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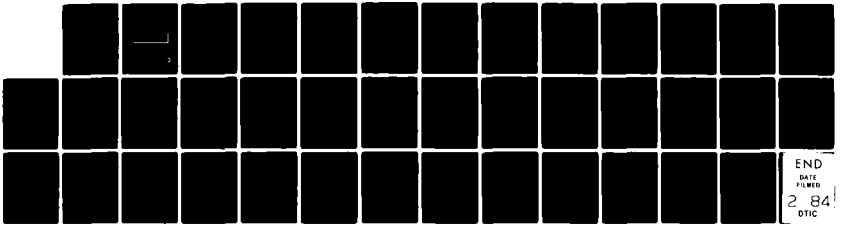

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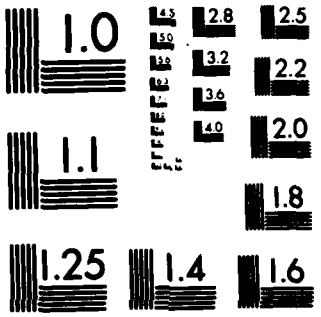

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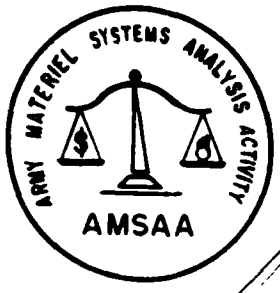

AMSAA

AD-
FINAL REPORT

ANNUAL REPORT
FISCAL YEAR 1983

INVENTORY RESEARCH OFFICE

January 1984

US Army Inventory Research Office
US Army Materiel Systems Analysis Activity
800 Custom House, 2d & Chestnut Sts.
Philadelphia, PA 19106

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report describes work done by the US Army Inventory Research Office during the period October 1982 - September 1983. Reports published during the period are listed, along with papers presented at professional meetings and notes on other professional activities.

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US ARMY INVENTORY RESEARCH OFFICE
OVERVIEW

This report describes IRO activities in FY1983. Annual Reports for previous years go back to FY1966.

Five projects were completed in FY1983, one of which (Project DRACULA) was initiated during the year. DRACULA was the only new project. One was merged with another ongoing project. Eight projects are carried over from previous years. Most of these carry-over projects represent work areas rather than specific delineated problems including, for example, development and application of multi-echelon, level of repair and war planning models. Developments in these areas can be summarized as follows:

Multi-Echelon Modelling - applications of SESAME continue to increase and with increasing usage, requests for further model enhancements continue to emerge. Some have been incorporated. As decided at a recent meeting of the Provisioning Technical Working Group, the remainder will be added during a complete redesign of SESAME that will simplify the program and make it easier to maintain, as well as reduce running time.

Level of Repair Analysis - the Optimal Allocation of Test Equipment/Manpower Evaluated Against Logistics (OATMEAL) model had further application during the year being used in the proposal evaluating process for a major electronics system. An off shoot of OATMEAL was also developed for determining optimal quantities and placement of multi-application test equipment. Work on Phase II enhancements to OATMEAL are now being considered.

War Planning - a great deal of recomputation of Combat PLLs was done during the year with new input data. All Divisional PLLs were completed, along with PLLs for an Armored Cavalry Regiment. Quality of the PLLs continues to come under question because of input data problems. Proposal was made to set up a permanent data base for Combat PLL/ASL and relate war planning purpose by extracting data from existing and planned maintenance and supply data systems. Proposal was accepted in concept; MRSA is to do follow-on evaluation of feasibility.

A "pilot" Combat ASL was computed for a representative Armored Division using data obtained from field organizations. As in the case of the PLLs, it was found that no input data can be used without considerable scrubbing. The models and computational procedures appear to be working properly.

Work on implementation of RIMSTOP (Retail Inventory Management Stockage Policies) continued, with work concentrating on problems arising from unexpectedly large numbers of items with very erratic demand. Implementation in DS4 has been suspended by the Army DCSLOG until a better methodology for projecting future supply performance and costs is developed and until further analyses are completed on effects of erratic demand items on DS4 can be better estimated.

