Planning and Operations Research Department, Naval Inventory Control Point (NAVICP) Code M041, requested a study to compare the performance of two sets of inventory control procedures for managing high-cost repairable items. One of these sets is embedded in the Navy's existing wholesale inventory control system. The procedures of this set characterize a periodic review process, which calculates four decision variables in order to manage Navy inventories. These variables represent how much to order, how much to repair, when to order, and when to repair. The other set of procedures are adapted from a commercial software package called Bandwidth Management developed by Stewart-Frazier Tools Inc. Two versions of these latter procedures are modeled in this thesis. These procedures characterize a periodic review process, which calculates three decision variables. These variables represent how much to deliver, how much to repair, and when to repair. This thesis uses simulation to model the two sets of procedures and to compare their performance with respect to three formal measures of effectiveness adopted by NAVICP: Supply Material Availability (SMA), Average Delay for a Delayed Requisition (ADDR), and Average Monthly Investment Level (AMIL). The comparison results of the thesis indicate that the existing Navy inventory procedures generate better performance in all three formal measures of effectiveness.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Navy Repairable Items, Inventory Models

A COMPARISON OF ANALYSIS IN DISTRIBUTED INTERACTIVE SIMULATION AND HIGH LEVEL ARCHITECTURE

Steven D. Knight-Captain, United States Army

B.S., United States Military Academy, 1988

Master of Science in Operations Research-June 1998

Advisor: Arnold H. Buss, Department of Operations Research

Second Reader: MAJ William S. Murphy, Jr., TRADOC Analysis Command-Monterey

As the Department of Defense (DoD) continually relies more on Modeling and Simulation (M&S) for testing, analyzing, and training, issues of interoperability have become one of the most important concerns. As such, DoD adopted the Distributed Interactive Simulation (DIS) protocol in 1991. Although successful in many aspects, DIS is limited by available information from models, memory and network requirements, and analytical tools available. Therefore, in 1996 the Defense Modeling and Simulation Office (DMSO) released the High Level Architecture (HLA), an object-oriented approach to interoperability.

This thesis compares these different approaches to analysis to determine functionality in terms of gathering, processing, and reporting on analytical questions in both environments. To compare DIS and HLA analysis, three simulation runs were conducted: Janus vs. Janus in DIS, HLA without an Analysis Federate, and HLA with an Analysis Federate. The Analysis Federate is an HLA-compliant software package that gathers and processes information for analysis requirements. The results of the three simulation runs and subsequent analysis demonstrated the techniques and approaches for each infrastructure. The resulting comparison between them show HLA with the Analysis Federate is the easiest and most functional tool.

The Analysis Federate fills an analysis void currently in HLA and by implementing it with the study question model tree methodology, an analyst will be more effective and be able to provide real-time feedback.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Analysis Federate, Distributed Interactive Simulation (DIS), High Level Architecture (HLA), Federation Object Model (FOM), Simulation Object Model (SOM), Janus, Gateway, Study Question Model Tree, Federation, Run-Time Infrastructure (RTI), Protocol Data Unit (PDU), PDU Adapter Software System (PASS)

**ANALYSIS OF NAVY DELAYED ENTRY PROGRAM AND
RECRUIT TRAINING CENTER ATTRITION**

Bryant W. Knox-Lieutenant, United States Navy

B.A., Davidson College, 1985

M.S., Boston University, 1998

Master of Science in Operations Research-June 1998

Advisor: Samuel E. Buttrey, Department of Operations Research

Attrition from the Navy's Delayed Entry Program (DEP) and attrition from Bootcamp are costly phenomena. The Commander of Naval Recruiting (CNRC) and Center for Naval Analysis (CNA) have periodically modeled both DEP and Bootcamp attrition with logistic regression. This thesis analyzes current data provided by CNRC and CNA. Both DEP and Bootcamp attrition are modeled using logistic regression and tree-structured classification. For DEP, the logistic model indicates that individuals who accept incentives prior to enlistment (i.e., Navy College Fund or Enlisted Bonus Program) and individuals who change enlistment programs (while in DEP) have a significantly lower propensity to attrite from DEP than others. The DEP tree model indicates that an individual with a low Armed Forces Qualification Test (AFQT) score, no high school diploma and a long scheduled DEP duration has a 97% probability of attriting. For Bootcamp, the logistic model indicates that individuals who use tobacco products, individuals who do not exercise, and individuals that have criminal waivers have a significantly higher propensity to attrite than others. The Bootcamp tree model shows that smokers and individuals with low AFQT scores have higher propensities to attrite than others. The models are tested using random partitions and this analysis shows that all of the models predict poorly at the individual level, despite strong statistical significance.

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: Attrition, DEP, Bootcamp, Logistic Regression, Tree-structured Classification, AFQT

OPTIMIZING SELECTION OF TOMAHAWK CRUISE MISSILES

Scott D. Kuykendall-Lieutenant, United States Navy

B.S., United States Naval Academy, 1992

Master of Science in Operations Research-March, 1998

Advisor Richard E. Rosenthal, Department of Operations Research

Second Reader: George W. Conner, Department of Operations Research

The Tomahawk Land Attack Cruise Missile (TLAM), launched from surface ships and submarines, has become the weapon of choice for the United States in many situations. In an era of high-precision, fast-delivery weapons, the method currently used for assigning TLAM engagements is out of step with the development of the weapons themselves. Missile assignment today is manual, with the potential consequences of inefficient missile-to-mission matching and unnecessary delay.

This thesis develops a new optimizing approach to missile-to-mission matching, using integer programming. In a matter of seconds for a single ship or a matter of minutes for a battle group, the optimization model determines which missile to select for each tasking order and provides back-up assignments if requested. The objective of the model is to ensure the correct weapon is applied against each target while maximizing the potential of the firing unit(s) to perform future taskings.

The new missile-to-mission matching model is better than current methods and performs robustly in extensive sensitivity analyses. The optimization model is currently being considered for shipboard implementation by the Naval Surface

1998 THESIS ABSTRACTS

Warfare Center. At the very least, the model can be used to independently assess the performance of any new missile-to-mission matching decision support considered by the Navy.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Conventional Weapons

KEYWORDS: Tomahawk Land Attack Cruise Missiles (TLAM), Vertical Launch System (VLS), Missile Selection, Missile-to-Mission Matching (M3)

HUMAN FACTORS ANALYSIS OF UNITED STATES NAVY AFLOAT MISHAPS

Rex D. Lacy-Lieutenant Commander, United States Navy

B.S., Georgia Institute of Technology, 1982

M.S., Central Michigan University, 1988

Master of Science in Operations Research-September 1998

Advisor: Samuel E. Buttrey, Department of Operations Research

Second Reader: CDR John K. Schmidt, School of Aviation Safety

The effects of maritime mishaps, which include loss of life as well as environmental and economic considerations, are significant. It has been estimated that over 80 percent of maritime accidents are at least partially attributable to human error. Human error has been extensively studied in a number of fields, particularly aviation. The present research involves application of the Human Factors Accident Classification System (HFACS), developed by the Naval Safety Center, to human error causal factors identified in selected investigation reports of significant mishaps occurring on U.S. Navy afloat and diving units from 1992 to 1996. An evaluation of the reliability of the classification system was performed by measuring the level of agreement between two independent raters' application of the system to mishap analysis. Descriptive statistics and categorical data analysis were performed and meaningful insights were revealed regarding the types of human error that were associated with afloat naval mishaps. Comments and recommendations regarding implementation of the classification system for use in maritime accident analysis are provided.

