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Monterey, California 93943-5138

SUMMARY OF RESEARCH 1995

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13. ABSTRACT (Maximum 200 words.)

This report contains 63 summaries of research projects in the Department of Systems Management which were carried out under funding of the Naval Postgraduate School Research Program. A list of recent publications is also included which consists of conference presentations and publications, books, contributions to books, published journal papers, and technical reports.

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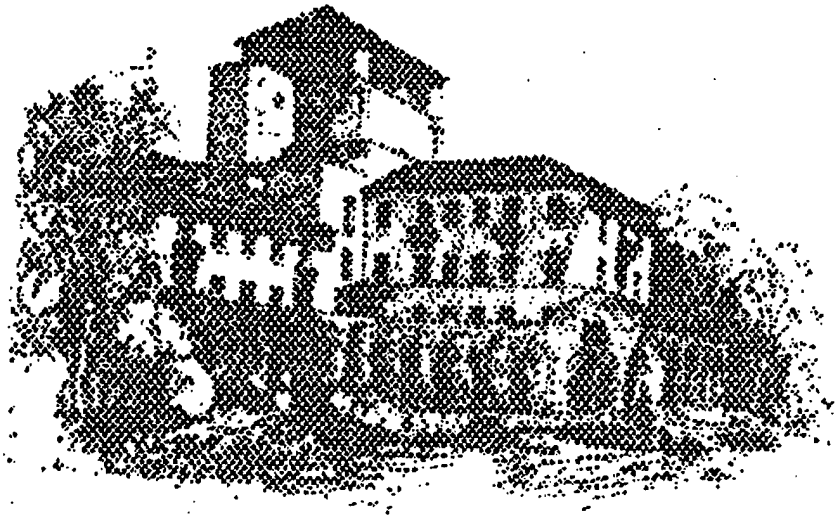
THE NAVAL POSTGRADUATE SCHOOL MISSION

The mission of the Naval Postgraduate School is to provide advanced professional studies at the graduate level for military officers and defense officials from all services and other nations. The School's focus is to increase the combat effectiveness of the armed forces of the United States by providing quality education which supports the unique needs of the defense establishment.



Introduction

Research is an integral part of graduate education. At the Naval Postgraduate School (NPS), the goals of research are to:

- Provide a meaningful, high quality, capstone learning experience for our students.
- Keep faculty on the leading edge of advances in defense-related science, technology, managment and policy to ensure that the latest information is incorporated into NPS courses and curricula.
- Apply faculty and student knowledge to enhance Navy/DoD operational effectiveness.

Pursuit of these goals increases the technical and managerial capability of the officer corps to keep pace with an increasingly complex defense posture in today's world.

The overall research program at NPS has two funded components:

- The Direct Funded Research (DFR) Program provides internal funding from the School's operating budget to stimulate innovative research ideas of benefit to the DoN and may be used for cost-sharing with reimbursable research efforts. This funding ensures, in particular, that all Navy-sponsored NPS curricula are equitably supported, that new faculty are provided an opportunity to establish a research program of importance to DoN/DoD and other national security interests, and that faculty and students from across the campus are encouraged to interact with one another.
- The Reimbursable Research (RR) Program includes those projects externally funded on the basis of proposals submitted to outside sponsors by the School's faculty. These funds allow the faculty to interact closely with RDT&E program managers and high-level policy makers throughout the Navy, DoD, and other government agencies as well as with the private sector in defense-related technologies. This ensures that NPS research remains highly regarded by academic peers and government officials and fosters a closer relationship between NPS and other outside organizations.

The two research programs are complementary and ensure that the overall research program is flexible, responsive, balanced and supportive of the unique needs of the military.

All research projects, both reimbursable and direct funded, support the School's research mission:

- To develop an overall research investment strategy that ensures a high quality, creative learning experience for NPS graduate students.
- To encourage faculty and student pursuit of new discoveries and applications which enhance the long term effectiveness of the armed forces.
- To stimulate interactions between NPS faculty and a wide variety of potential research sponsors (Government, Universities, Private Industry).
- To publicize (both internally and externally) significant achievements of the NPS research program and market NPS research capabilities.
- To foster synergy and force multiplication with Navy/DoD commands and laboratories to increase the potential for successful research and development programs

The Department of Systems Management provides defense-oriented graduate-level instruction in the foundation disciplines of management and economics as well as the broad range of specialty management disciplines, including acquisition and contracting, financial management, public budgeting, information technology, logistics, manpower analysis, and transportation. A high-quality faculty split their time between teaching officer-students and conducting basic and applied research for sponsors from all four services and OSD. In its efforts to increase its service to DoD, the department works close with the Institute for Defense Education and Analysis (IDEA). IDEA has established close partner-like relationships with several defense organizations aimed at applying the department's instructional and research expertise to its partners' specialized needs.

Table of Contents

Faculty Listing 1

Department Summary 3

Reimbursable Funding 9

Project Summaries:

Software Project Management 11
Stress, Affect, Hormones and Health: Can A Revised Interpretive Style Make a Difference? 12
The Effect of Different Types of Music on Mood, Tension, and Mental Clarity 12
Alternative Concepts of Operation for Direct Downlink of Sensor Information 13
Depot Maintenance Resource Prediction Model: Validation, Refinement and Enhancement 14
Naval Postgraduate School Support for Military Sealift Command Re-Engineering Efforts 14
Alternative Average Inventory Formulations 15
Generic Product and Service Quality Economics 16
Welfare Economics of Freight Service Quality 16
The Internal Dynamics of Two Inventory-Theoretic Freight Service Choice Models 17
Submarine Combat Architecture Consulting 18
Naval Air Station Network-In-A-Box 18
Navy Next Generation Computer Resources Tasking 18
Seanet Industry Assessment 19
Aviator Night Vision System Helmet-Mounted Display (ANVIS/HUD) Training System Development 19
Analysis and Redesign of Navy Retention/Separation Questionnaire 20
Value Engineering--A 1960's Cost Reduction Concept: Still Viable in the 1990's? 21
Depot Maintenance Resource Prediction Model System Validation, Refinement, and Enhancement 21
Object-Oriented Technology 22
Metrics for Military Readiness (1) 22
Metrics for Military Readiness (2) 22
Readiness Course Development 23
Joint Warfare and Medical Readiness: Resource and Policy Implications for the Military Health Services System 23
America's All-Volunteer Force 24
Minority Officer Pipeline Study 25
Systems Management Research Support for the Rapid Acquisition of Manufactured Parts (RAMP) Program 26
Individual Firm Strategic Change 27
An Extension of the Newsboy Problem for Perishable Goods 27
Cost Effectiveness Analyses for the Naval Aircraft Engine Component Improvement Program 28
Assessment of Employee Attitudes at NAWC-ADI After the Base Realignment and Closure (BRAC) Decision 29
Navy Fleet and Flight Hour Budgeting and Impact of Budget Reduction 29
Impact of Budget Reduction and DOD Financial Management Education Assessment 31
Design and Implementation of a Prototype Maintenance Advisor Expert System for the MK92 Fire Control System 31
A Comparative Study of Document Workflow Manager Applications 32

Database, Network, and Operational Analyses for the Tomahawk Engineering 2000 Project 33
Identifying and Resolving Semantic Conflicts for the Database Integration of the Joint Maritime Command Information System (JMCIS) 34
Cost Per Output Analysis for US Army Reserve 34
Systems Acquisition Management Support 35
Center for Acquisition Education, Training, and Research (CAETR) 36
Civilian Hybrid Engineering Program (CHEP) 36
Chapters 1-6 and 8 of "Navy and Defense Inventory Management" 37
Readiness-Based Sparing Replenishment Model for Repairable Items 37
Cost Effectiveness Analysis of the Naval Aircraft Engine Component Improvement Program 38
Economic Cost Analysis Modeling in Relation to Material Logistics/Shelf Life 39
A Conceptual Model for Determining an Optimal Drug Testing Program 40
Analysis of Financial Ration Patterns in the Defense Industry 40
Collaborative Systems for the Adaptive Retention of Decision Rationale 41
Complex Traceability Techniques 42
Dynamics of Change 43
A Needs Assessment for Financial Management Education for Department of Defense Health Care Executives 44
Value Chain Analysis for Strategic Planning and Analysis 45
Strategic Profit Analysis 46
Development of a Metrics-Based Software Reliability Model 46
Develop a Distributed System Software Reliability Model and a Software Reliability Engineering Process 48
A Fine-Grained Ethernet Performance Model 49
Optimal Policies for Configuring Cellular Communications Networks 50
Electronic Commerce at the Armed Services Board of Contract Appeals (ASBCA) 51
Cost Per Output Analysis for U.S. Army Recruiting Command 52
Experimentation of Bonus Incentive Recruiting Model (BIRM) 52
Augmentation of Critical Force Pool Readiness Geographic Information System (GIS) Models 53
U.S. Army Reserve RT 18 Market Analysis 53
A Study of Issues Related to Sexual Harassment and Gender Discrimination and Their Implications for the U.S. Navy 54
Application of Intrinsic Motivation Theory to the Military 55

Publications and Presentations 57

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SYSTEMS MANAGEMENT

Systems Management is the largest academic department at the Naval Postgraduate School, with approximately 80 full-time faculty and 30 support staff. The department's mission is to "improve the managerial capabilities and leadership qualities of Naval and other officers, as well as government executives, through graduate education, research, and professional service"; further, Systems Management strives to "conduct a variety of research that supports military decisionmaking, problem solving, and policy setting, improves administrative processes and organizational effectiveness, contributes knowledge to academic disciplines, and develops the quality of graduate education." Faculty research is an important component of System Management's mission, and it is integrated to the greatest possible extent with the educational process. Students are encouraged to participate in faculty projects, and faculty research results are typically incorporated in classroom instruction. The department's research efforts are augmented through its affiliation with the Institute for Defense Education and Analysis (IDEA) and by the participation of adjunct professors in many specialty areas. In 1995, Systems Management faculty were engaged in a broad range of research activities, with approximately $6 million in reimbursable funding from sponsors in the Department of Defense and the Military Services. For ease of exposition, the department's research projects during 1995 can be grouped into six functional areas: acquisition and contracting; logistics and transportation; information technology management; financial management; manpower, personnel, and training analysis; and organization, management, and policy analysis. Research in these six areas is summarized below.

Acquisition and Contracting

Research in Acquisition and Contracting focused largely on support activities for the departmental program in Systems Acquisition Management. This included support for Army thesis students, an acquisition library and related services, and other functions. In addition, the Defense Acquisition University (DAU) supported the Center for Acquisition Education, Training, and Research (CAETR), which administers courses offered by NPS faculty from various departments and groups. (NPS is a consortium member of DAU.) Research activities in 1995 also included an effort to explore interest within the Army and Navy for an engineering master's program that would address the educational needs of civilians employed in the Systems, Planning, Research, Development, and Engineering (SPRDE) career field. (These objectives are defined in the Defense Acquisition Workforce Improvement Act.) Separate research investigated the feasibility of using electronic means to manage filings, official publications, and other functions at the Armed Services Board of Contract Appeals; and an in-depth analysis of the concept of value engineering, which was adopted by DoD in 1962 as part of its Cost Reduction Program.

Logistics and Transportation

Systems Management faculty conducted a number of research projects in Logistics and Transportation during 1995. Most of the research centered on modeling and simulation, including: development of a readiness-board model for the Navy's Inventory Control Points; development of models to predict savings in costs associated with the Naval Aircraft Engine Component Improvement Program; development of a cost/benefit model and inventory management model to manage hazardous material; development of a Best Value model for Rapid Acquisition of Manufactured Parts facilities; production of several chapters for a new textbook called *Navy and Defense Inventory Management*; a study to extend the "newsboy problem" of determining order quantities for perishable goods; a comparison of alternative formulations for specifying the average holding cost area; development of a general model that addresses the welfare economics of product and service quality; an examination and comparison of two inventory-theoretic freight service choice models; and an investigation of the welfare economics associated with incremental changes in freight service quality. Additionally, a project was initiated to extend and investigate applications of a strategic change model for transportation planning.

SYSTEMS MANAGEMENT

Information Technology Management

A wide array of research projects was associated with Information Technology Management during 1995. These projects included the following: development of a metrics-based software reliability model; development of a software reliability model for distributed systems and a software reliability engineering process; development of an Ethernet performance model; development of optimal policies for configuring cellular communication networks; development of a prototypical collaboration system that will permit the adaptive retention of decision rationale; development of a model of requirements traceability to support large-scale systems design and maintenance; and a study of software project management. Additionally, related research in 1995 involved the development of a prototypical maintenance expert system for the MK92 Fire Control System; a comparative study of document workflow manager applications; a study for the Tomahawk Engineering 2000 Project; and the development of a methodology for dealing with semantic conflicts during database integration of the Joint Maritime Command Information System. Several projects reviewed and analyzed the Depot Maintenance Resource Prediction Model used by the US Army Program Management Systems Development Agency; and another looked at object-oriented methodologies used for developing information systems. A project undertaken by the Command, Control, and Communications Academic Group assessed improvements in warfighter support that could occur due to the availability of directly-downlinked sensor information.

Financial Management

Research projects in Financial Management included: an assessment of budget reductions, as well as several related issues, in the Navy's AIRPAC, PACFLT command; an evaluation of budget reductions in DoD and development of a DoD Financial Management Education and Training Program; a needs assessment for executive financial management education within the new DoD health care reform program (TRICARE); a study of value chain analysis in the context of strategic planning; and development of a new approach to profit variance analysis. Additionally, internally-funded research looked at financial ratio patterns within the US Defense Industry; and critical changes in medical readiness associated with DoD's new policy on joint-service medical planning, training, operations, and interoperability.

Manpower, Personnel, and Training Analysis

Faculty in the Manpower, Personnel, and Training Analysis area come from a variety of academic disciplines, and associated research projects reflect this diversity of expertise. For example, research in 1995 included: a continuing, "lessons learned" study of the All-Volunteer Force; several analyses in support of a major DoD study of the "officer pipeline" and career opportunities for female and minority officers; development of a conceptual model to redesign the Navy's exit survey for enlisted personnel and officers; a cost-per-output analysis to support the US Army Recruiting Command and a similar study that focused on the Army Reserve; and a project to design and implement the Army's bonus incentive recruiting model (or BIRM). Several additional projects were undertaken for the Army: a study to enhance the Geographic Information System (GIS) model used by the Critical Force Pool Readiness Office; an analysis of Army Reserve Troop Program Unit leadership practices; and development of an information base and decision support system for assessing the Army Reserve market. Several projects in 1995 focused directly on readiness concerns, including studies to develop measures of military readiness and an initial effort to design a course in military readiness that would be offered as part of the Joint Warfare Analysis curriculum and other academic programs.

Organization, Management, and Policy Analysis

Research in Organization, Management, and Policy Analysis often intersects with other functional areas, as listed above. For example, in 1995, an ongoing effort attempted to empirically examine the dynamics of change in public organizations, challenged to adapt to an increasingly competitive environment; and other research focused on the application of intrinsic motivation theory to the military (in support of DoD's Eighth Quadrennial Review of Military

Compensation). In addition, Systems Management faculty studied issues related to sexual harassment and gender discrimination and their implications for the Navy. Studies were also undertaken to examine the effect of a training intervention on stress, emotions, and hormones; and, an assessment was made of employee attitudes, to assist the Naval Air Warfare Center (Aircraft Division) in closing its facility.