Personnel notes of interest are:

Mr. John Casey, a graduate OR student at University of Delaware, worked at IRO during the summer. As has been true of nearly every past summer student employee, he proved to be extremely competent. His work lay in developing and testing computational algorithms for Kotkin's non-stationary multi-echelon model.

Mr. Rosenman, after a long career with the IRO, has decided to retire. He will leave in December 1983.

US ARMY INVENTORY RESEARCH OFFICE
COMPLETED STUDY SUMMARY

TITLE: Forecasting Methods for Parts Support of Depot Overhaul

IDENTIFICATION NUMBER:
IRO Project No. 259

REPORT: "Forecasting Methods for Parts Support of Depot Overhaul," Edwin Gotwals, Karl Kruse, AMSAA *Interim Note* F-61, July 1983.

SPONSOR: DARCOM Directorate for Supply Maintenance and Transportation, DRCSM-WRS

PROJECT OFFICER:
W. Karl Kruse/Edwin Gotwals

INITIATION/PROGRAMMED COMPLETION DATES:
January 1981/July 1983

ABSTRACT: The Parts Explosion (PE) process at the MSCs produces forecasts of the parts needed to support overhaul programs. Despite several attempts to correct the deficiencies of this process, the MSCs remain dissatisfied with the parts forecasts.

Although the complaints have been about the PE process, the problems which appear in the output of PE are really caused by problems in the Maintenance Overhaul Factor Reporting System (MOFARS) and the Overhaul Consumption Data (OCD) processes. The MOFARS is a system by which the depots and the MSCs coordinate their planning data. The OCD file is the MSC's repository for overhaul factors and is updated primarily by MOFARS.

For the most part, the MSCs' complaints relate to the incompleteness of the OCD file. At the overhaul depot it is a simple matter to update the Mortality Data File (MORT) which is the depot repository for overhaul factors. However, the system at the MSC requires that the OCD always be compatible with the NSNMDR. Various checks make it unnecessarily difficult for the MSCs to update the OCD based on consumption experience. Recommendations on how the system can be significantly improved have been made.

MAJOR CONCLUSIONS/RECOMMENDATIONS:
This study recommends expanding the capability of the overhaul depot forecasting system so that long term forecasts can be produced at the depot for use by the MSCs for timely procurement of parts. Other alternatives developed suggest more efficient ways to process the overhaul facility information at the MSCs.

IMPLEMENTATION STATUS:
DESCOM did not concur in these recommendations on the grounds that they believe responsibility for producing long range forecasts should remain at the MSCs.

Alternative approaches to correcting the current system are presently being undertaken independently at various MSCs and several SCRs have been submitted. Because of the low priority placed on these problems, there is presently no coordinated activity being pursued.

RELATED STUDIES:

None.

US ARMY INVENTORY RESEARCH OFFICE
COMPLETED STUDY SUMMARY

TITLE: Updating Failure Factors

IDENTIFICATION NUMBER:
IRO Project No. 275

REPORT: DARCOM PAM 750-5 "Objective Determination of Failure Factors," April 1983.

SPONSOR: DARCOM Directorate for Supply, Maintenance and Transportation, DRCSM-PM

PROJECT OFFICER:
Donald A. Orr

INITIATION/PROGRAMMED COMPLETION DATES:
April 1979/December 1982

ABSTRACT: Engineering estimates of failure factors (replacement rates of components) often do not reflect actual experience once the end item is fielded. Updating of these estimates is needed particularly for the later provisioning requirements of long-term procurement and deployment programs.

An automated method of combining initial failure factors with experienced replacement rates for parts in fielded systems has been developed. Field experience is represented by wholesale demand rates; however, the model adjusts for field repair actions that are not seen in the wholesale demand data.

MAJOR CONCLUSIONS/RECOMMENDATIONS:
In the absence of retail replacement data, this method has been given DARCOM/DA approval as the procedure for updating failure factors. Commands' experience over the next year will indicate the efficacy of the options and the proper values of certain algorithm parameters.