DoD KEY TECHNOLOGY AREA: Other (Accident Analysis)

KEYWORDS: Maritime Mishaps, Accident Analysis, Human Factors, Human Error

ARMY SPECIAL OPERATIONS LOGISTICS PLANNING AID

Timothy S. Lanquist-Lieutenant Junior Grade, United States Navy

B.S., United States Naval Academy, 1995

Master of Science in Operations Research-September 1998

Advisor: LTC Charles H. Shaw, III, Department of Operations Research

Second Reader: David A. Schrad, Department of Operations Research

Given the clandestine nature of Special Operations Forces' (SOF) missions and the inability to adequately predict possible contingency scenarios, it is imperative that SOF logistics support be flexible and responsive. Currently, SOF logistics support is inequitable across Service lines, of limited joint flexibility, and has no single point of contact for logistics planning, coordination, and command and control resulting in inconsistent support for SOF operations. The possible implementation of a Joint Special Operations Logistics Command (JSOLOGCOM) has the potential to greatly improve support to SOF using all existing resources and is consistent with logistics concepts espoused in Joint Vision 2010 and SOF Vision 2020. The first step in evaluating the JSOLOGCOM concept for feasibility is a determination of logistical requirements for SOF units' missions. This thesis provides SOF logistics planners with generic planning factors for all classes of supply and specific planning factors for Class V, Ammunition, and Class VIII, Medical. It outlines a methodology that can be used to determine mission specific planning factors for any class of supply as well as field services. This thesis has also provided SOF logistics planners with a computer based, user-friendly, and flexible logistics planning aid that can be used to create more accurate logistics estimates than they have been able to in the past.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREA: Other (Logistics)

KEYWORDS: Logistics, Special Operations Forces, Army, Planning Factors

**COMPARISON OF PROFICIENCY OBJECTIVES, PERFORMANCE
OBJECTIVES, AND SUCCESS AT FOLLOW-ON TRAINING**

Johnna M. Marchant-Lieutenant, Unites States Navy

B.S., Portland State University, 1986

Master of Science in Operations Research-September 1998

Advisor: Samuel E. Buttrey, Department of Operations Research

Second Reader: John Thain, Department of Evaluation and Research, Defense Language Institute

The Defense Language Institute Foreign Language Center (DLIFLC) trains students in over 21 foreign languages for the Department of Defense (DoD). The National Security Agency (NSA) and Defense Intelligence Agency (DIA) are responsible for setting the training objectives for students entering professional fields in intelligence.

In the past, general proficiency in listening, reading, and speaking skills has been the focus of language learning and testing in the DoD. Certain minimum scores on the Defense Language Proficiency Test (DLPT) are required for certain training and operational positions within the DoD. DoD has not established applicable performance objective scores for training and operational positions. Individual service commanders at DLIFLC may exercise some discretion in borderline cases where general minimum DLPT requirements have not been met. They may take into account performance objective scores and grant waivers for attending Goodfellow Air Force Base (GAFB) follow-on training.

The purpose of this study is to determine how the performance objective scores relate to success on the DLPT and how the combination of DLPT and performance objective tests might possibly relate to success on follow-on training at GAFB. Success at GAFB is defined by on-time graduation, number of required special-assistance hours, and performance on "block" tests.

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: DLPT, Performance Objective

**AN ANALYSIS OF THE IMPACT OF MILITARY EXPORT OFFSETS
ON THE UNITED STATES INDUSTRIAL BASE**

David G. McCord-Captain, United States Marine Corps

B.S., United States Naval Academy, 1989

Master of Science in Management-September 1998

Advisors: Thomas H. Hoivik, Department of Operations Research

Sandra M. Desbrow, Department of Systems Management

The purpose of this thesis is to determine what effect the growth of offsets, as a condition of sale of military articles, has had on the U.S. defense industrial base. These effects are measured by assessing how this trade practice has impacted the employment, trade, and competitiveness of the U.S. defense industry. Additionally, the present U.S. Government policy towards offsets is explained. Analytical data taken from both Office of Management and Budget and Department of Commerce reports are presented and analyzed. Interviews with large and small- to medium-sized business spokesmen, in addition to Department of Commerce experts, are presented to augment the quantitative results. Different levels of U.S. Government oversight are explained as well as their advantages and disadvantages. The macroeconomic effects of offsets on the U.S. defense industry are inconclusive. However, offsets do seem to impact the U.S. defense industry adversely at the subcontractor level when specific industrial sectors are analyzed. Large defense contractors view offsets as a necessary marketing tool in order to maintain global competition. Most small- to medium-sized contractors do not support the use of offsets, claiming that they export jobs and work orders overseas, eroding the defense industrial base at the subcontractor level.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREA: Other (Defense Industrial Base)

KEYWORDS: Defense Contractors, Offsets, Defense Industrial Base, Defense Industry

**ANALYSIS OF PREDICTIVE FACTORS FOR
FULLY MISSION CAPABLE RATES OF DEPLOYED AIRCRAFT**

Patricia B. Moore-Lieutenant Commander, United States Navy

B.A., State University of New York, Binghamton, 1982

Master of Science in Operations Research-September 1998

Advisor: Samuel E. Buttrey, Department of Operations Research

Second Reader: Lyn R. Whitaker, Department of Operations Research

As the U.S. military reduces its forces, the ability to maintain an acceptable level of readiness is of concern to the U.S. Navy. Both personnel and equipment readiness and the ability to predict them have been the focus of much attention. Fully Mission Capable (FMC) rates measure the percentage of time that aircraft are fully able to meet mission requirements. FMC rates have been determined to be the best single measure of equipment condition, providing an indication of aircraft readiness. This thesis evaluates the capabilities of logistic regression and regression trees in predicting aircraft readiness for a specific carrier deployment or aircraft type/model/series (TMS). The data are taken from observations of squadrons by aircraft TMS by month from 1981 through 1997. Empirical results indicate that logistic regression and regression trees provide forecasting results with standard errors of prediction better than taking the mean and standard deviation of the historical data.