FY95 REIMBURSABLE PROGRAM
Department of Systems Management

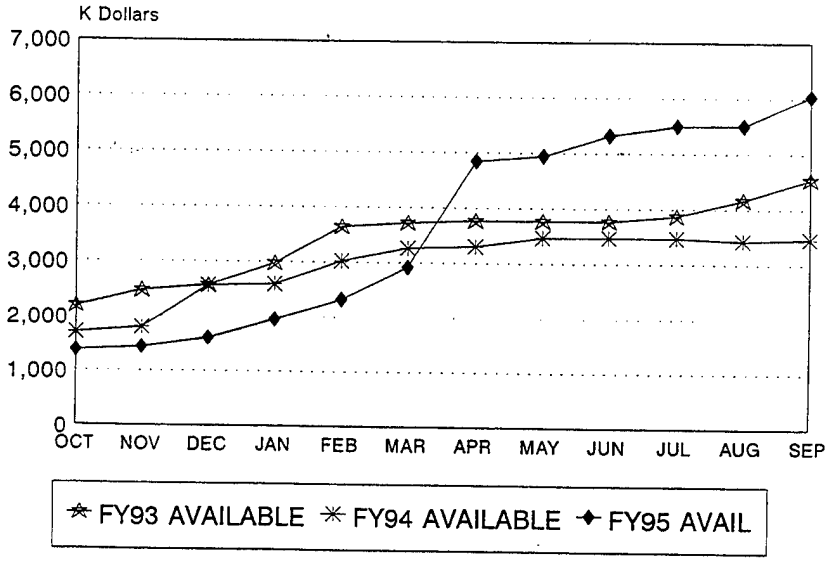

Figure 1. Reimbursable Funds Available by Fiscal Year.
This graph shows the amount of reimbursable funding available to the department. Dollar amounts include research and academic reimbursable activities.

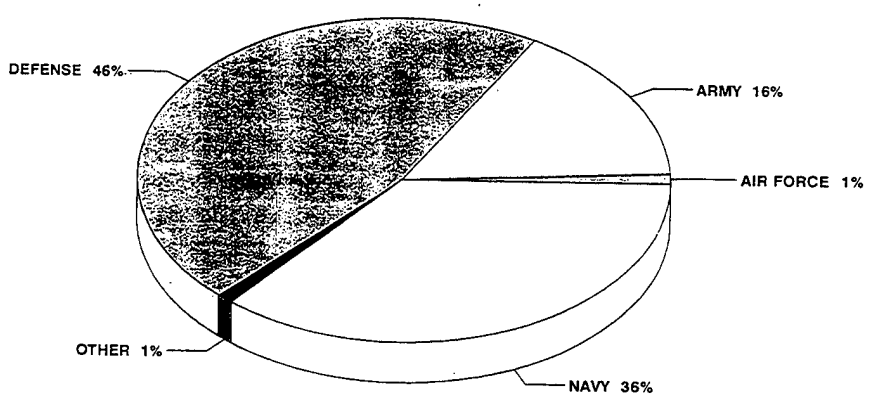

Figure 2. FY95 Reimbursable Sponsor Profile.

SOFTWARE PROJECT MANAGEMENT

Tarek Abdel-Hamid, Professor
Kishore Sengupta, Associate Professor
Department of Systems Management
Sponsor: Unfunded

OBJECTIVE: The goal of this project is to examine the processes by which software projects are managed and to investigate methods by which the management of software projects can be improved.

SUMMARY: The research project entailed conducting laboratory experiments on the decision processes underlying the management of software projects. The research finds that individuals have difficulty in making decisions in complex, dynamic environments. The quality of the decisions can be improved by delivering information on the task environment as well as setting specific goal structures.

PUBLICATION:

Sengupta, K. and Abdel-Hamid, T.K., " The Impact of Unreliable Information on the Management of Software Projects: A Dynamic Decision Perspective," to appear, IEEE Transactions on Systems, Man, and Cybernetics.

THESES DIRECTED:

Swanson, D., "An Experimental Investigation of the Decision Processes of Software Project Managers," Master's Thesis in Information Technology Management, September 1995. (Awarded the Navy League Award for best thesis)

Swett, C., "An Experimental Investigation of the Impact of Conflicting Project Goals on Staff Resource Allocation," Master's Thesis in Information Technology Management, June 1995.

Russ, K., "An Experimental Investigation of the Impact of Risk on Software Project Management," Master's Thesis in Information Technology Management, September 1995.

OTHER:

Abdel-Hamid, T., Sengupta, K., and Swett, C., "Goal Setting and Software Project Performance: An Empirical Investigation," submitted to Information Systems Research.

Sengupta, K. and Abdel-Hamid, T., "Coping with Staffing Delays in Software Project Management: An Experimental Investigation," submitted to Organization Science.

DOD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Software projects, decision process

STRESS, AFFECT, HORMONES AND HEALTH: CAN A REVISED INTERPRETIVE STYLE MAKE A DIFFERENCE?

Robert Barrios-Choplin, Visiting Assistant Professor
Department of Systems Management
Sponsor: Naval Postgraduate School, Institute of HeartMath

OBJECTIVE: This study examined the effect of a training intervention on stress, emotions, and hormones. The training was designed to alter the interpretive style, or "world view" of participants to lower stress and unhealthy hormones while raising positive emotions and healthy hormones.

SUMMARY: There were 49 participants and a control group of 15. Subjects completed a psychological profile and gave saliva samples (from which hormones were extracted) just prior to the training, and again after one month of practicing the interpretive style techniques. Most positive emotions increased, and stress and most negative emotions decreased from time one to time two. Effects were increased with amount of practice. The "negative" hormone, Cortisol, decreased after the training, while the "positive" hormone, DHEA increased. Implications are that techniques designed to change individual's interpretation of environmental stimuli are effective in reducing stress, negative emotions, and promoting healthier hormone levels.

OTHER:

Barrios-Choplin, B., McCraty, R., and Atkinson, M. "Stress, affect, hormones and health: Can a revised interpretive style make a difference?" submitted to the Academy of Management Annual Meeting, forthcoming in August 1996.

DOD KEY TECHNOLOGY AREA: Other (Organizational Behavior)

KEYWORDS: Stress, emotions, hormones, health

THE EFFECT OF DIFFERENT TYPES OF MUSIC ON MOOD, TENSION, AND MENTAL CLARITY

Robert Barrios-Choplin, Visiting Assistant Professor
Department of Systems Management
Sponsor: Naval Postgraduate School, Institute of HeartMath

OBJECTIVE: This study examined the effect of four types of music on the moods, tension levels, and mental clarity of normal individuals. In particular, it examined the effect of "designer music", which is created to affect the above feelings.

SUMMARY: This study included 144 individuals, from teen-agers to the elderly. Each participant completed a feelings survey prior to listening to each of four types of music (rock, new-age, classical, designer). After 15 minutes of music, they completed the same survey. Rock music lowered mental clarity and positive mood, while raising tension and negative mood. Designer music raised mental clarity and positive mood, while lowering negative mood and tension. The other types of music produced mixed results. Implications are that designer music can be an effective moderator of tension and negative mood, while promoting clear thought and positive moods.

OTHER:

McCraty, R., Atkinson, M., Barrios-Choplin, B., and Rozman, D., "The effect of different types of music on mood, tension, and mental clarity," accepted for presentation at the Eighth International Montreux Congress on Stress, Switzerland, February 1996.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: Tension, mood, mental clarity, music

ALTERNATIVE CONCEPTS OF OPERATION FOR DIRECT DOWNLINK OF SENSOR INFORMATION

Dan C. Boger, Professor
Carl R. Jones, Professor
Department of Systems Management and
Command, Control, and Communications Academic Group
Sponsor: Defense Support Project Office

OBJECTIVE: The objective of this continuing project is to assess improvements in warfighter support which could occur due to the availability of directly-downlinked sensor information.

SUMMARY: Direct downlink of information to the Joint Force Commander (JFC) can provide enormous benefits in providing real-time command and control of warfighting forces and weapons systems. By examining specific JFC-level scenarios which focus on command and control as well as weapons systems, several alternative concepts of operation for sensor information processing and dissemination were compared with current, existing sensor information architectures. Primary measures of effectiveness focused on the tradeoffs between latency and quality of information received by the JFC/weapons systems. Enhancements to current architectures and systems were recommended.

CONFERENCE PRESENTATION:

Boger, D.C. and Jones, C.R., "The Value-Added to the Warfighter by Providing DDL Information (U)," OBP/DDL Conference, Washington, DC, January 1995.

THESES DIRECTED:

Heida, J.D., "ELINT Information Flow Modeling for the Joint Task Force Commander in a Client-Server Environment (U)," Master's Thesis, March 1995.

Casimes, A.T., "Synthetic Aperture Radar and the Tomahawk of the Future (U)," Master's Thesis, March 1995.

Kilgo, M.L. and Nichting, D.P., "Direct Downlink (DDL) and the Army Tactical Missile System (ATACMS): A Concept of Operation (U)," Master's Thesis, June 1995.

Mackovick, L.T. and Stader, P.A., "A Comparison of Future Synthetic Aperture Radar Imagery Dissemination Methods Using Timeliness as a Measure of Performance (U)," Master's Thesis, June 1995.

Steck, K.L., "The Application of Simulated Annealing to the Scheduling of National Systems (U)," Master's Thesis, September 1995.

DOD KEY TECHNOLOGY AREAS: Space Vehicles, Battlespace Environments, Command, Control, and Communications, Conventional Weapons, Sensors, Modeling and Simulation

KEYWORDS: Concepts of Operation, sensors, communications, networking

DEPOT MAINTENANCE RESOURCE PREDICTION MODEL: VALIDATION, REFINEMENT, AND ENHANCEMENT

Dan C. Boger, Professor
Shu S. Liao, Professor
Department of Systems Management
Sponsor: Program Management Systems Development Agency, Headquarters, Department of the Army

OBJECTIVE: The goal of this project was to review and analyze the existing version of the Depot Maintenance Resource Prediction Model for possible refinement and enhancement. This is the final phase of a multiyear project.

SUMMARY: The principal focus of this research project was on the data, quantitative methods, and algorithms of the model. The research used data from combat vehicles and aircraft to identify, validate, and refine the predictive algorithms of the model. The research identified additional decision needs of current Army users (ODCSLOG, ASA(FM), HQ AMC) and decision needs of other potential DoD users. Research results from prior years showed that the model does not produce consistent outputs. Therefore, the focus of the current phase of research shifted to examination of the structure and validity of the algorithms used in the model. A "black box" testing approach utilized a small set of sample data to manually calculate what the model results should be and compared this to actual model output. Results from this testing showed that a significant portion of source data was being rejected due to various cross-validation procedures built into the model. The model uses National Stock Number (NSN) as a key data element in these procedures. However, two problems with this approach were surfaced. First, NSNs are not unique; different activities may use a different NSN for the same item. Second, new item NSNs are not added to the NSN master file in a timely fashion. Therefore, the use of NSNs as the main validation criterion results in a large number of (invalid) data input rejections and is the primary cause of the model's incorrect outputs.

OTHER:

A draft copy of a technical report, "Depot Maintenance Resource Prediction Model: Validation, Refinement, and Enhancement," has been sent to the sponsor for comment.

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

KEYWORDS: Model, depot maintenance, resource requirements, decision support, validation

NAVAL POSTGRADUATE SCHOOL SUPPORT FOR MILITARY SEALIFT COMMAND RE-ENGINEERING EFFORTS

Dan C. Boger, Professor
David R. Whipple, Professor
Department of Systems Management
Sponsor: Military Sealift Command

OBJECTIVE: The goal of this project was to provide support to Military Sealift Command (MSC) in its re-engineering efforts and to provide "seed money" for identifying specific areas of further investigation which would warrant individual research projects from NPS faculty to support detailed portions of the MSC re-engineering efforts.

SUMMARY: The principal focus of this research project was on NPS providing, in an advisory capacity, strategic consultation to MSC in all of its re-engineering activities. This strategic consultation focused primarily on the education of MSC managers in the processes of re-engineering and change management. Additionally, it involved drawing on the "real time" input of appropriate Systems Management Department faculty into specific issues and action alternatives being considered by MSC in the management of change. In addition, potential follow-on research projects were defined

collaboratively, allowing for an appropriate match between availability of NPS physical resources and MSC interests. A limited number of specific projects involving faculty or thesis students were identified and funded as follow-on research. Finally, for projects which MSC and NPS determined were important to the re-engineering effort but which NPS was unable to support, NPS provided guidance on alternative ways in which MSC could obtain that support.

OTHER:

A number of briefings to the Military Sealift Command Executive Steering Committee were provided in Washington and in Monterey. Additionally, several faculty members from the Department of Systems Management traveled to various MSC locations for data-gathering and other preliminary research activities.

DOD KEY TECHNOLOGY AREA: Other (Change Management)

KEYWORDS: Management education, re-engineering, reinvention, reorganization

ALTERNATIVE AVERAGE INVENTORY FORMULATIONS

David G. Brown, Visiting Assistant Professor
Department of Systems Management
Sponsor: Unfunded

OBJECTIVE: This project is concerned with comparing alternative formulations for specifying the average holding cost area in the context of stochastic continuous single-item inventory models. The research question is: Which formulation provides the best combination of accuracy and ease of specification, and under what conditions? One possible answer is that different formulations are most appropriate under different conditions. This is a new active project this year.

SUMMARY: Activity during 1995 primarily involved working with a thesis student in using simulation to compare two average holding cost area formulations. A conceptual outline for this project was developed earlier based on previous inventory modeling work. This background material was used by the thesis student as a possibility. The two formulations were compared using the *Crystal Ball* simulation program installed as an "ad-in" to a spreadsheet package. One of the holding area formulations is significantly more complex than the other. Before the simulation, based on an examination of inventory areas for different inventory cycle scenarios, it was expected that this more complex formulation would be more accurate. However, based on the initial work (as documented in the resulting thesis) it appears the other more simple formulation may be more accurate under most situations.

THESIS DIRECTED:

Jaw, P.-Y., "Forecasting and Inventory Area Model Choice," Master's Thesis, March 1995.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Inventory models, model validation, holding cost area

GENERIC PRODUCT AND SERVICE QUALITY ECONOMICS

David G. Brown, Visiting Assistant Professor
Department of Systems Management
Sponsor: Unfunded

OBJECTIVE: This project is concerned with developing a general model that addresses the welfare economics of product and service quality, and which provides a framework for examining the quality of service between DON and DOD units. This is a new active project this year.

SUMMARY: Activity during 1995 was primarily concerned with initial model development, and a DFR Merit Program research proposal for continuing this work in FY96.

The model development built upon previous work concerning the welfare economics of freight service quality, another ongoing research project (see 1994 and 1995 summaries for that research project). The work in 1995 primarily consisted of replicating the previous work with greater rigor and a more general demand model. In particular, the work was able to show that total surplus maximization and monopoly profit maximization have the same equation for characterizing product or service quality. This is a particularly important result because it disputes the current understanding of this relationship.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Economics, surplus, product quality, service quality

WELFARE ECONOMICS OF FREIGHT SERVICE QUALITY

David G. Brown, Visiting Assistant Professor
Department of Systems Management
Sponsor: Unfunded

OBJECTIVE: The goal of this project is to investigate the welfare economics associated with incremental changes in freight service quality. This includes developing a shipper surplus model which treats service quality as a second price in addition to freight rate, using this welfare measure to determine a characterization of socially optimal service quality, and then examining issues such as carrier competition and freight rate regulation relative to this characterization. This is a continuing project from last year.

SUMMARY: Activity during 1995 was primarily concerned with refining the previous research, documenting it in a research paper, and initiating a larger related project concerned with generic service and product quality welfare product and quality issues, especially as they relate to the quality of service between DOD units.