IMPLEMENTATION STATUS:
MICOM has incorporated the IRO algorithm (a special case of which is their local update procedure) in bridging programs which access CCSS files. This FORTRAN-COBOL program has been given to the other Commands to use for automated updating.

RELATED STUDIES:
None.

US ARMY INVENTORY RESEARCH OFFICE
COMPLETED STUDY SUMMARY

TITLE: War Reserve ADP System Project

IDENTIFICATION NUMBER:
IRO Project No. 281

REPORT: "War Reserve Automated Process," Functional Description prepared by ALMSA and IRO, 10 June 1983.

SPONSOR: DARCOM Directorate for Supply, Maintenance and Transportation, DRCSM-PPW

PROJECT OFFICER:
Steven Gajdalo

INITIATION/PROGRAMMED COMPLETION DATES;
April 1980/July 1983

ABSTRACT: Computations of wholesale and pre-positioned war reserves at the Materiel Readiness Commands are only partially automated and are not standardized. Furthermore, the wholesale/retail computations are not integrated. Under this arrangement it is difficult to justify/audit computed requirements and to respond to "what if" questions from DA and DoD. A new regulation (DoDI 4140.47) has directed that all Services and Defense Logistics Agencies have a common baseline for war reserve computations, necessitating major changes in current DARCOM approaches to computations.

MAJOR CONCLUSIONS/RECOMMENDATIONS:
Use a multi-echelon model to integrate wholesale and retail computations of war reserves. Compute wholesale/retail stock levels for secondary items to achieve specified weapon system operational availability goals at least cost. Design and develop an ADP system to do this. Little of what is in the existing ADP system can be salvaged.

IMPLEMENTATION STATUS:
The ADP system has been designed and is being programmed at ALMSA. Most of the recommended features will be implemented in the Commodity Command Standard System (CCSS) in May 84. The remaining features will be implemented as enhancements in subsequent CCSS releases tentatively scheduled for November 84 and May 85. The war reserve budgets from this system will be operational for the first time for FY86 budget submissions.

Testing of the Service Item Control Center (SICC) portion of the system is to be completed at Troop Support & Aviation Command (TSARCOM) and Communications -Electronics Command (CECOM) in September 84. Testing of the retail interface is to be done at Theater Army Materiel Management Center (TAMMC) using Logistics Center and CCSS programs. Completion is scheduled for November

1984. Implementation in Standard Army Intermediate Level System SAILS) (which will provide ABF data) is scheduled for December 1984.

RELATED STUDIES:

1. Work on OMNIBUS/ALA will commence in FY84. AMSAA is doing a concept study scheduled for April 84 completion. Functional Description will be done by ALMSA and the MSCs by April 85. Implementation should be in the 1986-1987 time frame. The IRO role will be consultative on an as needed basis. This would mark completion of a total ADP system for mobilization planning.

2. Operational Readiness Logistics Support Models, IRO Project No. 260 (ongoing).

3. Combat PLL/ASL Methodology, IRO Project No. 283 (ongoing).

4. RIMSTOP Implementation, IRO Project No. 283 (ongoing).

US ARMY INVENTORY RESEARCH OFFICE
COMPLETED STUDY SUMMARY

TITLE: Predicting Failure Rates of Aircraft Components Using Sortie Data

IDENTIFICATION NUMBER:
IRO Project No. 290

REPORT: "Sortie Duration and Helicopter Component Failures (An Empirical Study)," Edwin Gotwals, AMSAA Technical Report, May 1983.

SPONSOR: US Army Troop Support and Aviation Materiel Readiness Command DRSTS-BAS

PROJECT OFFICER:
Edwin P. Gotwals

INITIATION/PROGRAMMED COMPLETION DATES:
October 1981/May 1983

ABSTRACT: The purpose of this study was to investigate the effects that sorties have on component failures for Army aircraft. The underlying hypothesis was that the stress occurring during take off and/or landing causes more failures of aircraft components than does continuous flying. Under this hypothesis an increase in the number of sorties for a given flying hour program should result in an increase in demand for spare parts. The Army's current method of forecasting demand is based solely on flying hours and past experience and thus is inconsistent with this hypothesis.