DoD KEY TECHNOLOGY AREA: (Other) Aircraft Readiness

KEYWORDS: Aircraft Readiness, Fully Mission Capable Rates, Logistic Support, Logistic Regression, Regression Trees

**BATTLE GROUP ORDNANCE AND FUEL LOGISTIC TASK MEASURES OF
PERFORMANCE FOR THE UNIVERSAL NAVAL TASK LIST**

Gary L. Morris-Lieutenant, United States Navy

B.S., United States Naval Academy, 1992

Master of Science in Operations Research-September 1998

Advisors: George Conner, Department of Operations Research

Kevin J. Maher, Department of Operations Research

Second Reader: Alan R. Washburn, Department of Operations Research

A set of well-defined and quantifiably justified Measures of Performance (MOPs) is required for the armament and fuel tasks of a Carrier Battle Group (CVBG) as described in the Universal Naval Task List (UNTL). These MOPs are incorporated in the CVBG's training plan and provide the BGCDR a method to evaluate the CVBG's level of ability to perform the necessary tasks. This thesis proposes 37 MOPs and the methodology to subjectively evaluate the MOPs to determine which ones are well defined, and objectively evaluate them to determine how well they collectively measure task performance. The proposed MOPs are derived from the task descriptions and objectives found in the UNTL. They are subjectively scrutinized using the twelve criteria required by the UNTL and objectively evaluated using correlation analysis. A simulation is developed for each task to provide the data for the objective analysis. The results indicate that 23 of the 37 proposed MOP's meet the required criteria of being well defined and useful in measuring task performance. Based upon the developed methodology, it is recommended that the Naval Doctrine Command consider the 23 MOPs for inclusion into its revised UNTL.

DoD KEY TECHNOLOGY AREAS: Other (Measures of Performance)

KEYWORDS: Carrier Battle Group, Measures of Performance, Measures of Effectiveness, Ordnance, and Fuel

1998 THESIS ABSTRACTS

A TASK ANALYSIS OF UNDERWAY REPLENISHMENT FOR VIRTUAL ENVIRONMENT SHIP-HANDLING SIMULATOR SCENARIO DEVELOPMENT

**Steven D. Norris-Lieutenant, United States Navy
B.S., Norwich University, 1992**

Master of Science in Computer Science-September 1998

Advisors: Rudolph P. Darken, Department of Computer Science

John S. Falby, Department of Computer Science

Second Reader: Dylan Schmorow, Department of Operations Research

While developing a Virtual Reality (VR) Ship-handling simulator for the Surface Warfare Officer School (SWOS) in Newport, RI, researchers at the Naval Air Warfare Center Training Systems Division (NAWCTSD) in Orlando, FL discovered a need for a task analysis of a Conning Officer during an Underway Replenishment (UNREP). The purpose of this task analysis was to document the tasks the Conning Officer performs and cues used to accomplish these tasks. The task analysis would ensure that the correct tasks and cues would be modeled in the VR UNREP scenario.

The approach taken was to survey cognitive task analysis models to find a notation that would document the tasks performed by a bridge team during an UNREP. The Goals, Operators, Methods, Selection Rules (GOMS) model was selected. A GOMS-like model was used to represent the sequential aspects of the UNREP task, while a table was developed to capture the parallelism of the tasks. The UNREP task analysis was then reviewed by qualified Surface Warfare Officers to validate its accuracy.

The result of this effort was a validated task analysis model of a Conning Officer during an UNREP. This model was provided to NAWCTSD in support of their future efforts in the development of a VR UNREP Ship-handling simulator scenario.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Human Systems Interface, Manpower, Personnel and Training, Modeling and Simulation

KEYWORDS: Ship-handling, Virtual Reality, Task Analysis, Virtual Environment, Surface Warfare, Computer Simulation, Underway Replenishment, Computer Graphics

CLASSIFYING PUBLIC SWITCH TELEPHONE NETWORK (PSTN) SWITCHING STATIONS: A NATIONAL SECURITY AGENCY APPLICATION

**Allen S. Olson-Major, United States Marine Corps
B.S., University of Minnesota, 1982**

Master of Science in Operations Research-September 1998

Advisors: R. Kevin Wood, Department of Operations Research

Norman D. Curet, National Security Agency

Second Reader: Gerald G. Brown, Department of Operations Research

The U.S. National Security Agency wishes to predict the routing of messages over various communications networks. Before routing predictions can be made in a public switch telephone network (PSTN), the hierarchical level of the network's switching stations must be known. This thesis develops an integer linear programming model for accomplishing this classification. In this model, a PSTN is represented as a graph in which switching stations are nodes and the logical connections between the switching stations are arcs. Algebraic constraints represent the engineering standards common to PSTNs. The model also incorporates probabilistic inferences about the class of switching stations to improve classification accuracy for networks not following typical PSTN structural practices. Preprocessing routines that analyze the network's topology and employ various heuristics to reduce the size of the problem are evaluated. The sample PSTNs are solved using IBM's Optimization Subroutine Library solver on a 166 MHz desktop model is implemented in Generic Algebraic Modeling System Development Corporation's GAMS and personal computer. Accurate classification solutions are obtained in under two seconds for actual PSTNs, while extremely large notional networks of over 300 nodes and 900 arcs are solved in under two minutes.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREAS: Command, Control, and Communications, Modeling and Simulation

KEYWORDS: Hierarchical PSTN, Integer Program, Linear Programming, Telecommunications

ANALYZING SENSOR-SHOOTER LINKS THROUGH SIMULATION

Keith E. Olson-Captain, United States Army

B.S., United States Military Academy, 1988

Master of Science in Operations Research-June 1998

Advisor: LTC Charles H. Shaw, III, Department of Operations Research

Second Reader: Samuel H. Parry, Department of Operations Research

Today's military is changing. We are changing the size and structure of our forces, reevaluating our missions, and looking at military applications of new and emerging technologies. Simulation will play a key role in aiding decision-makers during these changes. This thesis demonstrates the development and use of simple, single-purpose simulation models. These models answer specific questions and can be created quickly with readily available tools. The simulation developed in this thesis is designed to serve as a basis for further studies involving the Longbow Apache. This simulation is a stochastic, process-oriented, event-step model.

To demonstrate the use of this model, a comparative analysis was performed to evaluate two field artillery "call-for-fire" procedures. Is a proposed call-for-fire procedure based on new digital technologies superior to the current process? The experiment incorporated a pre/post-process design resulting in paired observations of the artillery's effectiveness before and after incorporation of the new technology.

Results indicate the proposed procedure is superior to the current procedure. Sensitivity analysis was also performed on two input parameters as a three-by-three factorial experiment. This analysis concluded the previous results were sensitive to the specific parameter values chosen. Recommendations are made for model improvement and topics for future study.