The research refinement and paper was primarily concerned with the "first model" discussed in last year's summary. With that model it is assumed that each shipper desires at most one unit of freight service which will be purchased from the carrier if the freight rate and service level combination is evaluated to be less than or equal to the shipper's individual threshold. The work concentrated on two formulations of this model. With the first formulation each individual shipper is explicitly recognized with its own unit cost function, and the second uses a continuous model which approximates the case of a large number of shippers with a common unit cost function.

There were two principal research results with this project this year. By combining the continuous shipper surplus model with previous work on the relationship between carrier profit and freight service quality a total surplus expression for freight service quality was developed. By maximizing this expression subject to a volume constraint, a condition called "quality efficiency" was derived which characterizes the most technically efficient service quality level. The

second principal result was the development of an economic explanation for why the freight rate and service quality surplus components are path dependent. The proceedings paper focused on both of these results.

PUBLICATION:

Brown, D.G., "Joint Freight Rate and Service Quality Shipper Surplus -- A Unit Demand Development," Proceedings of the 37th Annual Meeting of the Transportation Research Forum, Chicago, IL, pp. 162-182, October 1995.

CONFERENCE PRESENTATION:

David G. Brown, "Joint Freight Rate and Service Quality Shipper Surplus -- A Unit Demand Development," 37th Annual Meeting of the Transportation Research Forum, Chicago, IL, October 19, 1995.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Transportation economics, freight service quality, welfare economics, shipper surplus, full price

THE INTERNAL DYNAMICS OF TWO INVENTORY-THEORETIC FREIGHT SERVICE CHOICE MODELS

David G. Brown, Visiting Assistant Professor
Department of Systems Management
Sponsor: Unfunded

OBJECTIVE: Within the inventory-theoretic transportation literature, unit stockout cost and probability-of-stockout are the most popular procedures for specifying safety stock. The goal of this project was to examine and compare these two procedures with respect to criteria primarily based on microeconomic problems such as carrier-choice and the problem of minimizing the sum of shipper inventory and carrier costs with respect transportation service quality. This is a continuing project from last year and before.

SUMMARY: Activity during 1995 was primarily directly towards significantly revising a research paper based on this work, which was published late in the year.

PUBLICATION:

Brown, D.G., "Internal Dynamics of Inventory-Theoretic Models for Microeconomic Transportation Applications," The Logistics and Transportation Review, Vol. 31, No. 3, pp. 253-279, September 1995.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Freight service quality, inventory-theoretic, model validation, microeconomic transportation models, inventory models

SYSTEMS MANAGEMENT

SUBMARINE COMBAT ARCHITECTURE CONSULTING

Rex Buddenberg, Lecturer
Department of Systems Management
Sponsor: Naval Sea Systems Command

OBJECTIVE: Help define a growth path for Trident submarines which now face a thirty year life cycle instead of the original twenty. Several components in the combat system reach end of service lives before the submarine faces decommissioning.

SUMMARY: Defined a network-centric combat systems architecture that allows graceful upgrade of components in the combat system. Including reuse of components developed outside the submarine community. Located signal processing and mission replay program in the carrier ASW establishment that accomplishes a great deal of what the Tridents need to do in the near term for their towed array replacement.

DOD KEY TECHNOLOGY AREAS: Command, Control and Communications, Computing and Software, Human Systems Interface, Sensors, Surface/Under Surface Vehicles - Ships and Watercraft

KEYWORDS: Submarine combat system architecture

NAVAL AIR STATION NETWORK-IN-A-BOX

Rex Buddenberg, Lecturer
Department of Systems Management
Sponsor: Naval Air Station, Paxutent River

OBJECTIVE: Provide educational input to management personnel who are defining a program to extend internet to air stations for a variety of purposes. Provide training material for implementers.

SUMMARY: Provided training and educational material in the form of briefings to program sponsor and as World Wide Web pages. Networking technology is becoming inexpensive enough and prevalent enough that many commands are 'fixing themselves' with local budgets rather than waiting for a central program, and without any guidance that reduces risks and raises the probabilities that one command's network will be interoperable with and be manageable by another's. By placing up some low-risk general purpose guidance for local action in NAVAIR's WWW server, we improve these odds.

DOD KEY TECHNOLOGY AREA: Command, Control and Communications

KEYWORDS: Networking, internetworking

NAVY NEXT GENERATION COMPUTER RESOURCES TASKING

Rex Buddenberg, Lecturer
Department of Systems Management
Sponsor: Space and Naval Warfare Systems Command

OBJECTIVE: As a concluding activity to a program that is terminating, NGCR was writing an Acquisition Guide and a Supportability Guide, and requested my assistance.

SUMMARY: Provided comments on existing chapters and drafts of new chapters in these two publications.

OTHER:

My work is incorporated (anonymously) in these Navy publications and is not separately publishable.

DOD KEY TECHNOLOGY AREAS: Command, Control and Communications, Computing and Software, Conventional Weapons

KEYWORDS: Acquisition, supportability

SEANET INDUSTRY ASSESSMENT
Rex Buddenberg, Lecturer
Department of Systems Management
Sponsor: National Science Foundation

OBJECTIVE: Provide continuing current information to NSF and the university oceanographic community on the commerical satellite industry, internetworking technology and its applications to oceanographic research and extension of the Internet to sea.

SUMMARY: Used the lab funding in this proposal to build an Internet to sea lab which will be used both as an educational tool and as a testbed for commercial satellite communications and internetwork products.

PUBLICATION:

Buddenberg, R., "The Impending Revolution in At-Sea Communications," Poster session at American Geophysical Union Meeting, December 1995.

OTHER:

Informal presentations at periodic Research Vessel Technician meetings.

At request of NSF sponsor, reviewed plans and budget submissions by research vessel technicians.

DOD KEY TECHNOLOGY AREA: Command, Control and Communications

KEYWORDS: Internetworking

AVIATOR NIGHT VISION SYSTEM HELMET-MOUNTED DISPLAY (ANVIS/HUD) TRAINING SYSTEM DEVELOPMENT
Anthony P. Ciavarelli, Associate Professor
Aviation Safety Programs
Kishore Sengupta, Assistant Professor
Department of Systems Management
Sponsor: Naval Air Systems Command (PMA-205)

OBJECTIVE: The objective of this project is to develop a Computer-based/Multimedia training system to teach pilots how to use the Aviator Night Vision System Helmet-mounted Display.

SUMMARY: This training system development project is a direct outgrowth of a previous training requirements study, which was completed in FY 94. The work for FY 95, and FY 96, centers on the development of interactive courseware that is designed to improve Aviator Night Vision Helmet-mounted Display (ANVIS/HUD) training. Using the Naval Postgraduate School's Multimedia Laboratory, project team members will design, develop, and evaluate instructional system prototypes for ANVIS/HUD users. Interactive courseware development will include, specification of learning objectives, preparation of curriculum outline and lesson plans, as well as authoring of computer-based tutorials, practice exercises, unit tests, and development of student progress monitoring features.

THESES DIRECTED:

Bryant, R. and Day, G., " A Computer-based Multimedia Prototype for Night Vision Goggle Training," Master's Thesis, December 1994.

Meza, F.Q. , "Developing Multimedia Instructional Systems for Night Vision Goggles," Master's Thesis, 1995.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEY WORDS: Night vision goggles, training technology, instructional systems, computer-based training, multimedia

ANALYSIS AND REDESIGN OF NAVY RETENTION/SEPARATION QUESTIONNAIRE

Alice M. Crawford, Senior Lecturer
Department of Systems Management
Sponsor: Bureau of Naval Personnel

OBJECTIVE: The objective of this project was to identify design flaws in the Navy's exit survey, to determine survey items that reflect current areas of satisfaction and dissatisfaction for Navy enlisted and officer personnel, and to implement these findings in the design of a new survey.

SUMMARY: The Marine Corps and the Army are in the process of redesigning their exit surveys, and the Air Force has an extensive survey in use. Thus, coordination with the other services was undertaken to learn from their research in the area. This information was integrated with a review of exit survey literature. Next, enlisted and officer personnel were interviewed with respect to aspects of their Navy jobs that they find either satisfying or dissatisfying. This resulted in a large set of items. Given constraints imposed by the sponsor for a one-page survey, it was necessary to reduce the list of items considerably. A first review was conducted by the researchers, based on how frequently items were mentioned in the interviews, and a second review was undertaken by the sponsor. The sponsor's review was based on feedback collected by the Navy Career Information Team from fleet personnel and their data were almost identical to the data collected by NPS. Subsequently, a new survey was created, which utilized the new items and included new scales, and was submitted to the sponsor.

PUBLICATION:

Crawford, A. and Dougherty, J., "Analysis and Redesign of Navy Retention/Separation Questionnaire," Naval Postgraduate School Technical Report, NPS-SM-95-007, October 1995.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: Retention, separation, surveys

VALUE ENGINEERING--A 1960'S COST REDUCTION CONCEPT: STILL VIABLE IN THE 1990'S?

Sandra M. Desbrow, Assistant Professor
Department of Systems Management
Sponsor: Naval Postgraduate School

OBJECTIVE: The objective of this research is to produce an in-depth analysis of the concept of value engineering from its inception in 1962. This research when complete will detail the usage of value engineering by the Department of Defense (DOD) over the last 32 years, review the seminal legal controversies that have arisen in applying this concept, and provide recommendations for improvements in the process.

SUMMARY: As the Federal Government once again embarks on a new round of procurement reform with the enactment of two Federal Acquisition Streamlining Acts, a thorough review of past cost saving regulations is in order to put today's changes into perspective and to predict possible benefits and pitfalls. The Value Engineering concept was adopted by DOD in 1962 as part of its Cost Reduction Program. It is an organized effort to analyze the functions of systems, equipment, facilities, services, and supplies for the purpose of achieving the essential functions at the lowest life cycle cost consistent with required performance reliability, quality, and safety. Contractors can submit a Value Engineering Change Proposal (VECP) outlining a cost reducing change which if accepted by the Government results in a sharing of the cost saving with the contractor. A review and analysis of the use of VECPs, the legal controversies that have arisen, and recommendations for changes to the process and its continued use will be presented.

DOD KEY TECHNOLOGY AREA: Other (Procurement Reform)

KEYWORDS: Value engineering, Value Engineering Change Proposals (VECPs), contract cost reduction, cost savings

DEPOT MAINTENANCE RESOURCE PREDICTION MODEL SYSTEM VALIDATION, REFINEMENT, AND ENHANCEMENT

Daniel R. Dolk, Professor
Shu S. Liao, Professor
Dan C. Boger, Professor
M.H. Ackroyd, Associate Research Professor
Department of Systems Management
Sponsor: U.S. Army Program Management System Development Agency

OBJECTIVE: The purpose of this project was to review and analyze the existing version of PMSDA's Depot Maintenance Resource Prediction Model (DMRPM) for possible refinement and enhancement. The research used data related to combat vehicles to identify and validate the reource predictive algorithms, and to identify additional decision needs of current users and areas for refinements. The DMRPM software program was also evaluated and validated with respect to the suitability of its architecture. This project terminated during 1995.

SUMMARY: Algorithms for the DMRPM were documented in meetings with the sponsor and associated subcontractors. An object-oriented model of depot maintenance was developed from this documentation. This design was incorporated within the DMRPM program by the contractor responsible for software development. Further validation was not possible because of unresolvable problems with data validity. The project was terminated when the sponsoring agency was dissolved.

DOD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Model management, object-oriented, depot maintenance, algorithm validation

OBJECT-ORIENTED TECHNOLOGY

Daniel R. Dolk, Professor
M.H. Ackroyd, Associate Research Professor
Department of Systems Management
Sponsor: Defense Information Support Agency, Software System Directorate

OBJECTIVE: The purpose of this project was to review the relationship between object-oriented methodologies used for developing information systems and the activity of enterprise modeling. This project terminated during 1995.

SUMMARY: We drafted a report which laid out requirements for enterprise modeing in the large based upon the unifying paradigm of model management and then assessed existing object-based methodologies with respect to how well they met these requirements. The project was terminated when the sponsoring agency was reorganized.

DOD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Object-oriented, model management, enterprise modeling

METRICS FOR MILITARY READINESS

Daniel R. Dolk, Professor
Shu S. Liao, Professor
Department of Systems Management
Sponsor: Defense Management Data Center

OBJECTIVE: Military readiness is a phenomenon much talked about but little analyzed. Measurements for readiness tend to be highly subjective and tailored to the situation at hand. This project examines the relevance of multiattribute theory, complexity theory, and nonparametric statistical techniques for developing metrics which provide management indicators for tracking readiness. The metrics should be able to provide an "early warning system" for detecting degradation of readiness during peacetime.

SUMMARY: We drafted a report which laid out requirements for enterprise modeling in the large based upon the unifying paradigm of model management and then assessed existing object-based methodologies with respect to how well they met these requirements. The project was terminated when the sponsoring agency was reorganized.

DOD KEY TECHNOLOGY AREAS: Modeling and Simulation, Manpower Personnel and Training, Computing and Software

KEYWORDS: Readiness, genetic algorithm, data mining, geographical information system

METRICS FOR MILITARY READINESS

Daniel R. Dolk, Professor
George W. Thomas, AssociateProfessor
Department of Systems Management
Sponsor: U.S. Army Reserve

OBJECTIVE: Military readiness is a phenomenon much talked about but little analyzed. Measurements for readiness tend to be highly subjective and tailored to the situation at hand. Readiness for the Reserve component of the military is quite different from the Active counterparts; for example, attrition is the biggest readiness problem in the Reserve

compared with the active Army. The goal of this project is to lay out a research study plan for the U.S. Army Reserve to measure readiness.

SUMMARY: We drafted a report which laid out two major projects to be undertaken: one in measuring the impact of attrition on readiness using genetic algorithms and a second to study recruit market supportability using geographic information system technology. The project has been extended to support the second study in 1996.

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

KEYWORDS: Readiness, genetic algorithm, geographical information system

READINESS COURSE DEVELOPMENT

Daniel R. Dolk, Professor
Department of Systems Management
Sponsor: Naval Postgraduate School - Institute of Joint Warfare Analysis

OBJECTIVE: Develop a course on military readiness which can be offered as part of the JWA curriculum and also be offered as electives to other NPS curricula.

SUMMARY: I am in the process of developing a syllabus plus an annotated bibliography available on the Internet.

DOD KEY TECHNOLOGY AREAS: Manpower Personnel and Training, Command, Control and Communications

KEYWORDS: Readiness

JOINT WARFARE AND MEDICAL READINESS: RESOURCE AND POLICY IMPLICATIONS FOR THE MILITARY HEALTH SERVICES SYSTEM

Richard Doyle, Associate Professor
Department of Systems Management
Sponsor: Naval Postgraduate School - Institute of Joint Warfare Analysis

OBJECTIVE: The objective of this research is to identify and assess critical changes in medical readiness associated with DoD's new policy on joint service medical planning, training, operations and interoperability.

SUMMARY: Research was conducted on the policy and budget implications of selected changes associated with DoD's current joint service policy. Documents such as the Medical Readiness Strategic Plan (MRSP), the POM, the 733 Report and the 1995 follow-on to the 733 report, the semi-annual medical readiness status briefing given by the medical services and the products of the Senior Readiness Oversight Council and the Defense Science Board Task Force on Readiness were reviewed. An emerging area of defense policy called joint medical readiness was delineated. The findings were incorporated into EME (Executive Management Education) modules developed for the Navy's Bureau of Medicine and Surgery.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: Jointness, medical readiness, Defense Health Program, Medical Health Services System, Medical Readiness Strategic Plan, 733 report, Senior Readiness Oversight Council, Defense Science Board Task Force on Readiness

AMERICA'S ALL-VOLUNTEER FORCE

Mark J. Eitelberg, Associate Professor
Department of Systems Management
Sponsor: Office of the Assistant Secretary of Defense
(Force Management Policy)

OBJECTIVE: The goal of this project is to chronicle the manpower policies and programs that succeeded--or failed--in sustaining the All-Volunteer Force (AVF); and to provide a "lessons learned" evaluation that will assist in setting a course for the future.