This study investigates the effect that sorties, flying hours, and usage have on component failures for Army aircraft. The report documents the work done. It includes many graphs in the appendix depicting 20 years of 1352 flying hour data which may be useful in other research work.

MAJOR CONCLUSIONS/RECOMMENDATIONS:
This study was not able to show any relationship between failures and flying hours, sorties, or utilization. The data were limited in that other causal effects could not be removed from the analysis nor could the explanatory variables be controlled adequately to statistically quantify the study's findings. Other IRO studies did demonstrate the favorable use of flying hours in making demand forecasts and the lack of results of this study should not be construed as negating these findings.

IMPLEMENTATION STATUS:
Due to the nature of the findings, implementation recommendations were not made.

RELATED STUDIES:

1. "Projection of Peacetime Maintenance Data from Naval Aircraft to Obtain Wartime Requirements for Spare Parts and Manpower," Pierpont Buck, Paper given at 47th Symposium of Military Operations Research Society on 8 July 81, Institute for Defense Analyses.

2. "Demand Forecasting with Program Factors," Martin Cohen, AMC Inventory Research Office, September 1975 (AD A017858).

3. "Saber Sustainer, COL Christopher C. Shaw, Briefing, Air Force Studies and Analysis, March 1981.

4. "Time Dependent Failure Rates for Jet Aircraft," Maurice Shurman, Briefing, Boeing Company, Seattle, WA, 1980.

5. "The Effect of Operational Factors on Aircraft Failures," (U) Linda Cavalluzzo, Memorandum 82-1639, Center for Naval Analyses, 19 October 82, Confidential.

US ARMY INVENTORY RESEARCH OFFICE
COMPLETED STUDY SUMMARY

TITLE: Over-Ocean Cargo Forecasting

IDENTIFICATION NUMBER:
IRO Project No. 293

REPORT: "Over-Ocean Cargo Forecasting," R. L. Deemer, E. P. Gotwals, IRO Technical Report, October 1983.

SPONSOR: DARCOM Directorate for Supply, Maintenance, and Transportation, Supply and Distribution Management Division, DRCSM-PST

PROJECT OFFICER:
Robert L. Deemer/Edwin P. Gotwals

INITIATION/PROGRAMMED COMPLETION DATES:
July 1982/September 1983

ABSTRACT: Operational Analysis of the over-ocean forecasting process identified several changes to the current system which should improve the accuracy of the forecasts. One of these is assignment of Transportation Account Codes (TAC) by Major Subordinate Command. Manhours spent on the DARCOM forecast can be reduced in most cases. A correction for the statistical portion of the DARCOM forecast is suggested along with improvement of the actual technique.

Lack of data restricted analysis to qualitative procedures. Recommendations are made to include data gathering so quantitative analysis can be made in the future.

MAJOR CONCLUSIONS/RECOMMENDATIONS:

The ICP long range forecast should be augmented to include data from the Army Modernization Information Memorandum along with the Total Army Equipment Distribution Program (TAEDP).

The final long range forecast submitted by the ICPs can be delayed for two months without causing any problems with the use of the forecast.

The ICPs should submit two forecasts to the Logistics Control Activity (LCA), one to include changes made to the TAEDP projections, the other based on unaltered TAEDP data. This will provide the necessary data for a quantitative analysis of the DARCOM forecast.

The LCA feedback report lacks accuracy because of the inability to identify ICP forecasted items. One way of improving the accuracy is for each ICP to have a Transportation Account Code (TAC) assigned to the items they are responsible for. In addition, LCA should use the billing tape from Military Sealift Command (MSC) as a source of data to trace shipments.

IRO Project 293 (cont)

A new algorithm has been recommended for the LCA statistical forecasts.

IMPLEMENTATION STATUS:

Recommendations are being reviewed by DARCOM forecasters, viz, DARCOM, LCA, ALMSA, and the five ICP forecasters. DARCOM has a yearly review with the forecasters at which time our recommendations will be discussed. The meeting will be held the first quarter of FY84.