DoD KEY TECHNOLOGY AREAS: Modeling and Simulation, Command, Control, and Communications, Conventional Weapons

KEYWORDS: Digitization, Information Superiority, Dominant Battlespace Awareness

ALLOCATING FLIGHT HOURS TO ARMY HELICOPTERS

Bradley W. Pippin-Captain, United States Army

B.S., United States Military Academy, 1988

Master of Science in Operations Research-June 1998

Advisor: Robert F. Dell, Department of Operations Research

Second Reader: Thomas Halwachs, Department of Operations Research

Army helicopter battalions, consisting of 24 helicopters valued from \$206.4 million (1311-60 Blackhawk battalion) to \$432 million (ALH-64 Apache battalion), allocate flight hours to helicopters using manual techniques that have caused an unnecessary decrease in battalion deployability. This thesis models the battalion's flight hour allocation problem using optimization; it develops both a mixed integer linear program and a quadratic program. The 2nd Battalion, 4th Aviation Regiment of 4th Mechanized Division, currently uses a spreadsheet implementation of the quadratic program developed by the author called QFHAM (Quadratic Flight Hour Allocation Model), that is available to other battalions for use with existing software and computer resources. The mixed integer linear program, called FHAM (Flight Hour Allocation Model) more appropriately models the problem, but requires additional software. This thesis validates the two models using actual flight hour data from a UH-60 battalion under both typical training and contingency scenarios. The models provide a monthly flight hour allocation for the battalion's aircraft that results in a steady-state sequencing of aircraft into phase maintenance, thus eliminating phase maintenance backlog and providing a fixed number of aircraft available for deployment. This thesis also addresses the negative impact of current helicopter battalion readiness measures on deployment and offers alternatives.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREA: Air Vehicles

KEYWORDS: Helicopter, Flight Hour Allocation, Phase Maintenance

ANALYSIS OF MID-GRADE NAVAL AVIATOR RETENTION

Scott H. Poindexter-Major, United States Marine Corps

B.S., United States Naval Academy, 1984

Master of Science in Operations Research-September 1998

Advisors: William Krebs, Department of Operations Research

Samuel Buttrey, Department of Operations Research

Second Reader: CDR John K. Schmidt, School of Aviation Safety

Attrition of aviators is of major concern to the Navy because of the costs and numbers involved. The Navy currently forecasts aviator retention and attrition by extrapolating historical trends. This thesis recommends that the Navy replace the current method with two alternative statistical techniques: *logistic regression* and *classification trees*. They are recommended for two reasons. First, the proposed techniques make significantly more accurate forecasts of aviator retention than the current method. Second, the proposed techniques, unlike the current method, can identify the significant variables affecting aviator retention. Use of the proposed techniques can therefore lead to the formulation of better aviator retention policies by the Navy. These arguments are demonstrated with a case study of an existing retention database. The variables identified as most significant for aviator retention in this analysis were the geographic location of an aviator's duty station, assignment to non-flying billets, and grade. Policy implications of these findings are discussed.

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: Retention, Employee Turnover, Naval Aviation, Manpower, Logistic Regression, Classification Trees

**A FORCED ENTRY PLANNING MODULE FOR AMPHIBIOUS AIR ASSAULTS FOR THE JOINT
WARFARE ANALYSIS EXPERIMENTAL PROTOTYPE**

George D. Pointon-Major, United States Marine Corps

B.S., United States Naval Academy, 1986

Master of Science in Operations Research-March 1998

Advisors: Samuel H. Parry, Department of Operations Research

Mark Youngren, Department of Operations Research

The most difficult challenge in modeling and simulating modern warfare is the attempt to address every possible scenario, operating plan, and tactic. One such model is the Joint Warfare Analysis Experimental Prototype (JWAEP) being developed at the Naval Postgraduate School. A scenario in which JWAEP needs further development is littoral warfare, which for the Marine Corps represents amphibious assault operations. An aspect of this type of warfare is referred to as "forced entry" when friendly ports are not available in the region of interest. Forced entry occurs by air, sea, or a combination of air and sea. Although these missions are very complex, mission planning is similar for each mode of transport. This thesis introduces the Forced Entry Planning Module (FEPM), a tactical decision planning aid, and offers a test of the conceptual amphibious air assault portion of FEPM using the most current United States Marine Corps amphibious air assault doctrine.

The concept was tested by constructing a stand-alone model, using deterministic combat attrition, to evaluate three potential methods for choosing a route to an amphibious air assault objective under uncertainty. The results indicated that each of the proposed methods predicted mission outcome under uncertainty with varying degrees of success. This limited testing has validated the concept of FEPM and the proposed methods. However, further refinement and testing is required before a final determination of which method is "best" for evaluating routes for forced entry missions is made.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: Forced Entry Planning Mode (FEPM), Joint Warfare Analysis Experimental Prototype (JWAEP), Wargaming, Simulation, Uncertainty, Stochastic Modeling

**AN OBJECT-ORIENTED DISCRETE-EVENT SIMULATION OF LOGISTICS
(MODELING FOCUSED LOGISTICS)**

John L. Ruck-Lieutenant Commander, United States Navy

B.S.E., Tulane University, 1982

M.S., Central Michigan University, 1995

Master of Science in Operations Research-September 1998

Advisor: Arnold H. Buss, Department of Operations Research

Second Reader: Gordon Bradley, Department of Operations Research

Joint Vision 2010 puts forth four operational concepts describing how U.S. forces will conduct combat in the future. One of these concepts is Focused Logistics, which Joint Vision 2010 defines as “the precise application of logistics.” In order to study the effects of Focused Logistics, a flexible method of simulating possible logistics systems is needed. The Flexible Experimental Logistics Simulator (FLEXLOGS) is an object-oriented, discrete-event simulation that is designed to be used to evaluate proposed future logistics strategies. First, the author develops a model capable of simulating any proposed logistics scheme with minimal modification to the software. Second, the thesis discusses the design and use of the model.

Finally, the model is used to explore the shape of curves defined by the probability of combat victory verses “logistical footprint size” and “premium transportation availability.” The model implements the draft Logistical Conceptual Object Model being developed as part of the *Focused Logistics Study* by the Office of the Secretary of Defense, Program Analysis and Evaluation, Simulation Analysis Center.