SUMMARY: Information has been gathered from three major sources: published research, Congressional reports and Department of Defense documents; data maintained by the Defense Manpower Data Center; and interviews with current and former officials in the Department of Defense who were directly involved in designing or executing manpower policies during the AVF era (1973-present). Contractor support was obtained for three phases of the research: a study of the evolution of the AVF; an assessment of the "effectiveness" of the military since the end of the draft; and an evaluation of the military's experience in Operation Desert Shield/Desert Storm, a defining moment of the AVF. Students at the Naval Postgraduate School have also made important contributions--in the form of project papers and theses--to the research effort. This study is a multi-year effort that looks at ten major areas, including recruiting, compensation, population participation, changing missions, and other topics.

PUBLICATIONS:

Eitelberg, M.J., "The All-Volunteer Force After Twenty Years," Two Decades of the All-Volunteer Force, J.E. Fredland, C.L. Gilroy, R.D. Little, and W.S. Sellman, eds., Pergamon, to appear in 1996.

Eitelberg, M.J. and Little, R.D., "Influential Elites and the American Military After the Cold War," US Civil-Military Relations: In Crisis or Transition?, D.M. Snider and M.A. Carlton-Carew, eds., The Center for Strategic and International Studies, 1995.

CONFERENCE PRESENTATIONS:

Eitelberg, M.J. and Little, R.D., "Influential Elites and the American Military," Biennial Conference of the Inter-University Seminar on Armed Forces and Society, Baltimore, MD, October 1995. (Part of a panel--"The Military, the Media, and Congress: Tensions and Resolve in the Post-Cold War Era"--organized and chaired by the authors.)

Eitelberg, M.J., "Population Participation in the American Military," series of papers presented at The Technical Cooperation Program (TTCP) annual meeting of UTP-3, Panel on Military Human Resource Issues, Portland, OR, July 1995.

THESES DIRECTED:

Harris, W.E., MAJ, USMC, "Military Compensation and the All-Volunteer Force: Lessons Learned," Master's Thesis, December 1994.

Brown, J.R., LCDR, USCG, "Non-Traditional Missions and the US Military: Past, Present, and Prospects," Master's Thesis, June 1995.

Haase, T. LCDR, German Navy, "An Analysis of the Performance of Different Demographic Groups of Navy Enlisted Cohorts," Master's Thesis, June 1995.

Turner, R.S., LT, USN, "The Impact of the Drawdown on USN Aviator Retention Rates," Master's Thesis, March 1995.

Mazenko, D.S., CAPT, USMC, "The Fairness of Change in the Military Retirement System," Master's Thesis, December 1995.

OTHER:

Laurence, J.H., "The All-Volunteer Force: A Historical Perspective," Consultant Report, November 1995.

Binkin, M., "The AVF Goes to War: Lessons of the Persian Gulf Conflict," Consultant Report, October 1995.

The principal investigator is preparing a book-length manuscript, tentatively titled *America's All-Volunteer Force.* Several individuals have contributed to the effort. Additional publications, theses, and related papers can be found in the research summary for 1994.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: Military manpower, personnel, recruitment, population representation, compensation, force management, roles/missions, attrition, military accession policy

MINORITY OFFICER PIPELINE STUDY

Mark J. Eitelberg, Associate Professor
Stephen L. Mehay, Professor
Department of Systems Management
Sponsor: Office of the Under Secretary of Defense (Personnel and Readiness)

OBJECTIVE: The goal of this project was to conduct statistical analyses of career pipelines and opportunities for female and minority officers in the US military.

SUMMARY: In March 1994, Secretary of Defense William Perry directed the Under Secretary of Defense (Personnel and Readiness) to lead a major study of the officer "pipeline" and to recommend ways that would improve the flow of female and minority officers from recruitment through general and flag officer ranks. Researchers at NPS conducted several analyses for the DoD "Officer Pipeline Study." The NPS portion of the study was divided into four tasks: a review of trends and current issues; an analysis of DoD data on the accession, promotion, and retention of minority officers over time (with emphasis on the period of the defense drawdown); an analysis of the promotion, retention, and success of minority junior officers in the Navy using a specially-constructed data file that includes measures of individual performance and promotion board outcomes; a study of the promotion and retention of minority officers in the Marine Corps, likewise incorporating information on promotion board results and individual performance. The results of this project will be part of a DoD report, scheduled for publication in 1996.

CONFERENCE PRESENTATIONS:

Eitelberg, M.J. and Mehay, S.L., "NPS Study of Minority Officers: Promotion and Retention Outcomes During the Pre-Drawdown and Drawdown Periods," Biennial Conference of the Inter-University Seminar on Armed Forces and Society, Baltimore, MD, October 1995. (Part of a panel--"Minority Officers in the Military: Current Issues and Trends"--organized and chaired by the authors.)

Mehay, S.L. and Bowman, W.R., "Performance and Promotion of Minority Officers in the US Navy," Biennial Conference of the Inter-University Seminar on Armed Forces and Society, Baltimore, MD, October 1995.

THESES DIRECTED:

Darrow, C.D., MAJ, Australian Army, "The Impact of the Force Drawdown on the Promotion of Minority Officers in the US Military," Master's Thesis, March 1995.

Kaspar, D.M., LT, USN, "The Effects of the Drawdown on Promotion and Career Opportunities of Female Officers," Master's Thesis, March 1995.

Lux, J.E., LT, USN, "The Effects of the Military Drawdown on Recruiting of Minority Officers," Master's Thesis, March 1995.

Miller, B.D., LT, USN, "The Impact of the Drawdown on Minority Officer Retention," Master's Thesis, March 1995.

Stigler, W.J., LT, USN and Jones, J.E., LT, USN, "Survey of Minority Officers in the Navy: Attitudes and Opinions on Recruiting and Retention," Master's Thesis, September 1995.

Wade, J.F., CAPT, USMC, "Survey of Black Officers in the Marine Corps: Attitudes and Opinions on Recruiting, Retention, and Diversity," Master's Thesis, December 1995.

OTHER:

Department of Defense, "Officer Pipeline Study," Office of the Under Secretary of Defense, forthcoming (1996).

Eitelberg, M.J. and Mehay, S.L., "Women and Minorities in the Officer Pipeline," Naval Postgraduate School, forthcoming (1996).

Mehay, S.L., "Minority Status and the Performance of Junior Officers in the Navy and Marine Corps," Naval Postgraduate School, forthcoming (1996).

DOD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: Minority officers, promotion, equal opportunity, retention, commissioning sources, force management, population representation, diversity

SYSTEMS MANAGEMENT RESEARCH SUPPORT FOR THE RAPID ACQUISITION OF MANUFACTURED PARTS (RAMP) PROGRAM

Kenneth J. Euske, Professor
Alan W. McMasters, Professor
Department of Systems Management
Sponsor: Naval Supply Systems Command

OBJECTIVE: A continuing project to develop, test and facilitate implementation of a Best Value model for RAMP facilities.

SUMMARY: Discussions with the Rapid Acquisition of Manufactured Parts (RAMP) Program Office and the Navy's Inventory Control Points (ICPs) indicated that a Best Value spreadsheet model, previously developed by NPS, for deciding between vendors' bids based on both unit cost and production lead time needed to be changed to accommodate multiple vendors and ICP fixed order quantities. In addition, the previous model assumed that demand during procurement lead time was Poisson distributed and would not exceed a mean value of 50 units. Larger mean values are expected now. Finally, the spreadsheet was in the Lotus 123 format. An Excel format was now desired. A new

spreadsheet model was developed to respond to these requested changes. The new spreadsheet can compare three vendors' bids at the same time and a normal probability distribution is used to approximate the Poisson for mean values of lead time demand above 30 units. The new model has been well received by both the sponsor and the users.

THESIS DIRECTED:

Childress, D.A., "A Model for Evaluating Proposals from Multiple Vendors which have Different Prices and Lead Times," Master's Thesis, December 1995.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Acquisition management, Computer Integrated Manufacturing, inventory management

INDIVIDUAL FIRM STRATEGIC CHANGE

Jane Feitler, Visiting Assistant Professor
Department of Systems Management
Sponsor: Naval Postgraduate School

OBJECTIVE: The objective of this project is to extend a model of strategic change to investigate the types of specific strategic changes firms made over time and the performance implications of the decision to change or not change strategies over time.

SUMMARY: This continuing research further extends and investigates strategic changes found in the U.S. Motor Carrier industry's Less Than Truckload (LTL) segment. Applications of what firms did over an eighteen year time span (1976-1993) provides insight as to what strategic change actions managers are more likely to make when faced with external and internal changes, as well as the performance implications of those strategic actions. A set of managerial strategic changes that can be utilized by firms in the transportation sector was identified. The set of changes will also be identified with their likely performance outcomes. Using a longitudinal data base, it is feasible to investigate whether there are certain time periods where some types of strategic changes bring about better outcomes than at other times, i.e. during recessions, times of rising fuel prices, etc. Thus, specific time periods and their more likely set of strategic changes will also be identified.

DOD KEY TECHNOLOGY AREA: Other (Strategic Change)

KEYWORDS: Strategic change, performance, transportation

AN EXTENSION OF THE NEWSBOY PROBLEM FOR PERISHABLE GOODS

Paul J. Fields, Assistant Professor
Department of Systems Management
Sponsor: Naval Postgraduate School

OBJECTIVE: The objective of this research was to extend the classic text-book formulation of order quantity determination under conditions of demand uncertainty to achieve a formulation and solution that are more representative of actual decision-making situations.

SUMMARY: This research extended the newsboy problem of determining order quantities for perishable goods under conditions of demand uncertainty. The assumption that instances of demand are independent and identically distributed

was relaxed. In addition, the solution was not constrained by limiting ordering to only one order per period. A more realistic formulation with a more practical solution resulted.

This research has shown that a mathematically optimal solution achieved by the classic model can be impractical or even infeasible in practice. However, the solution to the extended problem is both mathematically optimal and feasible in practice. Through case studies, this research has demonstrated that the improvement in production planning and inventory control can be as high as 50%. In fact, when properly implemented and supported by an appropriate management information system, the model can achieve performance levels within 10% of decision-making with perfect knowledge of demand.

OTHER:

From this research, three papers have been prepared and submitted for publication. "An Method of Data Updating for Variance Reduction in Demand Forecasting" was submitted to the *International Journal of Forecasting*; "An Extension of the Newsboy Problem for Perishable Goods" was submitted to *Management Science*; and "An Analysis of Three Forecasting Method Selection Techniques" was submitted to *Decision Sciences*.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Newsboy problem, perishable goods, order quantity, production planing, inventory control

COST EFFECTIVENESS ANALYSES FOR THE NAVAL AIRCRAFT ENGINE COMPONENT IMPROVEMENT PROGRAM

Paul J. Fields, Assistant Professor
Alan W. McMasters, Professor
Department of Systems Management
W. Max Woods, Professor
Department of Operations Research
Sponsor: Naval Air Systems Command

OBJECTIVE: The objective of this research was to provide a methodology for conducting cost/benefit analyses in support of the Navy's aircraft engine Component Improvement Program (CIP) in a constrained budget environment.

SUMMARY: This research supported participation in the Cost Effectiveness Analysis Model (CEAMOD) User's Group and representation by behalf of the Navy in the User's Group. This research also supported the Navy's review of the updates made to the CEAMOD software used in estimating total life-cycle costs for the Navy's aircraft engines. The User's Manual was also updated. In addition, The Weibull distribution was included in the expected value calculations for annual engine failures. A model for determining the cost effectiveness of an engine warranty was also developed. Methodologies were also developed for estimating and predicting reliability parameters for aircraft engines.

OTHER:

A paper was prepared explaining the CEA Model for presentation at the RAMS Symposium, forthcoming in January 1996.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Cost effectiveness, Total Life-Cycle Cost, aircraft engine component improvement

ASSESSMENT OF EMPLOYEE ATTITUDES AT NAWC-ADI AFTER THE BASE REALIGNMENT AND CLOSURE (BRAC) DECISION

Susan Page Hocevar, Assistant Professor
Department of Systems Management
Sponsor: Naval Air Warfare Center - Aircraft Division, Indianapolis

OBJECTIVE: In 1995, NAWC-ADI was named for closure by the BRAC Commission. This study assessed employee preferences for various future employment options, attitudes regarding organizational effectiveness and morale.

SUMMARY: This research was conducted to provide data to assist senior leaders at Naval Air Warfare Center, Aircraft Division, Indianapolis, as they planned strategies for implementing the decision to close the facility. There were two main components of the survey designed. The first assessed employee preferences for federal vs. private sector employment, preferences among NAVAIR facilities for geographic relocation, and confidence in finding future employment. The second component assessed employee perceptions about aspects of organizational performance that had been the focus of a significant change effort at NAWC-ADI over the past four years. Taking questions from surveys used in prior research studies, trends were measured in areas such as: teamwork, empowerment, innovation, communication. The survey was administered to over 1600 personnel representing over 80% of the total population. The data were analyzed for the total sample, as well as subgroupings (e.g., wage grade vs. professional). The results of the longitudinal comparisons of perceptions of organizational effectiveness showed a continuing improvement in perceptions of customer focus, quality service to customers, efficiency of work. Decreases were found in ratings of management truthfulness, support for innovation and cooperation, and commitment to the organization.

OTHER:

Hocevar, S.P., "Summary of Employee Attitude Survey Results Following BRAC Decision," Naval Postgraduate School Project Report, in process.

A briefing document with results of survey and analysis was delivered to the sponsor 12/95.

Hocevar, S.P., "Longitudinal Trends in Employee Perceptions of Quality of Worklife: Through Large Scale Change and Base Closure," paper in progress for journal submission.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: Employee attitudes, base closure, quality of work life

NAVY FLEET AND FLIGHT HOUR BUDGETING AND IMPACT OF BUDGET REDUCTION

Lawrence R. Jones, Professor
Jerry L. McCaffery, Professor
Department of Systems Management
Sponsor: COMNAVAIRPAC

OBJECTIVE: The goal of this project was to assess the budget and the impact of budget reductions in the AIRPAC, PACFLT command, to assess management control system and accounting changes to respond to budget austerity including those related to the DMR process and to analyze U.S.- Japan national defense resource burdensharing.

SUMMARY: Research was performed in the field, in AIRPAC HQ and at installations to assess the characteristics of budget and accounting systems. These systems were analyzed in terms of the roles of the participants and their relationships in budget preparation, analysis and justification. The budget preparation system was analyzed for methods and alternatives to improve efficiency and cost-effectiveness. Preliminary results were presented to the sponsor and

feedback was obtained on approaches to further analysis. The climate and characteristics of the POM and budget preparation were assessed with the assistance of the sponsor to assist in the design of further research.

PUBLICATIONS:

Jones, L.R., "Leaders in the Field: Aaron Wildavsky: A Man and Scholar for All Seasons," Public Administration Review, Vol. 55, No. 1, January/February 1995.

Jones, L.R. and McCaffery, J.L., "Budgeting According to Wildavsky," Politics, Policy and Budgeting, N. Caiden and J. White, eds., Transaction Press, 1995.

Jones, L.R. and Thompson, F., "Public Policy Analysis," Public Policy and Management, J. Rabin, ed., Greenwich, CT, JAI Press, 1995.

CONFERENCE PRESENTATIONS:

Jones, L.R., "Teaching Financial Management," panel chair and paper presentation, Association for Budgeting and Financial Management National Conference, Arlington, VA, October 1995.

Jones, L.R., "Chief Financial Officer's Act Implementation," Association for Budgeting and Financial Management National conference, Arlington, VA, October 1995.

McCaffrey, J.L., "Budgeting Using Computers," Association for Budgeting and Financial Management national conference, Arlington, VA, October 1995.

McCaffrey, J.L., Chair, Plenary session on Budget Issues in 1995-96, and presentation on performance measurement, Association for Budgeting and Financial Management National Conference, Arlington, VA, October 1995.

THESES DIRECTED:

Snyder, E., LT, USN, "Contracting-Out in the Navy," Master's Thesis, March 1995.

Friend, G., LT, USN,"DBOF Stabilization Rates," Master's Thesis, June 1995.

Wolfgang, D., LT, USN, "Performance Measurement and Performance Budgeting in DoD," Master's Thesis, June 1995.

Vandermar, S., LT, USN,"Staffing in the AIRPAC Comptroller Office," Master's Thesis, June 1995.

Wilson, D., LT, USN, "Use of Computer Spreadsheets in Navy Budgeting," Master's Thesis, June 1995.

Lindberg, D., LT, USN, "The Smart Travel Program for Navy Air Stations," Master's Thesis, December 1995.

Bass, K., MAJ, USMC, "DBOF Performance Evaluation for the Marine Corps," Master's Thesis, December 1995.

DOD KEY TECHNOLOGY AREA: Other (Financial Analysis)

KEYWORDS: Budget reduction, accounting systems, cost-effectiveness

IMPACT OF BUDGET REDUCTION AND DOD FINANCIAL MANAGEMENT EDUCATION ASSESSMENT

Lawrence R. Jones, Professor
Department of Systems Management
Sponsor: Department of Defense, Office of the Comptroller

OBJECTIVE: The goal of this project was to assess the impact of budget reductions in DOD and to assist in development of DoD Financial Management Education and Training.

SUMMARY: Research was performed to assess budget reductions. These were analyzed in terms of the roles of the participants and their relationships. The budget system was analyzed for methods and alternatives to improve efficiency and cost-effectiveness. Preliminary results were presented to the sponsor and feedback was obtained on approaches to further analysis. The climate and characteristics of the budget preparation were assessed with the assistance of the sponsor to assist in the design of further research. An assessment of DoD Financial Management Education and Training was conducted and reported to the DOD Comptroller staff.

OTHER:

Presentation to the DoD Financial Management Education Coordinator, Washington, D.C. October 1995.

DOD KEY TECHNOLOGY AREAS: Other (Financial Analysis), Manpower, Personnel and Training

KEYWORDS: Financial Management Education, budget reductions

DESIGN AND IMPLEMENTATION OF A PROTOTYPE MAINTENANCE ADVISOR EXPERT SYSTEM FOR THE MK92 FIRE CONTROL SYSTEM

Magdi N. Kamel, Associate Professor
Martin J. McCaffrey, Visiting Assistant Professor
Department of Systems Management
Sponsor: Naval Surface Warfare Center - Port Hueneme Division

OBJECTIVE: This work is part of a continuing project whose objective is to develop a prototype maintenance advisor expert system for the MK92 Fire Control System to enhance the ability of MK92 technicians to better determine, diagnose, and resolve problems within the system.

SUMMARY: The effort for the current reporting period included the following tasks:

a. Revising, refining, and expanding expert knowledge procedures for both performance and calibration portion of the Daily System Operability Test (DSOT) developed in an earlier effort
b. Designing and implementing the expert procedures using an expert system shell
c. Performing testing, validation, and verification on the implemented procedures
d. Developing a configuration management plan to assist the project development team in managing changes to software and domain knowledge
e. Fielding an initial prototype of the calibration module and collecting users feedback

PUBLICATIONS:

McCaffrey, M.J. and Kamel, M.N., "Diagnostic Expert Systems Offer the Fleet Millions of Dollars in Savings and Significant Improvement in Operational Readiness," Surface Warrior, Vol. 2, No. 3, April-May 1995.

Kamel, M.N., McCaffrey, M.J., and Metzler, P.G., "Design and Implementation of a Prototype Maintenance Advisor Expert System for the MK92 Fire Control System," Proceedings of 6th International Conference on Database and Expert Systems Applications, London, United Kingdom, September 1995.

CONFERENCE PRESENTATION:

McCaffrey, M.J. and Kamel, M.N., "Software Engineering Approach for Expert Systems Development: Lessons Learned in the Development of the MK92 MOD 2 Fire Control System Diagnostic Expert System," 8th Australian Joint AI Conference, Canberra, Australia, November 1995.

THESIS DIRECTED:

Metzler, P.G., "Configuration Management for Expert System Development: Application to the MK92 Prototype Maintenance Advisor Expert System," Master's Thesis, March 1995.

DOD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Expert systems, knowledge acquisition, knowledge representation

A COMPARATIVE STUDY OF DOCUMENT WORKFLOW MANAGER APPLICATIONS

Magdi N. Kamel, Associate Professor
Martin J. McCaffrey, Visiting Assistant Professor
Department of Systems Management
Sponsor: Naval Surface Warfare Center - Port Hueneme Division,

OBJECTIVE: The Objective of this project is to perform a comparative analysis of Commercial Off-The-Shelf (COTS) Workflow products to support the integration of Port Hueneme Division, (PHD) Naval Surface Warfare Center (NSWC) workflow requirements into the Integrated Data Management System (IDMS) centralized on-line Technical Data Management System

SUMMARY: The effort for the current reporting period included completing the following tasks:

a. Performing two in-depth case studies on workflow management projects in industry
b. Investigating the viability of using the Continuous Acquisition and Life-cycle Support (CALS) initiative and its data format specifications in the Request for Proposals (RFP) for R&D of a weapon system
c. Investigating the various networking options available for extending workflow management to the fleet
d. Developing a methodology for using workflow technology to re-engineer current business processes and applying the methodology to re-engineer the technical manual changes process at Port Hueneme Division of the Naval Surface Warfare Center.

THESES DIRECTED:

Dibble, J.D., "Workflow Technology in Action: An Analysis of Workflow Approaches and their Application to Port Hueneme Division-Naval Surface Warfare Center," Master's Thesis, March 1995.

Fuhs, G.H., "Application of the Continuous Acquisition and Life-Cycle Support (CALS) Initiative to the Evolved Seasparrow Missile Program," Master's Thesis, March 1995.

Nassif, T.A., "Supporting the Fleet: Taking Workflow to the Waterfront," Master's Thesis, March 1995.

Bitzer, S.M., "Workflow Re-engineering: A Methodology for Business Process Re-engineering with Workflow Management Technology," Master's Thesis, September 1995.

DOD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Document management, business process analysis, business process re-engineering, workflow automation, workflow software

DATABASE, NETWORK, AND OPERATIONAL ANALYSES FOR THE TOMAHAWK ENGINEERING 2000 PROJECT

Magdi N. Kamel, Associate Professor
Martin J. McCaffrey, Visiting Assistant Professor
Department of Systems Management
Sponsor: Naval Surface Warfare Center - Port Hueneme Division

OBJECTIVE: The objective of this project is to provide the detailed analysis needed to design and create an open, integrated, system for the Tomahawk community. Specifically, the effort performs three separate tasks: database analysis, network analysis, and operational analysis.

SUMMARY: The effort for the reporting period focused on database analysis. It specifically completed the following tasks:

a. Developing a generic methodology for identifying an integrating strategy and architecture for heterogeneous databases in a distributed environment
b. Performing a detailed analysis of the structure and functionality of Tomahawk Information Management Engineering System (TIMES) and Tomahawk Engineering Exchange Network (TEXN) databases
c. Developing a high level conceptual data model for TIMES and TEXN
d. Identifying semantic schema conflicts between TEXN and TIMES
e. Determining the degree of data overlap between TIMES and TEXN
f. Investigating alternative database integration strategies and architectures based on degree of overlap between databases to be integrated
g. Recommending the most suitable integration strategy and architecture for TIMES and TEXN

THESIS DIRECTED:

O'Neill, T.E. and Prell, M.J., "A Methodology for the Integration of Multiple Distributed Heterogeneous Databases: Application to Databases of the Tomahawk Engineering Community," Master's Thesis, September 1995.

OTHER:

Kamel, M.N. and McCaffrey M.J., "Tomahawk Engineering 2000 Project: Database Analysis Final Report," Naval Postgraduate School Technical Report, to appear early 1996.

DOD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Database analysis, network analysis, operational analysis

IDENTIFYING AND RESOLVING SEMANTIC CONFLICTS FOR THE DATABASE INTEGRATION OF THE JOINT MARITIME COMMAND INFORMATION SYSTEM (JMCIS)

Magdi N. Kamel, Associate Professor
Department of Systems Management
Sponsor: Naval Postgraduate School

OBJECTIVE: The objective of this project is to develop a methodology for identifying, classifying, and resolving semantic conflicts occurring during the database integration of the Joint Maritime Command Information System (JMCIS).

SUMMARY: This research completed the following tasks:

a. Examination of previous C^4I database integration efforts
b. Development of a methodology for identifying and classifying semantic conflicts
c. Development of algorithms and heuristics for resolving semantic conflicts
d. Investigation of different implementation options of the developed methodologies in a form suitable for use by database integrators to facilitate the integration efforts

PUBLICATION:

Ceruti, M.G., Kamel, M.N., and Thuraisingham, B.M., "Object-Oriented Technology for Integrating Distributed Heterogeneous Database Systems," Proceedings of 12th DoD Database Colloquium, Database '95, San Diego, CA, August 1995.

DOD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Database integration, federated database systems, semantic conflicts identification and resolution

COST PER OUTPUT ANALYSIS FOR US ARMY RESERVE

Keebom Kang, Associate Professor
Katsuaki L. Terasawa, Associate Professor
Department of Systems Management
Sponsor: U.S. Army Recruiting Command (USAREC)

OBJECTIVE: The objective of this research is to develop a transparent and documentable cost per output methodology for the USAR recruiting activities. The results of this research will provide the decision-maker at the USAR with a decision support tool for policy making.

SUMMARY: High attrition rates in the reserve force is a significant problem. Seventy percent of reserve soldiers do not complete their six year enlistment contract. Separation from the reserve unit before completion of the contractual term of service lowers readiness while increases training and recruiting costs. Army reserve recruits are classified as non-prior service (NPS) -- those without prior miliary training and experience -- and as prior service (PS) -- individuals who have served in the active or reserve forces. Our study shows that PS soldiers have lower attrition rates and are more

cost-effective over a seven year life cycle than NPS soldiers. High quality NPS soldiers show similar results when compared to lower quality NPS soldiers.

The Reserve Personnel Army (RPA) account, the largest among *big ten* accounts, constitutes 75% of the total AR recruiting budget, yet USAREC does not have spending discretion over this account. Without spending authority and responsibility, managers may have little incentive to reduce costs and the ones they can reduce are over-shadowed by what they do not control. Also the recruiters may not be as productive as they could be, although they work very hard, because of the current quota system. The bonus incentive system would help maximize market potential and help USAREC in the efficient allocation of resources. USAREC approved the implementation of our proposed bonus incentive recruiting system. Both the RA and AR cost per output studies are being continued under the new project, *Experimentation of Bonus Incentive Recruiting Model (BIRM).*

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: Recruiting, cost per output, life-cycle cost, decision-support, manpower, cost-benefit analysis, reserve

SYSTEMS ACQUISITION MANAGEMENT SUPPORT

David V. Lamm, Associate Professor
Department of Systems Management
Sponsor: Assistant Secretary of the Army (RD&A)

OBJECTIVE: The Military Deputy to the Assistant Secretary of the Army (Research, Development & Acquisition) is the sponsor of the Systems Acquisition Management curriculum at NPS. This funding supports Army thesis students (military and civilian) in the 816 program, an acquisition library and librarian, faculty travel for development purposes, and the academic associate.

SUMMARY: The objective of the 816 curriculum is to provide selected officers and Government civilians an advanced education in the fundamental concepts, methodologies, and analytical techniques necessary for the management of major defense systems. The curriculum is open to both U.S. students and officers/civilians of Allied nations. The curriculum is currently eight quarters for Army officers and seven quarters for all others, however, the Army sponsor is seeking to shorten the program for Army officers to six quarters. This will take effect in July 1996. A key feature of this program is its relationship with the requirements of the Defense Acquisition Workforce Improvement Act (DAWIA) which statutorily requires mandatory training in various career fields. The most significant of these requirements is the Advanced Program Management Course (PMT302) sponsored by the Defense Systems Management College (DSMC). The NPS 816 curriculum is the only program in the country which has satisfied comparability requirements for PMT 302, a Level III (Executive Level) Program Management course. The 816 curriculum also satisfies requirements through Level III in Test and Evaluation (T&E) Engineering and Level II (Intermediate Level) in Systems Planning, Research, Development and Systems Engineering (SPRDE). A comparability review was conducted in November 1995 for purposes of continuing review and modifications made to reflect the new PMT 302 which superseded PMT 301.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: Systems Acquisition Management, advanced education

SYSTEMS MANAGEMENT

CENTER FOR ACQUISITION EDUCATION, TRAINING AND RESEARCH (CAETR)

David V. Lamm, Associate Professor
Department of Systems Management
Sponsor: Defense Acquisition University (DAU)

OBJECTIVE: NPS is a consortium member of the Defense Acquisition University (DAU). CAETR is the organization which budgets and administers courses offered by NPS faculty from various departments and groups. The objective of this funding is to support the courses sponsored, maintained and offered by NPS at both resident and on-site locations, and to fund acquisition research sponsored by DAU.

SUMMARY: As a consortium member of the DAU, NPS sponsors and offers three courses (TST 202, TST 301, LOG 304) and co-designed and offers a fourth course (SYS 201). NPS delivers these courses in both the resident and on-site mode utilizing faculty members from a variety of departments including Systems Management, Operations Research, Mathematics, C4I, and Mechanical Engineering. NPS offers approximately 45 course offerings each fiscal year. NPS is also currently preparing to offer the core courses (ACQ 101 and ACQ 201) which will add approximately 20-25 additional course offerings per year. Another consortium school, the Naval Center for Acquisition training (NCAT), is an echelon 3 command under NPS and reports to NPS through CAETR. NCAT is headquartered in Norfolk, VA and has detachments in Rock Island, IL and Kaiserslautern, Germany. NCAT sponsors LOG 204 and SYS 201 and is a certified offeror for a variety of courses in the Contracting, Logistics, Manufacturing & Production, Quality Assurance, and Business/Financial Management career fields.

OTHER:

Text materials for each course sponsored by NPS has been developed and is constantly under revision as acquisition reform actions are implemented.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: CAETR, Defense Acquisition University (DAU), training

CIVILIAN HYBRID ENGINEERING PROGRAM (CHEP)

David V. Lamm, Associate Professor
Department of Systems Management
Sponsor: Assistant Secretary of the Navy (RD&A)

OBJECTIVE: The objective of this funding is to explore interest in the Navy and Army regarding engineering masters programs for civilians in the acquisition workforce as defined by the Defense Acquisition Workforce Improvement Act (DAWIA).

SUMMARY: Approximately 20,000 to 25,000 civilians in the Army and Navy acquisition workforces (from a total of approximately 58,000) are employed in the Systems Planning, Research, Development and Engineering (SPRDE) career field. Both the Army and Navy acknowledge that more needs to be accomplished in providing educational opportunities for civilians in the acquisition workforce, comparable to the level of opportunity for uniformed officers of these Services. In developing potential NPS curricula for these individuals, NPS teams are visiting Army and Navy field sites (e.g., NRAD, NAWC-WD, ATCOM, CECOM, TACOM, etc.) to determine potential interest. Curricula would be tailored to individual needs, would include sufficient acquisition courses to satisfy DAWIA requirements, and would be offered in a variety of methods including resident at NPS, Video Teleconferencing (VTC), local college courses, and other distance learning methods. Following a review of interest from field commands and potential students, and development of appropriate curricula, NPS will propose implementation of these programs to the Assistant Secretary for Research, Development and Acquisition (RD&A) in each service.