DoD KEY TECHNOLOGY AREAS: Modeling and Simulation, Other (Logistics)

KEYWORDS: Focused Logistics, FLEXLOGS, Discrete-Event Simulation

**A BENCHMARK USABILITY STUDY OF THE TACTICAL DECISION-MAKING
UNDER STRESS DECISION SUPPORT SYSTEM**

Dylan D. Schmorow-Lieutenant, United States Navy

B.S., Western Michigan University, 1989

Ph.D., Western Michigan University, 1993

Master of Science in Modeling, Virtual Environments, and Simulation-September 1998

Advisor: Rudolph Darken, Department of Computer Science

Second Reader: George Conner, Department of Operations Research

This study evaluates the usability of a U.S. Navy Decision Support System (DSS). The DSS was developed to enhance the performance of tactical decision-makers within a Navy Combat Information Center. The goals of this study were to test the DSS against usability criteria and objectives to track future redesign efforts and system improvements. The purpose of this analysis was to: (1) assess the system’s usability, (2) identify problems areas in the graphical user interface, (3) report trends in user feedback, and (4) provide recommendations addressing major usability issues encountered by participants. The study tested whether the DSS met the usability objectives of: (a) 90% successful task completion, (b) ease-of-use ratings of somewhat easy or better, and (c) satisfaction ratings of somewhat satisfied or better. The DSS did not meet these usability objectives for task completion or ease-of-use; however, the DSS did meet the usability objective for user satisfaction. All participants reported that they enjoyed working with the DSS and believed that it would be a significant step forward in information management. Based on the usability data gathered in the study, recommendations are provided to address the usability issues.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREA: Human Systems Interface

KEYWORDS: Usability, Human Factors, Human Computer Interaction, Synthetic Environments, Decision Support

DYNAMIC PLATFORM INDEPENDENT META-ALGORITHMS FOR GRAPH-PARTITIONING

Victor Scott Schwartz-Lieutenant, United States Navy

B.S., University of Nebraska, 1992

Master of Science in Operations Research, September 1998

Advisor: Gordon H. Bradley, Department of Operations Research

Second Reader: R. Kevin Wood, Department of Operations Research

A dynamic platform-independent solver is developed for use with network and graph algorithms of operations research. This solver allows analysts to solve a large variety of problems without writing code. Algorithms from a library can be integrated into a meta-algorithm which also provides easy monitoring of solution progress.

The solver, DORS, is demonstrated by heuristically solving a graphpartitioning problem to minimize the number of nodes adjacent to other segments of the partition. The model arises from a network-upgrade project faced by the Defense Information Systems Agency (DISA), a problem with over 200 nodes and 1400 arcs. Solutions are provided on a 266 MHz Pentium H PC using Windows NT 4.0. Eight variants of the problem are solved involving modification to the objective function, constraints on the size of partition segments, and on the number of those segments.

DORS (and the meta-algorithm it implements) appears to find a good solution for one of the two problem formulations for DISA, but has difficulty solving the other. Because the solver allows new algorithms to be easily added to create more powerful meta-algorithms. DORS should provide a good solution approach for both problem formulations given a more versatile library of algorithms.

DoD KEY TECHNOLOGY AREAS: Computing and Software, Modeling and Simulation

KEYWORDS: Graph Partitioning, Java

COST ANALYSIS OF INTER-DEPOT TRANSPORTATION OPTIONS FOR U.S. NAVY EAST COAST AIR-LAUNCHED MISSILES

Charles L. Sellers-Lieutenant, United States Navy

B.S., Virginia Polytechnic Institute and State University, 1990

Master of Science in Operations Research-September 1998

Advisor: David G. Brown, Department of Systems Management

Second Reader: Kevin J. Maher, Department of Operations Research

Since the disintegration of the Warsaw Pact and the Soviet Union, the Department of Navy has had to learn how to meet its commitments with an ever-decreasing budget. One Navy community addressing this downsizing is the east coast ordnance community. Because of restructuring and the closure of Weapon Station Charleston, South Carolina, the remaining east coast weapon stations are handling the same amount of ordnance with fewer personnel. As a result of the restructuring, the aircraft carriers, ordnance ships, and large deck amphibious ships conduct ordnance transfers at Naval Weapon Station (NWS) Earle, New Jersey. These ships all carry air-launched missiles that have to be maintained at Naval Weapons Station Yorktown. This thesis develops cost equations associated with several different methods of transportation (commercial and Department of Defense). These equations are being used to generate cost curves for each of four types of missiles being transported between NWS Earle and NWS Yorktown. The curves are analyzed, and decision policies are determined which ensure the most cost-effective method of transportation is being used to transport the missiles.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREA: Conventional Weapons

KEYWORDS: U.S. Navy Ordnance, Ordnance Logistics, Decision Support, Transportation, Cost Analysis

**DEVELOPMENT OF A TEST MECHANISM FOR ANALYZING FORCE ATTRITION
METHODOLOGIES WITHIN AGGREGATED COMBAT SIMULATIONS**

Michael L. Shenk-Captain, United States Army

B.S., Clarion University of Pennsylvania, 1988

Master of Science in Applied Mathematics-June 1998

Advisors: Bard K. Mansager, Department of Mathematics

James G. Taylor, Department of Operations Research

For aggregated combat simulation models, the methods for calculating force attrition must be based upon sound mathematical formulations and parameter estimations. With an inherent lack of representative combat data for modern warfare scenarios, one effective method for determining the required parameter estimates is to thoroughly analyze the output from a stochastically based high-resolution combat model. It is this development of attrition parameters process, which so profoundly influences the validity of aggregated simulations, that lacks any comprehensive documentation or mathematical justification within the modeling community. By examining the development and validity of these processes for parameter estimation, valid attrition calibration formulae can be determined and used within force attrition algorithms in order to more precisely and justifiably model aggregated combat operations. The establishment of a user-friendly test bed for examining this attrition rate development process will play a major role in solidifying the understanding, implementation, and validation of current and future process techniques.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Combat Modeling, JANUS, Simulation, Attrition, ATCAL

**OPTIMAL RECRUITING STRATEGY TO MINIMIZE U.S. NAVY
DELAYED ENTRY PROGRAM (DEP) ATTRITION**

Paul G. Simpson-Lieutenant, United States Navy

B.S., United States Naval Academy, 1988

Master of Science in Operations Research-December 1997

Advisor: Richard E. Rosenthal, Department of Operations Research

Second Reader: Harold Larson, Department of Operations Research

This thesis develops an optimization-based model to assist the Navy Recruiting Command in placing nuclear power field recruits in the Delayed Entry Program (DEP). After signing enlistment contracts, individuals are enrolled in the DEP prior to entering recruit training. During DEP, some individuals may renege on their contracts, thus becoming DEP losses. Although DEP is costly, it is a necessary and important inventory management tool since it provides a pool of recruits to meet future accession goals.

The DEP placement problem is formulated as a nonlinear program that minimizes relative recruiting costs weighted with respect to the desired recruit category. The lowest recruiting costs are assigned to recruits in DEP lengths that ensure the lowest probability of becoming a DEP loss. Increased costs are assigned to direct shippers. A large penalty cost is assigned to monthly accession deficits. Integral to the model are estimates of DEP loss probability for the various combinations of recruit categories and DEP lengths.

This research concludes that the annual new contract objective (NCO) does not support the successful attainment of the accession goal. Furthermore, a NCO increase of 20% is required to achieve the accession goal with a 95% confidence level. Finally, the thesis addresses the accession goal confidence levels associated with incremental increases of the NCO.

1998 THESIS ABSTRACTS

KEYWORDS: Optimization Modeling, Nonlinear Programming, Delayed Entry Program (DEP), Military Recruiting

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

COMPANY TEAM SURVIVABILITY AT THE U.S. ARMY NATIONAL TRAINING CENTER

Steven A. Stoddard-Captain, United States Army

B.S., United States Military Academy, 1988

Master of Science in Operations Research-June 1998

Advisor: Harold J. Larson, Department of Operations Research

Second Reader: Samuel H. Parry, Department of Operations Research

This research answers the following questions about training exercises at the Army's National Training Center (NTC) at Fort Irwin, California: "Which company team was the most survivable in the task force?" and "What did that company team do differently to become the most survivable?" The research examines data collected over four month-long brigade training exercises at the NTC, including analysis of 88 company team battles. The measure of effectiveness (MOE) is the average system survival time for each company team for each battle. The company team that achieves the highest MOE score for a battle is considered the most survivable company team. The MOE is scaled for comparisons over the course of many battles. The MOE is then used as the dependent variable for a series of separate analyses of the data, which answer the second question. These analyses use a collection of 20 independent variables and six research questions to differentiate between more and less survivable company teams. The conclusions are that company teams whose leadership survives longer, who have a higher proportion of tanks, and who perform security operations better are more survivable. The research further recommends that the NTC's data collection efforts be automated and standardized among the collection teams.

DoD KEY TECHNOLOGY AREAS: Ground Vehicles, Manpower, Personnel, and Training

KEYWORDS: National Training Center (NTC), Company Team, Survivability

OPERATIONAL ANALYSIS OF THE SUSTAINABILITY OF A MOBILE MILITARY PLATFORM

James G. Stoneman-Lieutenant, United States Navy

B.S., United States Naval Academy, 1990

Master of Science in Operations Research-September 1998

Advisors: Donald P. Gaver, Department of Operations Research

Patricia A. Jacobs, Department of Operations Research

Second Reader: Ronald L. Brown, Department of Operations Research

This thesis illustrates the use of simulation techniques to evaluate the satisfaction of suitability requirements for a mobile platform carrying payload (for example, an Unmanned Aerial Vehicle with sensors) on a military mission (surveillance or reconnaissance). The Institute for Defense Analyses, in support of Director, Operational Test & Evaluation (DOT&E), recently developed a simulation to assist in the analysis of the Predator Unmanned Aerial Vehicle. That simulation has been extended to make it more applicable to a variety of platforms, and the extended simulation has been incorporated into the Military Aircraft Sustainability Simulation (MASS). The primary output from the simulation is an estimate of Effective Time On Station (ETOS), as that depends on platform subsystem reliability and the maintenance resources allocated. ETOS is the long-run percentage of time that the region under surveillance is being covered by at least one operating platform. An analytical model for a single platform also has been developed to augment and assist in verifying the MASS. This thesis shows that MASS can be an invaluable tool for evaluating a platform's suitability for a mission. The simulation can assist during the acquisition process, when the government must decide whether to buy a platform, and the simulation can assist in determining the most effective way to deploy such platforms once they are in use.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREAS: Air Vehicles, Human Systems Interface, Sensors, Ground Vehicles, Modeling and Simulation

KEYWORDS: Reliability, Sustainability, Unmanned Aerial Vehicle

**JOB SATISFACTION AMONG UNITED STATES NAVY AND MARINE CORPS
AVIATION OFFICERS—A STUDY OF THE IMPACT ON CAREER RETENTION**

Daniel J. Sullivan-Major, United States Marine Corps

B.S.I.E., Georgia Institute of Technology, 1985

Master of Science in Operations Research-September 1998

Advisors: William Krebs, Department of Operations Research

Samuel E. Buttrey, Department of Operations Research

Second Reader: CDR John K. Schmidt, School of Aviation Safety

United States Naval Aviation Officer retention has been identified by senior-level personnel managers as one of the largest challenges faced by the services in recent years. In robust economic times all branches of the armed forces face the challenge of retaining sufficient highly-trained volunteers. The aviation community is disproportionately affected due to the long lead time associated with aviation officer training and the potential for long-term lucrative civilian job opportunities compared with existing military pay and benefits. This study documents the development of a retention survey aimed to quantify Naval aviation officer attitudes towards job satisfaction and turnover intent. Previous research has indicated that measurements of job satisfaction are the most reliable predictor of one's intent to remain with an existing employer. To best understand this relationship, CART and logistic regression models are proposed to predict Naval aviation officer retention. These models were developed using a principal components analysis of survey data elements. Work satisfaction and age were analyzed in terms of their impact as moderators of the relationship between job satisfaction and retention. Work satisfaction factors were found to be significant in models that predicted turnover intent half again better than if one was to merely provide a sample estimate.

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: Job Satisfaction, Aviation Officers, U.S. Navy and Marine Corps, Retention, Principal Components Analysis, Regression Analysis

**HELICOPTER TERRAIN NAVIGATION TRAINING USING A WIDE
FIELD OF VIEW DESKTOP VIRTUAL ENVIRONMENT**

Joseph A. Sullivan-Lieutenant Commander, United States Navy

B.S., Catholic University of America, 1986

Master of Science in Computer Science-September 1998

Advisor: Rudolph P. Darken, Department of Computer Science

Second Reader: Dylan Schmorrow, Department of Operations Research

Helicopter terrain navigation is a unique task; training for this task presents unique challenges. Current training methods rely on dated technology and inadequately prepare pilots for real-world missions. Improved training specifically tailored to address the unique needs of the helicopter community that capitalizes on recent improvements in desktop virtual environment (VE) technology could substantially improve the training process and reduce training costs.

Based on the input of subject matter experts in current helicopter terrain navigation training techniques and VE technology, such a system was developed and tested on student pilots performing real-world tasks. A desktop VE that presented a simple to control and learn, interactive fly-through of a terrain model was used to augment conventional training at Helicopter Antisubmarine Squadron TEN (HS-10).

Results indicate that flight time for students that received VE training was more productive than for students that received conventional training. This work justifies the next logical step: fielding a system on a long-term basis as a squad-

1998 THESIS ABSTRACTS

ron asset. This system would provide improved training for the helicopter community and an invaluable source of research data for the Naval Postgraduate School.