SYSTEMS MANAGEMENT

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: CHEP, DAWIA, acquisition training, advanced education

CHAPTERS 1-6 AND 8 OF "NAVY AND DEFENSE INVENTORY MANAGEMENT"

Alan W. McMasters, Professor
Thomas P. Moore, Research Assistant Professor
Department of Systems Management
Sponsor: Naval Supply Systems Command

OBJECTIVE: This continuing research project involves the research and writing of Chapters 1-6 and 8 of a new textbook called *Navy and Defense Inventory Management.* This textbook will replace NAVSUP Publication 553, *Inventory Management,* published in 1983. The new textbook will be used in two graduate courses in the Systems Management Department at the Naval Postgraduate School and as a reference document by Navy and other supply system personnel. These chapters of the textbook include an introduction to military inventory management; an overview of inventory theory; descriptions of wholesale and retail provisioning processes in the Navy; descriptions of wholesale and retail requirements determination and management processes in the Navy Supply System; and an overview of Navy inventory management outside of the Navy Supply System.

SUMMARY: Work began on this project in late November, 1995. Detailed outlines of the contents of the chapters were circulated for comment to appropriate personnel at the Naval Supply Systems Command and the Naval Inventory Control Point. Parts of Chapters 1 and 2 were written, and research was done on an introductory scenario for Chapter 1 that illustrates both the uniqueness of military inventories and the importance to the Navy of good inventory management practices.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Inventory management, Navy Supply System, defense logistics, users' manual

READINESS-BASED SPARING REPLENISHMENT MODEL FOR REPAIRABLE ITEMS

Alan W. McMasters, Professor
Department of Systems Management
Sponsor: Naval Supply Systems Command

OBJECTIVE: A continuing project to develop a wholesale level inventory model for the Navy's Inventory Control Points to use to replenish their inventories of repairable items; the objective function of this model should be related to readiness.

SUMMARY: A new inventory model for managing repairables at the wholesale level is needed to determine when to replenish repairable items associated with a specific weapon system. This model should have the same objective function as the wholesale provisioning (or first buy quantity) model developed on this project between 1982 and 1986; namely, the minimization of the aggregate Mean Supply Response Time (MSRT).

Investigation of a realistic simulation model of the Navy's repairable inventory management process continued this past year, with the help of an Operations Research thesis student, in an attempt to determine a formula for describing safety stock as a function of the order quantity, repair quantity, and the maximum level of the inventory position. Formulas for the expected time weighted backorders and the probability of being out of stock at any instant of time were derived from the net inventory distribution developed last year. These were then used in a comparison between the current Navy

model and the new model for two different standard Navy measures of effectiveness. The new model's results were found to be much closer to reality than the existing model. These results were presented to the inventory modeling personnel at the Navy Ships Parts Control Center in May.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Inventory management, Navy repairable items, inventory model

COST EFFECTIVENESS ANALYSIS OF THE NAVAL AIRCRAFT ENGINE COMPONENT IMPROVEMENT PROGRAM

Alan W. McMasters, Professor
Department of Systems Management
Sponsor: Naval Air Systems Command

OBJECTIVE: A continuing project to develop models to predict the savings in life-cycle costs of proposed engineering changes intended to improve reliability, maintainability, and sustainability of turbine aircraft engines for Naval aircraft.

SUMMARY: An important element of aircraft logistical support is the aircraft engine Component Improvement Program (CIP). The CIP is essential for the continuing evolution of these engines. This project is looking for ways to justify that program. The first phase was to examine the current life-cycle cost models used by the Air Force and the Navy which are intended to show the expected savings from a specific proposed component improvement. NPS' evaluation of the Air Force's Cost Effectiveness Analysis Model (CEAMOD) resulted in its adoption by the Navy's in May 1993. The second phase was to validate the actual costs and logistics effectiveness of the CIP by looking at historical data. That may also suggest ideas for an improved model. A third phase addressed the problem of justifying warranties on aircraft engines. Finally, a fourth phase has been to determine ways of setting reasonable reliability goals for fielded engines.

An investigation into the CEAMOD's practice of truncating expected values of certain variables (such as the number of engine failures in a particular year) was conducted in 1993. The purpose was to see if using the true expected values would result in a different decision with regard to an ECP than the CEAMOD would recommend. The conclusion was that there would be no change. The changing of the CEA model to a non-integer version was a major issue at the last CEA Users' Group meeting in Cincinnati in May 1995. The decision was made to make that change.
The performance of the TF-34 engine was studied for the situation where there is a single engine failure/shut down in critical flight situations such as takeoff and climb out for the S-3 and ES-3A aircraft. The concern was that the remaining engine should have sufficient thrust to allow safe landing of the aircraft. Improving the single engine rate of climb (SEROC) was therefore the focus. It was recommended that increasing the engine operating temperature limits for the ES-3A would resolve the problem.

Methods were investigated for constructing fielded jet engine performance goals using non-parametric and parametric (Weibull distribution) analysis. The analysis was performed on TF-34 engine removal and repair data taken from the NALDA data base. Tables of conditional probabilities of failure were constructed that could be used by maintenance planners in scheduling engine removals for planned maintenance. The effect of cannibalizations on the probabilities of failure was considered significant enough to warrant an investigation into why it appeared to have been done so much. A result of that investigation was that improvement in the mean time between failure (MTBF) or mean time between repair (MTBR) could be achieved if the cannibalization program were improved (i.e., the number of cannibalizations performed was reduced). Discussions with NAVAIR personnel indicated that the cannibalization program has improved significantly within the last two years. A subsequent analysis of the TF-34 data base supported this claim.

THESES DIRECTED:

Caudill, M. R., "Methods For Performance Goal Setting of Fielded Jet Engines," Master's Thesis, June 1995.

Micklewright, A. J., "An Analysis of Single-Engine Rate-of-Climb Capabilities and Thrust Requirements of the S-3 and ES-3 Aircraft in Support of the TF34 Engine Component Improvement Program," Master's Thesis, June 1995.

Malsbury, J.A.,"Methods for Determining Goals and Expectations for Fielded Jet Engines," Master's Thesis, December 1995.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Naval aircraft engines, Component Improvement Program (CIP), cost/benefit analysis, aircraft engine warranties, reliability assessment

ECONOMIC COST ANALYSIS MODELING IN RELATION TO MATERIAL LOGISTICS/SHELF LIFE

Alan W. McMasters, Professor
Department of Systems Management
Sponsors: Naval Facilities Command Engineering Service Center, Pt. Heuneme, and Naval Supply Systems Command

OBJECTIVE: A continuing project to develop a cost/benefit model for determining if the benefits of increasing the shelf life of a hazardous material is worth the costs of the process for doing so. In addition, an inventory management model is being developed to manage hazardous material.

SUMMARY: Over the past two years a modeling effort has been under way to develop an inventory management model in support of the Hazardous Material Minimization Center Concept for the Fleet and Industrial Support Center (FISC) Puget Sound. Two models were proposed last year; an Economic Order Quantity (EOQ) continuous review model and a Silver-Meal type of periodic review model. This year those models were expanded and used to develop a model for determining if extending the shelf life of a hazardous material would be cost effective and a model which incorporates the possibility of shelf-life extension into the optimal policy for determining when and how much new material to order to replenish depleted inventories of hazardous material. Simulation results comparing the optimal total annual variable costs for the continuous review and periodic review models showed very little difference and suggested that the decision as to which is the preferred model should be left to the decision maker.

THESES DIRECTED:

Murray, D.D.,"An Inventory Model for Analyzing the Benefits of Extending Limited Shelf-Life Hazardous Material in the DoD Supply System," Master's Thesis, June 1995.

Collins, B.L., and Stroh, G.F.,"The Use of Simulation to Evaluate Inventory Models for Management of Hazardous Material," Master's Thesis, December 1995.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Hazardous material, inventory management, shelf life studies, cost/benefit analysis

SYSTEMS MANAGEMENT

A CONCEPTUAL MODEL FOR DETERMINING AN OPTIMAL DRUG TESTING PROGRAM

Stephen L. Mehay, Professor
Department of Systems Management
Sponsor: Navy Personnel Research and Development Center

OBJECTIVE: The goal of this project was to develop a conceptual model for determining an optimal drug testing strategy.

SUMMARY: The objective of this effort is to develop a conceptual model for determining an optimal drug testing strategy for the U.S. Navy. The model attempts to define appropriate objectives for the drug testing program and further refine the methodology for defining costs and benefits of the program. The model considers such issues as detection, deterrence, relevant probabilistic models, and potential gaming by personnel. Developing and linking concepts such as economic benefits and costs, probability of detection, deterrence, and drug kinetics are a principal focus. The research will provide the foundation for development of a system to determine an optimal Navy drug testing strategy.

PUBLICATION:

Borack, J. and Mehay, S., "A Conceptual Model for Determining an Optimal Drug Testing Program," Technical Report, Navy Personnel Research and Development Center, San Diego, CA, 1995.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel, and Training

KEYWORDS: Drug kinetics, drug testing, optimal drug policy, urinalysis strategies, cost-benefit analysis

ANALYSIS OF FINANCIAL RATIO PATTERNS IN THE DEFENSE INDUSTRY

O. Douglas Moses, Associate Professor
Department of Systems Management
Sponsor: Naval Postgraduate School

OBJECTIVE: The goal of this project was to investigate patterns exhibited by financial ratios within the U.S. defense industry and to determine the state of the art of financial analysis of defense industry firms within DoD. This year's work extended efforts initiated in 1994.

SUMMARY: This project was designed to assist in laying a foundation for conducting financial analyses of defense industry firms. One part of this year's effort involved documenting the practice of financial analysis of defense industry firms as currently conducted by organizations in DoD and the military services. Five organizations actively involved in financial analysis were identified, and findings indicated wide differences in analytical approaches used across the various organizations. The second part involved an analysis of financial ratios of defense industry firms, with attention focused on cross-sectional and time-series patterns. Two specific questions were addressed: (1) What are the fundamental dimensions of financial condition within the defense industry? Findings indicated eight consistent aspects of financial condition and identified specific ratios which best measured these aspects. (2) What models are most accurate for forecasting future values for financial ratios? Findings indicated that it was difficult to identify models which are superior to a random walk. Collectively, the findings add to basic knowledge relevant to conducting financial analyses of defense firms within DoD.

PUBLICATION:

Moses, O.D., "Basic Dimensions of Financial Condition Within the Defense Industry," Naval Postgraduate School Technical Report, NPS-SM-95-008, November 1995.

THESES DIRECTED:

Jenkins, J.D., LT, USCG, "Financial Ratio Time Series Models in Defense Industries," Master's Thesis, December 1994.

Gursoy, G., First LT, Turkish Army, "Financial Ratio Patterns in the U.S. Defense Industry," Master's Thesis, December 1994.

White, R.M., LCDR, USN, "The Primary Dimensions of Financial Condition for Firms Within The Defense Industry," Master's Thesis, December 1994.

Borah, D.C., LT, USN, "Financial Analysis of Private Sector Firms within the DOD," Master's Thesis, June 1995.

Katz, R.D., LT, USN, "Primary Dimensions of Change in the Financial Condition of Defense Industry Firms," Master's Thesis, June 1995.

Keith, K.G., LT, USN, "Analysis of the Relationship between Reliance on Government Business and Financial Condition of Defense Firms," Master's Thesis, June 1995.

OTHER:

A paper, "Forecasting Financial Ratios in the Defense Industry" is scheduled for presentation at the annual DoD Cost Analysis Symposium, Washington, DC, February 1996. The technical report listed above will be submitted for publication during early 1996. A second technical report, related to financial ratio forecasting, is in progress.

DOD KEY TECHNOLOGY AREA: Other (Financial Analysis)

KEYWORDS: Financial analysis, financial ratios, defense industry

COLLABORATIVE SYSTEMS FOR THE ADAPTIVE RETENTION OF DECISION RATIONALE

Balasubramaniam Ramesh, Assistant Professor
Kishore Sengupta, Associate Professor
Department of Systems Management
Sponsor: Naval Postgraduate School

OBJECTIVE: The objective of this research is to develop an environment to support military decision makers by capturing and reusing decision rationale.

SUMMARY: Military organizations do not have adequate mechanisms for retaining knowledge gained from non-canonical practices employed in solving complex problems. We have developed a prototype collaborative system that will permit the adaptive retention and reuse of such knowledge. This research has applicability in areas such as software engineering, concurrent engineering, and joint task force planning processes. This approach has been validated in the context of large scale systems development to elevate the process of systems maintenance to the level of specifications and the rationale behind their creation. The results of the study have implications for organizational learning as well as the capture and reuse of design rationale.

PUBLICATION:

Ramesh, B. and Sengupta, K., "Multimedia in a Design Rationale Decision Support System," Decision Support Systems, forthcoming.

THESIS DIRECTED:

Sudhoff, K. and Vance, C., "Hypermedia Process Knowledge Mapping (HYPERPKM)," Master's Thesis in Information Technology Management, September 1995.

OTHER:

The REMAP model and mechanisms developed in this research are being incorporated in the knowledge based software assistant CASE tool prototype being developed by the U.S. Air Force.

DOD KEY TECHNOLOGY AREAS: Computing and Software, Other (Design Automation)

KEYWORDS: Design rationale, process knowledge, systems development .

COMPLEX TRACEABILITY TECHNIQUES

Balasubramaniam Ramesh, Assistant Professor
Department of Systems Management
Sponsor: Naval Surface Warfare Center - Dahlgren Division

OBJECTIVE: The objective of this research is to develop a model of requirements traceability to support various stakeholders in large scale systems development.

SUMMARY: Development of complex, mission critical systems involves modification, refinement and evolution of initial requirements that lead to design solutions. In order to provide intelligent and useful support to the process of design and maintenance, a formal representation of the linkages between the design solutions and the requirements is essential. Based on an extensive empirical study of systems development personnel, this project has developed several models for requirements traceability. The semantics of various kinds of traceability information that can be captured and used in large scale systems development activities has been clearly defined. These models are being incorporated in several system engineering tools.

PUBLICATIONS:

Ramesh, B. and Luqi, "An Intelligent Assistant for Requirements Validation for Embedded Systems," Journal of Systems Integration, Vol. 5, No. 2, pp. 157-177, 1995.

Ramesh, B., Stubbs, C., Powers, T., and Edwards, M., "Lessons Learned from Implementing Requirements Traceability," CrossTalk: The Journal of Defense Software Engineering, April 1995.

Ramesh, B., Powers, T., Stubbs, C., and Edwards, M., "Implementing Requirements Traceability," Proceedings of the IEEE International Symposium on Requirements Engineering, York, UK, pp. 89-95, March 1995.

Ramesh, B. and Edwards, M., "Towards Models for Requirements Traceability," Proceedings of the IEEE International Symposium on System Engineering of Computer Based Systems. Tucson, AZ, pp. 229-239, March 1995.

Ramesh, B., "Supporting Model Lifecycle with Traceability," Proceedings of the First International Conference on Engineering of Complex Computer Systems - Workshop on Complex Systems Engineering Synthesis and Assessment Technology, Fort Lauderdale, FL, pp. A1-A8, November 1995.