DoD KEY TECHNOLOGY AREAS: Modeling and Simulation, Other (Training)

KEYWORDS: Virtual Environments, Terrain Association, Navigation, Training, Mission Rehearsal, Helicopters

A MONTHLY SORTIE SCHEDULING MODEL FOR IMPROVED EA-6B PROWLER COMBAT READINESS

Scott H. Swords-Lieutenant, United States Navy

B.S., Texas A&M University, 1990

Master of Science in Operations Research-March 1998

Advisor: John F. Raffensperger, National Research Council Post-Doctoral Associate

Second Reader: George W. Conner, Department of Operations Research

EA-6B Prowler crews conduct a variety of missions and are required to fly and train with sufficient regularity to maintain combat proficiency. These crews maintain this proficiency by completing regularly scheduled training qualifications. Squadrons determine their readiness level based on the percentage completion of these qualifications. Squadrons currently use an *ad hoc* method for scheduling training. This thesis develops a mixed integer program to plan monthly sorties, as a decision aid for squadron operations officers. The goal is to maximize squadron combat readiness by minimizing the number of aviators not fully combat-ready, subject to the number of flights available. The model is programmed in the GAMS language and uses a spreadsheet interface for both input and output. It is typically solved in 10 minutes on a Pentium 120 MHz PC with the OSL solver. The output is a matrix of pilots to flight assignments and aircrew to flight and seat assignments. This approach immediately yields a 10% improvement in average monthly readiness as compared to the *ad hoc* method and should be implemented as a methodology for scheduling monthly sorties.

DoD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: COMNAVAIRPACINST 3500.67C, EA-6B Prowler, Readiness, Scheduling, Training

OPTIMIZING UNITED STATES MARINE CORPS ENLISTED ASSIGNMENTS

Brian F. Tivnan-Captain, United States Marine Corps

B.S.M.E., University of Vermont, 1992

Master of Science in Operations Research-September 1998

Advisor: Robert F. Dell, Department of Operations Research

Second Reader: Hemant K. Bhargava, Information Systems Academic Group

The United States Marine Corps (USMC) has 156,000 active duty enlisted Marines and annually orders over 90,000 of them to permanently change station. The Commandant of the Marine Corps requires assignments of the “Right Marine, to the right place with the right skills and quality of life.” USMC manpower planning uses staffing goals (billet requirements) to capture the Commandant’s requirements, but, surprisingly, does not monitor how many Marines fill appropriate staffing goal billets. This thesis finds that although the staffing goals are completely achievable, only 45% of active duty Marines fill a staffing goal billet and 47% of staffing goal billets are under-staffed. The USMC has used the Enlisted Assignment Model (EAM) since the 1970s to help enlisted monitors determine assignments. EAM has several shortcomings. Among these, enlisted monitors reject most of EAM suggested assignments and EAM offers no measure of effectiveness to gauge the quality of its assignments. This thesis presents a network model, EAM-GLOBAL to optimize the by-name assignment of Marines to staffing goal billets. EAM-GLOBAL attempts to assign the “right Marines to the right places” while simultaneously balancing staffing shortages, allowing grade and military occupational specialty substitutions, and minimizing the costs of permanent change of station transfers within the continental United States.

1998 THESIS ABSTRACTS

DoD KEY TECHNOLOGY AREAS: Manpower, Personnel, and Training, Modeling and Simulation

KEYWORDS: Assignment Model, Staffing Goals, Manpower Models, Transportation Model, Network, Elastic Network Model

AIR FORCE SPECIAL OPERATIONS FORCES LOGISTICS PLANNING AID

Brett S. Wagner-Lieutenant, United States Navy

B.A., Texas Tech University, 1991

Master of Science in Operations Research-September 1998

Advisor: LTC Charles H. Shaw III, Department of Operations Research

Second Reader: David A. Schrady, Department of Operations Research

This thesis compiles and creates logistics planning factors (usage/consumption rates) for the United States Special Operations Command (USSOCOM) and Air Force Special Operations Forces (AFSOF). The primary goal of this thesis is to provide logistics planning factors to AFSOF logistics planners to aid in the planning and execution process. Incorporating operations research methods to develop these planning factors, certain classes of supply were analyzed according to the specific type of mission, threat, duration, area of operations, number of personnel involved, and time. This thesis includes a graphical, PC-based AFSOF Logistics Planning Aid (AFSOFLOGPLN) using these planning factors. Since planners require a flexible, reliable, and user-friendly system, the logistics planning aid is developed in Microsoft's Excel with a graphical user interface. This planning aid lets the user input different platforms and mission scenarios and then it computes the logistics requirements to support the AFSOF platform or unit for that mission. Finally, this thesis makes recommendations to the Air Force Special Operations Command logistics planners and USSOCOM that would further improve logistics support for their forces in the future.

DoD KEY TECHNOLOGY AREA: Other (Logistics)

KEYWORDS: Logistics Planning Factors, U.S.A.F. Special Operations Forces Units and Aircraft, AFSOFLOGPLN Aide

AN ANALYSIS OF AVIATION TEST SCORES TO CHARACTERIZE STUDENT NAVAL AVIATOR DISQUALIFICATION

Erich J. Wahl-Lieutenant, United States Navy

B.S., United States Naval Academy, 1988

Master of Science in Operations Research-March 1998

Advisor: Robert R. Read, Department of Operations Research

Second Reader: Samuel E. Buttrey, Department of Operations Research

The U.S. Navy uses the Aviation Selection Test Battery (ASTB) to identify those Student Naval Aviator (SNA) applicants most likely to succeed in flight training. Using classification and regression trees, this thesis concludes that individual answers to an ASTB subtest, the Biographical Inventory, are not good predictors of SNA primary flight grades. It also concludes that those SNA who score less than a six on the Pilot Biographical Inventory have a significantly higher disqualification rate in primary flight training than those SNA who score a six or higher. Those SNA who repeat the taking of the ASTB are more likely to disqualify from primary flight training than those SNA who pass it on the first attempt. Incidentally, significant differences exist in SNA performance and disqualification rates in Aviation Preflight Indoctrination among different racial groups. However, neither race nor gender is a significant factor in primary flight-training disqualification. Recommendations are provided to reduce the number of SNA entering the flight-training pipeline, if necessary, while significantly reducing the disqualification rate. Additionally, a method is given to identify those SNA most at risk of disqualifying from primary flight training.

DoD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

1998 THESIS ABSTRACTS

KEYWORDS: Attributes, Attrition, Cross-Validation, Disqualification, Partition, Tree

OPTIMAL USE OF GERMAN ARMY MAINTENANCE RESOURCES

Joerg Wellbrink-Captain, German Army

M.S.(E.E.), University of Federal Armed Forces, Munich, 1987

Master of Science in Operations Research-March 1998

Advisor: Robert F. Dell, Department of Operations Research

Second Reader: Gordon H. Bradley, Department of Operations Research

The German Army's maintenance branch, having lost 25 percent of its soldiers since the end of the Cold War, has insufficient military personnel within maintenance units to maintain all combat units' equipment. The Army, therefore, purchases civilian man-hours (mhrs) to satisfy some required maintenance. This thesis develops a mixed integer linear program, named ADOPT (administrative order optimizer), to optimally assign combat units' equipment to maintenance units and to predispose a budget to purchase civilian mhrs. ADOPT also determines beneficial cross-training of soldiers from one maintenance type to another. Since it is not always possible to maintain all combat units' equipment, ADOPT minimizes the gap, prioritized by equipment types, between needed maintenance mhrs and available military and civilian maintenance mhrs. ADOPT provides a tool to determine and evaluate options and principles that impact the readiness of a German Army Division's materiel. ADOPT validates its effectiveness with data of Military District VIII/ 14th Mechanized Infantry Division. Results indicate a potential budget saving of one-third when cross training of maintenance soldiers from one maintenance type to another is allowed. ADOPT also shows that the regional principle (assigning common combat units' equipment to the nearest maintenance units) is inefficient.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Assignment, Maintenance, Equipment, Mixed Linear Integer Programming

AN EXPLORATORY ANALYSIS OF CORRECTIVE MAINTENANCE

DURING EXTENDED SURFACE SHIP DEPLOYMENTS

G. Karl Werenskjold-Lieutenant, United States Navy

B.S., University of Colorado, 1990

Master of Science in Operations Research-September 1998

Advisor: Donald P. Gaver, Department of Operations Research

Second Reader: David A. Schrady, Department of Operations Research

The Chief of Naval Operations (CNO) Strategic Studies Group (SSG) XVI study of 1997 proposes to deploy ships for three year periods and rotate crews. This concept is called *Horizon*. An object-oriented, discrete-event simulation is written in Java to stimulate this extended deployment model and evaluate the corrective maintenance requirements for a single-ship deployment. The simulation estimates the mean on- and off-station times of the ship, the mean time between shore-based repair, and the mean operational availability of the ship. The simulation allows the user to perform sensitivity analysis on the input values to determine the significance of the results based upon the measures of the model. The results of this thesis show that the number of shore-base maintenance requirements is affected by inputs of the mean time-to-failure, logistics delay time, and percent of organic repair of the ship.

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Modeling, Simulation, Navy, Ship, Deployments, Failure, Maintenance

1998 THESIS ABSTRACTS

DEMONSTRATING THE REQUIREMENT FOR AMPHIBIOUS READY GROUP (ARG) REPLENISHMENT IN SEA-BASED LOGISTICS OPERATIONS

**Max A. Willey-Lieutenant, United States Navy
B.S., Old Dominion University, 1989**

Master of Science in Operations Research-December 1997

Advisor: David Schrady, Department of Operations Research

Second Reader: Arnold Buss, Department of Operations Research

Operational Maneuver From the Sea (OMFTS) is a new concept under development by the Marine Corps. OMFTS is a warfighting concept that revises the way combat power is projected in littoral regions in that it uses the sea as a maneuver space and safe haven for logistics, while further adopting *ship to objective* operations. Sea-Based Logistics (SBL) uses the Amphibious Ready Group (ARG) ships to provide a sea-base from which combat forces ashore are directly sustained. To function in this new capacity, the ARG units need replenishment to maintain high stockage levels of fuel, ammunition, and stores. This thesis develops a computer simulation for modeling the logistical support needed for ARG units functioning in a sea-base role for supporting combat forces ashore.

KEYWORD: Underway Replenishment (UNREP), Sea-Based (SBL), OMFTS, Amphibious Ready Group

DoD KEY TECHNOLOGY AREA: Modeling and Simulation

ANALYSIS OF AMPHIBIOUS SHIP LIFT CAPABILITY

Eric D. Williams-Lieutenant, United States Navy

B.A., University of Illinois, 1992

Master of Science in Operations Research-September 1998

Advisor: Samuel E. Buttrey, Department of Operations Research

Second Reader: Ronald L. Brown, Department of Operations Research

Amphibious ship lift is crucial in supporting operations of Marine Air Ground Task Forces (MAGTF) for a wide range of conflicts. This thesis examines three different aspects of amphibious ship lift capability. First, gross lift capabilities of all amphibious ships in the Navy today are determined. Since some storage space on board a ship is required for access, tie-downs, and other considerations, the second step of this thesis is to use historical load-out data from six-month deployments to derive expected net lift capability from gross lift capability. A three-ship Amphibious Ready Group (ARG) is traditionally required to support a six-month MAGTF deployment. The final part of this thesis utilizes a linear program to determine specific ship combinations that optimize ARG lift capability for both the Pacific and Atlantic Fleets.

DoD KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles-Ships and Watercraft

KEYWORDS: Amphibious Ship, Broken Stowage Factor, Amphibious Ready Group (ARG)

1998 THESIS ABSTRACTS

SOLUTION OF LARGE-SCALE ALLOCATION PROBLEMS WITH PARTIALLY OBSERVABLE OUTCOMES

Kirk A. Yost-Lieutenant Colonel, United States Air Force

B.S., United States Air Force Academy, 1980

M.S., Rensselaer Polytechnic Institute, 1986

Doctor of Philosophy in Operations Research-September 1998

Advisor: Alan R. Washburn, Department of Operations Research

Committee: Gerald G. Brown, Department of Operations Research

Robert F. Dell, Department of Operations Research

Guillermo Owen, Department of Mathematics

Craig M. Rasmussen, Department of Mathematics

Methods were developed for optimally solving problems that require allocating scarce resources among activities that either gather information on a set of objects or take actions to change their status. Also, the information gathered on the outcomes of the actions taken may be erroneous. The latter situation is called *partial observability*, and methodology available prior to this dissertation is combinatorially intractable for problems with more than one object. Two previously-uncombined methods were used—linear programming (LP) and partially observable Markov decision processes (POMDPs) – to construct a decomposition procedure to solve the resulting large-scale allocation problem with partially observable outcomes. Theoretically it was shown that this procedure is both optimal and finite; in addition, improvements were developed to the procedure that reduce runtimes on test problems by 95%. It was demonstrated that the procedure on a small targeting problem with a known analytical solution, as well as a large-scale military example concerned with allocating aircraft sorties, weapons, and bomb-damage assessment sensors to targets. Finally, analytical bounds were developed on the expected objective function values of a related allocation problem with more stringent resource constraints, and present a simulation-based approach to estimate the distributions of the outcomes for that model.

DoD KEY TECHNOLOGY AREAS: Air Vehicles, Command, Control, and Communications, Conventional Weapons, Sensors, Modeling and Simulation, Materials, Processes, and Structures

KEYWORDS: POMDP, MDP, Linear Programming, USAF, BDA, Sensor Modeling