Ramesh, B., "Traceability in Model Lifecycle Management," Proceedings of the ISDSS '95 Conference, Hong Kong, pp. 295-303, July 1995.

THESES DIRECTED:

Berry, E., "Randomization Testing of Machine Induced Rules," Master's Thesis in Information Technology Management, September 1995.

Sudhoff, K. and Vance, C., "Hypermedia Process Knowledge Mapping (HYPERPKM)," Master's Thesis in Information Technology Management, September 1995.

DOD KEY TECHNOLOGY AREAS: Computing and Software, Other (Design Automation)

KEYWORDS: Requirements traceability, systems development

DYNAMICS OF CHANGE

Nancy Roberts, Professor
Department of Systems Management
Sponsor: Unfunded

OBJECTIVE: This research represents an ongoing effort to empirically examine the dynamics of change. Its objective is to investigate, in real time, how change agents (public entrepreneurs and transformational leaders) diagnose problems in a system, conceptualize what changes are needed, and then design interventions to lead the change process.

SUMMARY: Public organizations are challenged to adapt to an increasingly competitive economic, political, technological, and social environment. Government policies established under the Post World War II era are being reexamined, and many cases, rejected. A massive world-wide transformation is underway, forcing policy makers to rethink their fundamental assumptions in all domains of public life, from education to warfighting.

Often reliant on incremental thinking and reactive problem solving, policy makers and public managers now are encouraged to be change agents, public entrepreneurs, and transformational leaders who will move us beyond the "givens" of public policy and management. How does one transform public policy? How does one reconfigure public bureaus to direct and implement those policies? These are the basic questions of this research.

The research has two aspects--the domain of public policy and the domain of public management. Radical, transformative changes in public policy have been the primary research focus over the past twelve years. Having completed a longitudinal study of radical policy change in 1995, the next phase of the project tackles the implications of radical policy change for public bureaus. It is expected that as radical shifts in public policy occur, public bureaus will need to be reconfigured and redesigned to match the new realities. This next phase of the project examines how the redesign efforts are faring and what lessons we can draw from them to aid military organizations.

PUBLICATIONS:

Roberts, N.C. and Dotterway, K., "The Vincennes Incident: Another Player on the Stage?" Defense Analysis, Vol. 11, No. 1, pp. 31-45, 1995.

Roberts, N.C. and King, P.J., Transforming Public Policy: Dynamics of Entrepreneurship and Innovation, San Francisco: Jossey-Bass, in press.

CONFERENCE PRESENTATION:

Roberts, N.C., "Innovation by Legislative, Judicial, and Management Design," Third Public Management Research Conference at the University of Kansas, October 1995.

THESES DIRECTED:

Bower, M., "Restructuring Naval Postgraduate School To Better Manage Base Operations Support," Master's Thesis, in Management, December 1995.

Treshansky, D., "Survey of Customer Satisfaction," Master's Thesis in Management, December 1995. (Co-advisor)

Onorati, A.B. and Robillard, S.E., "An Analysis of Naval Aviation Squadron Information Systems and Strategy for Implementation," Master's Thesis in Information Technology Management, September 1995.

Gregoire, J., "Improving Productivity with Information Technology," Master's Thesis in Information Technology Management, September 1995.

Prado, K., "A Strategic Plan for the Venezuelan Navy Communications Directorate," Master's Thesis in Information Technology Management, March 1995.

Sper, M.K., "Towards Understanding Terrorism: A Theoretical Examination of Internal Cohesion in Terrorist Groups and the Negative Dynamic of Violence," Master's Thesis in National Security Affairs, March 1995.

OTHER:

Roberts, N.C., "Public Deliberation: An Alternative Approach to Crafting Policy and Setting Direction," Working Paper.

DOD KEY TECHNOLOGY AREA: Other (Change Process)

KEYWORDS: Change process, innovation, public policy, public management

A NEEDS ASSESSMENT FOR FINANCIAL MANAGEMENT EDUCATION FOR DEPARTMENT OF DEFENSE HEALTH CARE EXECUTIVES

Joseph G. San Miguel, Professor
Department of Systems Management
Sponsor: Office of the Assistant Secretary of Defense for Health Affairs

OBJECTIVE: The objectives of this research are to perform a needs assessment for executive financial management education within the new Department of Defense health care reform program (TRICARE) and prepare recommendations for the design of an executive education program. The findings and recommendations will be provided to the TRICARE Managed Care Support Financial Management Work Group, OASD (Health Affairs). This is the first phase of a multi-phase research and curriculum development program that will result in the delivery of an executive education program to targeted health care financial managers and other tri-service health care executives.

SUMMARY: Rising costs have increased the pressure for improvements in the expenditure of funds for health care. One approach to budgeting health care dollars that has been adopted by the Department of Defense is capitation budgeting. This change in financing of DoD medical services has raised concern for the resource management systems and the organizational arrangements within the DoD medical service communities. The DoD health care reform

program known as TRICARE is transforming operational and strategic planning systems because of the three health care options that are provided to beneficiaries within a capitation-based financial management environment. The fixed-price contracts and risk sharing introduced in TRICARE present new challenges for front line managers and financial managers. In this context the Office of the Assistant Secretary of Defense (Health Affairs) TRICARE Managed Care Support (MCS) Financial Management Work Group requires a financial management executive education program to enhance resource management skills and knowledge unique to the TRICARE program. Congress, GAO, and OMB have also requested a professional education program to prepare health care managers for their responsibilities under TRICARE.

THESIS DIRECTED:

Martinez, S., LT, USN, "Analysis of the Cost of Providing Medical Care to Active-Duty Military Personnel in the Monterey Area," Master's Thesis, June 1995.

OTHER:

Briefed the Office of the Assistant Secretary of Defense for Health Affairs Financial Management Work Group in November 1995.

DOD KEY TECHNOLOGY AREA: Other (Financial Analysis)

KEYWORDS: Financial management, health care, management care

VALUE CHAIN ANALYSIS FOR STRATEGIC PLANNING AND ANALYSIS

Joseph G. San Miguel, Professor
Department of Systems Management
Sponsor: Society of Management Accountants of Canada

OBJECTIVE: The objectives of this research are threefold. First, value chain analysis is defined in the context of strategic planning and competitive analysis. Second, the steps in performing value chain analysis are explained in actual applications. Third, the internal and external information needs of managers and the role of the management accountant in value chain analysis are discussed.

SUMMARY: Value chain analysis can be implemented industry wide or intra-firm. Whether executives are concerned with strategic positioning of their goods and services or with expanding their core competencies, value chain analysis can provide valuable insights on current and future products and services. The value chain approach may involve activity based cost management, benchmarking, reengineering, life cycle costing, target costing and other management techniques. Upstream linkages with suppliers and downstream linkages with customers are examined. Low or non-value added activities can be identified. As the key decision makers in the firm, managers should be very interested in value chain analysis and its potential usefulness. Likewise, management accountants, who are the resident experts to gather, summarize, and report value chain information, are an important audience. As with kaizen, value chain analysis is not a one-shot application but a continuous process for evaluating the overall business as it strives to provide value to the customer.

PUBLICATION:

San Miguel, J.G., "Value Chain Analysis for Assessing Competitive Advantage," to appear, Society of Management Accountants, Ontario, Canada.

DOD KEY TECHNOLOGY AREA: Other (Financial Analysis)

KEYWORDS: Value chain analysis, strategic planning

STRATEGIC PROFIT ANALYSIS

Jospeh G. San Miguel, Professor
Department of Systems Management
Sponsor: Unfunded

OBJECTIVE: The aim of this research project is to develop a new approach to profit variance analysis that incorporates new theories concerning cost definitions, aggregation, and competitive analysis in strategic planning and profitability analysis.

SUMMARY: Conventional cost-volume-profit analysis and profit variance analysis has been criticized because of the underlying cost behavior assumptions and unrealistic decision horizon. Given recent changes in cost definitions, cost disaggregation theories, and use of value added factors, a new framework is needed to meet the challenges of global competition and information technology.

THESES DIRECTED:

Pickering, J.D., LT, USN, "Value Allocation to Network Surveillance Operations Division of Pacific Bell Company," Master's Thesis, December 1995.

Rutledge, J.A., CAPT, USMC, "Management Information Requirements of Military Sealift Command's Reengineered Business Line Organizational Structure," Master's Thesis, December 1995.

Fadok, G., LT, USN, "J.A.S.T. Affordability: A Model of Determining Avionics Component Cost," Master's Thesis, December 1995.

DOD KEY TECHNOLOGY AREA: Other (Financial Analysis)

KEYWORDS: Profit analysis, cost definitions

DEVELOPMENT OF A METRICS-BASED SOFTWARE RELIABILITY MODEL

Norman F. Schneidewind, Professor
Department of Systems Management
Sponsor: Naval Surface Warfare Center, Dahlgren

OBJECTIVE: Investigate whether the use of metrics would increase the predictive accuracy of the *Schneidewind Software Reliability Model.*

SUMMARY: If metrics improve prediction accuracy, they would be included in the model for future *Space Shuttle* software reliability prediction. It is appealing to *believe* that high complexity results in low reliability; therefore, by this reasoning, the inclusion of complexity should improve prediction accuracy.

Currently the model uses two parameters. Alpha (α) is the failure rate in the failure count interval *s-1*. The interval *s-1* precedes the interval *s* where we start to use the failure data of the parameter estimation range s,t. Beta (β) determines how fast the failure rate decreases. This model uses *s* to optimally select the failure data for parameter estimation. The

parameters α and β are assumed to be constant. Actually, they vary with execution time. There are two possible explanations for the fact that β varies with execution time, signifying a change in the rate of change in failure rate: 1) variations in the complexity of code at various stages of execution or, 2) a reflection of the fact that with fewer faults left in the code, as they are discovered and corrected, finding the remaining ones requires increasing amounts of execution time. If the explanation is the former, the use of metrics in parameter estimation could be beneficial.

Based on the results of the experiment we concluded the following:

a. The results showed that metrics, as formulated in the model, did not increase prediction accuracy. Accuracy was increased in only one module and it was a marginal improvement.

b. Although prediction was not improved, there was a significant benefit for the quality control of the *Space Shuttle*. This was the development of a Boolean Discriminant function procedure and result that was able to successfully classify the failed modules in 100 % of the 47 failed modules that were analyzed.

c. The accuracy of prediction of this model for the *Space Shuttle* is already fairly good (e.g., the "no metrics" predictions were already very close to the actual). We conclude that greater contributions to *Space Shuttle* software reliability can be made by employing a number of other enhancements that have been made recently: predicted test time as a function of remaining failures, and vice versa; risk analysis for time to failure and remaining failures predictions; constrained M.L.E. parameter estimation to prevent parameter estimates that can lead to infeasible mathematical predictions; and variable failure count interval.

PUBLICATIONS:

Schneidewind, N.F., "Software Metrics Validation: Space Shuttle Flight Software Example," Annals of Software Engineering, J. C. Baltzer AG, Science Publishers, Vol. 1, pp. 287-309, 1995.

Schneidewind, N.F., "Controlling and Predicting the Quality of Space Shuttle Software Using Metrics," Software Quality Journal, Vol. 4, pp. 49-68, Chapman & Hall, 1995.

Schneidewind, N.F., "Work in Progress Report: Experiment in Including Metrics in a Software Reliability Model," Proceedings of the Annual Oregon Workshop on Software Metrics, Silver Falls, OR, 5-7 June 1995.

Schneidewind, N.F., "Statistical Methods for Controlling and Predicting the Quality of Software," Proceedings of the Santa Clara Valley Section of the American Society for Quality Control, Quality Conference 95, Santa Clara, CA, 4-6 April 1995.

Keller, T., Schneidewind, N.F., and Thornton, P.A., "Predictions for Increasing Confidence in the Reliability of the Space Shuttle Flight Software," Proceedings of the AIAA Computing in Aerospace 10, San Antonio, TX, pp. 1-8, 28 March 1995.

CONFERENCE PRESENTATIONS:

Schneidewind, N.F., Tutorial: "Planning and Implementing a Software Quality Metrics Program," International Symposium on Software Reliability Engineering, Toulouse, France, 24 October 1995.

Schneidewind, N.F., "Non-Parametric Statistical Methods for Controlling and Predicting the Quality of Space Shuttle Flight Software," TIMS XXXIII Conference, Singapore, 26 June 1995.

Schneidewind, N.F., "Work in Progress Report: Experiment in Including Metrics in a Software Reliability Model," Annual Oregon Workshop on Software Metrics, Silver Falls, OR, 5-7 June 1995.

Schneidewind, N.F., Tutorial: "Statistical Methods for Controlling and Predicting the Quality of Software," Santa Clara Valley Section of the American Society for Quality Control, Quality Conference 95, Santa Clara, CA, 4 April 1995.

Keller, T., Schneidewind, N.F., and Thornton, P.A., "Predictions for Increasing Confidence in the Reliability of the Space Shuttle Flight Software," AIAA Computing in Aerospace 10, San Antonio, TX, 28 March 1995.

Schneidewind, N.F., "Software Metrics Validation and Application," Naval Surface Weapons Center, Dahlgren, VA, 7 November 1995.

DOD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Software reliability, software quality metrics, modeling

DEVELOP A DISTRIBUTED SYSTEM SOFTWARE RELIABILITY MODEL AND A SOFTWARE RELIABILITY ENGINEERING PROCESS

Norman F. Schneidewind, Professor
Department of Systems Management
Sponsor: Marine Corps Tactical System Support Activity

OBJECTIVE: Develop a software reliability model for distributed systems and implement a software reliability engineering process.

SUMMARY: The objective of this project was to improve the software reliability of Marine Corps AISs. In order to achieve this goal, a Software Reliability Engineering (SRE) process was designed for the implementation of reliability improvements in distributed systems. The reliability model and associated process, and the criteria for judging whether reliability goals have been met, encompassed multi-node systems. We prototyped the reliability plan "in the small" before committing to it "in the large". This meant trying out the model and the process on a relatively simple system with a minimum number of personnel involved.

Based on the above approach, it was feasible to develop a system software reliability model for distributed systems In order to implement the approach, it was necessary to partition the defects and failures into critical and non-critical classes and to further classify them as being associated with critical and non-critical servers and clients. Once this was done, predictions were made of *time to next failure* for each class; the predictions were classified according to those that would result in a software failure and those that would result in a system failure; and the probability of system failure was computed.

PUBLICATIONS:

Schneidewind, N.F., "Reliability and Risk Analysis of the NASA Space Shuttle Flight Software," Proceedings of the Twentieth Annual Software Engineering Workshop, NASA/Goddard Space Flight Center, 29-30 November 1995.

Schneidewind, N.F., "Predictions for Increasing Confidence in the Reliability of Safety Critical Software," Proceedings of the First IEEE International Conference on Engineering of Complex Computer Systems, Ft. Lauderdale, FL, pp. 104-107, 6-10 November 1995.

Schneidewind, N.F., Panel Chair: "Reliability of Safety-Critical Systems," Position Paper: "Experimentation with a Metrics-Based Reliability Model," Proceedings of the International Symposium on Software Reliability Engineering, Toulouse, France, pp. 266-267, 25-27 October 1995.

Schneidewind, N.F., "Reliability and Risk Analysis for Software That Must be Safe," Proceedings of the Fourth Bellcore/KPN/Purdue Workshop on Issues in Software Reliability, Leidschendam, The Netherlands, 22-23 October 1995.

CONFERENCE PRESENTATIONS:

Schneidewind, N.F., "Reliability and Risk Analysis of the NASA Space Shuttle Flight Software," Twentieth Annual Software Engineering Workshop, NASA/Goddard Space Flight Center, 29-30 November 1995.

Schneidewind, N.F., "Predictions for Increasing Confidence in the Reliability of Safety Critical Software," First IEEE International Conference on Engineering of Complex Computer Systems, Ft. Lauderdale, FL, 6-10 November 1995.

Schneidewind, N.F., Panel Chair: "Reliability of Safety-Critical Systems," Position Paper: "Experimentation with a Metrics-Based Reliability Model," International Symposium on Software Reliability Engineering, Toulouse, France, 25-27 October 1995.

Schneidewind, N.F., Tutorial: "Planning and Implementing a Software Quality Metrics Program," International Symposium on Software Reliability Engineering, Toulouse, France, 24 October 1995.

Schneidewind, N.F., "Reliability and Risk Analysis for Software That Must be Safe," Fourth Bellcore/KPN/Purdue Workshop on Issues in Software Reliability, Leidschendam, The Netherlands, 22-23 October 1995.

Schneidewind, N.F., Panel Chair: "Measurement for Maintenance Panel," International Conference on Software Maintenance," Nice, France, 17-20 October 1995.

Schneidewind, N.F., Tutorial: "Applying Standards to Software Reliability Engineering", Second International Symposium on Software Engineering Standards, Montreal, Canada, 21 August 1995.

Schneidewind, N.F., Tutorial: "Software Reliability Engineering," Pan Pacific Conference on Information Systems, Singapore, 29 June 1995.

Schneidewind, N.F., Tutorial: "State of the Practice in Software Reliability Engineering," Quality Week 95, Software Research, Inc., San Francisco, CA, 30 May 1995.

Schneidewind, N.F., "The State of the Practice in Software Reliability Engineering," The National University of Singapore, Department of Industrial and Systems engineering, Department of Information Systems and Computer Science, INTER-FACULTY SEMINAR, Singapore, 28 June 1995.

Schneidewind, N.F., "Predictions for Increasing Confidence in the Reliability of Safety Critical Software," High Consequences Operations Colloquium and Workshop, Sandia National Laboratories, Albuquerque, NM, 20 June 1995.

DOD KEY TECHNOLOGY AREA: Computing and Software

KEYWORDS: Software reliability, software reliability engineering process, modeling

A FINE-GRAINED ETHERNET PERFORMANCE MODEL

Norman F. Schneidewind, Professor
Department of Systems Management
Sponsor: Unfunded

OBJECTIVE: Develop an Ethernet performance model that would provide a greater detail of analysis than that available in other models and include all components of a Local Area Network (LAN) (e.g., hard disk) in the analysis.

SUMMARY: There is a plethora of models that deal with just the Ethernet component of LAN performance. These models typically evaluate performance in terms of engineering performance measures like utilization, throughput, offered load, and transmission delay, as opposed to *user* oriented measures . We wanted a complete model of user request response time -- the performance measure that is meaningful to the user -- that would also include other components such as disk queue and access times; these actually account for more of the total response time than the Ethernet bus delay components. We wanted to use the model as a decision making tool for estimating response times, under given loads and server configurations, and for choosing the best number of servers, based on a comparison of marginal improvement in response time with marginal cost. We were also motivated by the challenge of designing the Ethernet components of the model for simultaneous rather than random user inputs and server outputs. In the first implementation of the model, the Ethernet bus delay response time components were modeled by classical formulas involving expected delay as a function of probability of obtaining access to the Ethernet, average bus utilization, and packet size. We built upon this work to generalize the Ethernet model components for simultaneous user input and simultaneous server response. We showed that the model could be used to make important decisions concerning the optimal number of servers to use in the network and as a means of identifying the important contributors to response time.

CONFERENCE PRESENTATION:

Schneidewind, N.F., "A Fine Grained Analytic Ethernet Performance Model," TIMS XXXIII Conference, Singapore, 26 June 1995.

THESES DIRECTED:

Marchial, D., "Integration of Macintosh and PC Networks," Master's Thesis, March 1995.

Lanni, M.J., "Graphical User Interface Network Applications," Master's Thesis, March 1995.

McGillvray, P.J., "Integration of SM Departments Token Ring Local Area Networks," Master's Thesis, September 1995.

Steedly, W.M., "LAN Technology Transfer Using The Naval Postgraduate School's System," Master's Thesis, June 1995.

DOD KEY TECHNOLOGY AREA: Modeling and Simulation

KEYWORDS: Ethernet, performance analysis, modeling

OPTIMAL POLICIES FOR CONFIGURING CELLULAR COMMUNICATIONS NETWORKS

Suresh Sridhar, Visiting Assistant Professor
Department of Systems Management
Sponsor: Naval Postgraduate School

OBJECTIVE: The objective of this research was to develop optimal policies for configuring cellular networks and to study their impact on cost and the quality of service.

SUMMARY: Major components of costs and revenues and the major stakeholders were identified and a model was developed to determine the optimal system configuration (e.g. cell size, number of channels, etc.). Key properties relating the various parameters of interest were derived. Several experiments were conducted to study the interaction between various components of costs, revenues, and other design parameters.

PUBLICATION:

Gavish, B. and Sridhar, S., "Economic Aspects of Configuring Cellular Networks," Wireless Networks, Vol. 1, No. 1, pp. 115-128, 1995.

CONFERENCE PRESENTATION:

Gavish, B. and Sridhar, S., "Models for Configuring Cellular Networks with Mobility," Third International Conference on Telecommunication Systems, Nashville, TN, March 1995.

DOD KEY TECHNOLOGY AREAS: Other (Communications Networking), Computing and Software

KEYWORDS: Cellular networks, control policies, Economics of Networks

ELECTRONIC COMMERCE AT THE ARMED SERVICES BOARD OF CONTRACT APPEALS (ASBCA)

Mark W. Stone, Assistant Professor
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Sponsor: Naval Postgraduate School

OBJECTIVE: The goal of this project is to investigate the feasibility of utilizing electronic means to manage filings, official publications and other activities at the Armed Services Board of Contract Appeals (ASBCA).

SUMMARY: As it turns out, the judicial side of our legal system has been slow to adopt new electronic standards or even to use electronic tools. The ASBCA uses a couple of computers with Intel 80286 microprocessors. The administration at ASBCA uses these obsolete computers for only a few internal functions that have nothing to do with managing a caseload. In fact, to send the ASBCA a facsimile document, one must call and get the permission of an official in the ASBCA office.

The primary issues that arise when contemplating using electronic means for managing cases filed at the ASBCA (or any judicial forum) are document authentication and information security. While these two issues can be addressed using currently-available technology, the fact that the Board has been reluctant to trust any electronic tools means that the adoption of technology at this forum is still a long way off. The Navy recently called off further implementation of its participation in the government-sponsored Federal Acquisition Network (FACNET) as mandated by the Federal Acquisition Streamlining Act of 1994. Pending legislation will relax requirements for buying offices to be on-line within previously mandated time-lines. The government has been having trouble establishing an appropriate architecture for FACNET. These troubles, coupled with the general reluctance of judicial fora to trust electronic tools, means that any feasibility investigations would be more productive as electronic commerce becomes more commonplace in the government.

THESES DIRECTED:

Barnard, J.M., "Implementing Electronic Data Interchange (EDI) at the Defense Fuel Supply Center," Master's Thesis, December 1995.

Birmingham, R.B., "Intellectual Property Rights in Software Acquired by DoD," Master's Thesis, December 1995.

Clarke, M.T., "The Federal Acquisition Network: An Analysis of its Implementation and Impact on Federal Procurement," Master's Thesis, June 1995.

DOD KEY TECHNOLOGY AREA: Electronics

KEYWORDS: Electronic tools, legal system, electronic commerce

COST PER OUTPUT ANALYSIS FOR U.S. ARMY RECRUITING COMMAND

Katsuaki L. Terasawa, Associate Professor
Keebom Kang, Associate Professor
Department of Systems Management
Sponsor: U.S. Army Recruiting Command (USAREC)

OBJECTIVE: The objective of this research is to develop a transparent and documentable cost per output methodology for the U.S. Army recruiting activities; and to identify the areas for cost-savings with the future changes in the recruiting environment.

SUMMARY: Our study of USAREC's unit costing revealed several potential problems. The Military Personnel Army (MPA) account, the largest among *big ten* accounts, constitutes 57% of the total budget, yet USAREC does not have spending discretion over this account. Without spending authority and responsibility, managers may have little incentive to reduce costs and the ones they can reduce are over-shadowed by what they do not control. Also the recruiters may not be as productive as they could be, although they work very hard, because of the current quota system. The bonus incentive system would help maximize market potential and help USAREC in the efficient allocation of resources. USAREC approved the implementation of our proposed bonus incentive recruitng system. This project is being continued under the new project, *Experimentation of Bonus Incentive Recruiting Model (BIRM)*.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: Recruiting, cost per output, life-cycle cost, decision-support, manpower, cost-benefit analysis

EXPERIMENTATION OF BONUS INCENTIVE RECRUITING MODEL (BIRM)

Katsuaki L. Terasawa, Associate Professor
Keebom Kang, Associate Professor
Department of Systems Management
Sponsor: U.S. Army Recruiting Command (USAREC)

OBJECTIVE: The objective of this research is to design and implement the bonus incentive recruiting model (BIRM). This will help maximize market potential and increase cost-effectiveness of USAREC recruiting operation.

SUMMARY: The recruiters are working on the quotas set by the headquarters. Under the current system, a recruiter is not measured on how well he maximizes his market potential but rather on achieving a quota. In this risk-aversive environment, there is little incentive to surpass quotas from month to month regardless of a market's true potential. Unfortunately, in the process, valuable field information that could reduce aggregate recruiting costs is used only to help the recruiter in reducing his quota. As a result, the bias information in turn unnecessarily lowers the perceived ability of recruiting and distorts management's view of actual regional market potential. Therefore, if the national aggregate total is to be met it can only be accomplished through higher recruiting expenditures, which might not actually be necessary if the original recruiting structure were more efficient.

The bonus incentive system would help maximize market potential and help USAREC in the efficient allocation of resources. The proposed incentive system works as follows. Each recruiter forecasts his own production for next

period. The recruiter then is rewarded based on how accurate his forecast was compared to his actual production as well as on how many he recruited. Since the recruiter has the incentive to reveal his true market potential for his own benefit, we call this mechanism *truth revealing*. By implementing this system, we can fully utilize the market information from the recruiters who have the best knowledge.

We renamed the bonus incentive model as PRIME (Production Recruiting Incentive Model). We will test this PRIME at the Albany (NY) Battalion of the 1st Recruiting Brigade from April to September 1996. If the results are favorable, this incentive model will be implemented throughout the Army Recruiting Command.

THESIS DIRECTED:

Piper, S., "Bonus Incentive Recruiting Model (BIRM)," Master's Thesis, September 1995.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: Recruiting, incentive system, manpower

AUGMENTATION OF CRITICAL FORCE POOL READINESS GEOGRAPHIC INFORMATION SYSTEM (GIS) MODELS

George W. Thomas, Associate Professor
Daniel R. Dolk, Professor
Department of Systems Management
Sponsor: Office of the Chief of the Army Reserve

OBJECTIVE: The Critical Force Pool (CFP) Readiness Office uses a Geographic Information System (GIS) as one of its tools for managing the readiness of CFP units. This project will develop two enhancements to their GIS: 1) market supportability indicators to augment the information base of the GIS, and (2) software utilities in MAPINFO to increase the usefulness and user friendliness of the GIS.

SUMMARY: This project was funded in November 1995 and initiated in December 1995.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: Manpower, U.S. Army Reserve, Geographic Information System, readiness

U.S. ARMY RESERVE RT 18 MARKET ANALYSIS

George W. Thomas, Associate Professor
Department of Systems Management
Sponsor: Office of the Chief of the Army Reserve

OBJECTIVE: Provide an information base and decision support system for developing policy analysis and more effective management of the trained within 12 to 24 months (RT 12/24) market.

SUMMARY: In calendar 1995 acquisition of data on leavers from the active force was begun. Further data acquisition and modeling will be done in CY96.

DOD KEY TECHNOLOGY AREA: Manpower, Personnel and Training

KEYWORDS: Manpower, U.S. Army Reserve, TPU leadership, readiness

A STUDY OF ISSUES RELATED TO SEXUAL HARASSMENT AND GENDER DISCRIMINATION AND THEIR IMPLICATIONS FOR THE U.S. NAVY

Gail Fann Thomas, Associate Professor
Frank J. Barrett, Assistant Professor
Department of Systems Management
Sponsor: Naval Postgraduate School

OBJECTIVE: This study is a continuation of previous research on gender issues. The purpose of this project was to collect and analyze additional data from men and women Naval Officers about their experiences with sexual harassment and gender discrimination.

SUMMARY: Professor Barrett continued his work on gender dynamics within the US Navy. His work included in-depth interviews with 12 male and 8 female officers. Professor Thomas continued her work based on conversations with personnel in the Secretary of Defense for Manpower which indicated a need to look more broadly at issues related to gender and race. Previous research on gender issues revealed distinct differences in the experiences of minority and nonminority officers. Professor Thomas' project included a review of the literature related to diversity issues and interviews with Black women officers. The purpose of the interviews was to establish themes that might document successes and challenges of Black women officers in the US military.

PUBLICATIONS:

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CONFERENCE PRESENTATION:

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THESES DIRECTED:

Morgan, A., "Study of Black Women Managers," The University of San Francisco, February 1995.

Stigler, W. J., LT, USN and Jones, J.E., USN, "Survey of Minority Officers in the Navy: Attitudes and Opinions on Recruiting and Retention," Master's Thesis, September 1995.

Wade, J.F., CAPT, USMC, "Survey of Black Officers in the Marine Corps: Attitudes and Opinions on Recruiting, and Diversity," Master's Thesis, December 1995.

OTHER:

Guest editor for a Special Issue on Diversity in the Workplace; the Special Issue for the Journal of Business Communication is in progress and scheduled to be published in January 1997.

SYSTEMS MANAGEMENT

DOD KEY TECHNOLOGY AREAS: Manpower, Personnel, and Training, Other (Sexual Harassment, Minorities)

KEYWORDS: Women officers, equal opportunity, diversity, sexual harassment, minorities

APPLICATION OF INTRINSIC MOTIVATION THEORY TO THE MILITARY

Kenneth W. Thomas, Professor
Erik Jansen, Visiting Associate Professor
Department of Systems Management
Sponsor: Department of Defense

OBJECTIVE: To support the Presidentially-directed Eighth Quadrennial Review of Military Compensation in developing a military compensation system for the 21st century. This project focuses on the role of intrinsic motivation (IM) in motivating performance within the military. The goal is to apply IM theory and models to the military to develop a conceptual foundation for an integrated military compensation system linking both intrinsic and extrinsic rewards to organizational strategies.

SUMMARY: This project involved a review of the literature on intrinsic motivation and the development of conceptual models that would be helpful in understanding intrinsic motivation (IM) in the military--its nature, its strategic importance to the military of the next century, and the factors that shape it. IM can be thought of as the psychological compensation received by soldiers for performing their tasks. During calendar year 1995, models were developed that described the nature of intrinsic motivation and its consequences for DoD. Of particular importance is the relationship of IM to the self-management required of individual soldiers in the battlefield of the future, as well as to retention of soldiers--both key readiness factors. In addition, reviews of the research literature yielded the conclusion that extrinsic rewards (e.g., pay and recognition) tend generally to increase IM if they are understood in advance and if they are tied to quality standards.

This project continues on into 1996, when models will be developed of the factors that shape IM in the military. Here, a special emphasis will be placed on the role of leadership in shaping both IM and self-management.

OTHER:

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DOD KEY TECHNOLOGY AREA: Other (Military)

KEYWORDS: Intrinsic motivation, military compensation, self-management

1995

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