DA has already initiated action to have Transportation Account Codes assigned by MSC.

RELATED STUDIES:

"Over-Ocean Cargo Forecasting," R. L. Deemer, D. A. Orr, IRO Final Report, November 1976, AD-A034113.

US ARMY INVENTORY RESEARCH OFFICE
COMPLETED STUDY SUMMARY

TITLE: Data Management System for Combat PLL/ASL MACRIT and Related Purpose (Project DRACULA)

IDENTIFICATION NUMBER:
IRO Project No. 295

REPORT: None. Recommendations are contained in Minutes of DRACULA Working Group meeting held at MRSA on 2-4 August 1983.

SPONSOR: DARCOM Directorate for Supply, Maintenance, and Transportation DRCSM-PM

PROJECT OFFICER:
Donald A. Orr/Bernard B. Rosenman

INITIATION/PROGRAMMED COMPLETION DATES:
October 1982/September 1983

ABSTRACT: This study addressed the need for an automated data base, made from data extracted from existing or planned Army data systems, that can be used as input data for Combat PLL/ASL, MACRIT, and related purposes having to do with logistics support under combat conditions. Development of such data is now an "ad hoc" mostly manual process and input data that are produced such as Mean Usage Between Removal, Maintenance and Replacement Task Distributions are often of doubtful validity. A Working Group composed of representatives from the MSCs, MRSA, ALMSA, AMSAA, and the Army Logistics Center defined data requirements and developed a set of recommendations on how a data base could be created and maintained using data from existing and planned Army data systems.

MAJOR CONCLUSIONS/RECOMMENDATIONS:
No single Army data system contains all the information needed even for Combat PLL/ASL and the other applications and, indeed, there are some data elements such as end item usage that are not routinely collected at all. A system design approach was developed based on combining supply and maintenance data from the Standard Army Maintenance System and the Central Demand Data Base which, along with some extension of application of the MRSA End Item Codes and collection of field data on end item usage, would allow creation and up-dating of the needed data base.

IMPLEMENTATION STATUS:
Recommendations were accepted in principle by DARCOM HQ. MRSA was then tasked, via MFR on meeting of 26 September 83, to determine impact these recommendations would have on other on-going Army system projects and to determine implementation resource requirements. This is to be done in FY84.

IRO Project No. 295 (cont)

RELATED STUDIES:

Combat PLL/ASL.

US ARMY INVENTORY RESEARCH OFFICE
ONGOING STUDY SUMMARY

TITLE: Advanced Inventory Models

IDENTIFICATION NUMBER:
IRO Project No. 062

SPONSOR: Work of this kind is undertaken according to IRO perceptions of where basic theoretical advanced are needed.

PROJECT OFFICER:
N/A

INITIATION/PROGRAMMED COMPLETION DATES;
Ongoing.

PROBLEM: New and challenging logistics problems constantly arise in the Army that require advances in the practice of basic Inventory Theory and other areas of Operations Research. Theoretical work of this kind is carried on under this project number.

OBJECTIVES: To carry on in Inventory Theory and other areas of Operations Research where it is believed that development of improved models is limited by gaps in presently known theory.

CURRENT STATUS:

Multi-Echelon Models.

IRO work under Project 062 for FY83 concentrated on two areas: (1) the study of non-stationary multi-echelon inventory systems (Project Officer: M. Kotkin) and (2) the determination of optimal economic order quantities and reorder points for a periodic review inventory system with learning (Project Officer: A. Kaplan)

The SESAME model developed under Project 260 is a steady state inventory model assuming that important inputs do not change over time. There are many situations where their inputs do change, as for example, during wartime. Furthermore, the implicit steady state assumption of an infinite horizon is often not valid when calculating stock levels for limited time problems such as training exercises or contingency plans. During FY83 an analytical model was developed that precisely calculates the pipeline distributions of non-stationary multi-echelon inventory system under a one-for-one resupply policy. An optimization problem was also formulated with two measures of performance because it was felt that for non-stationary systems one measure (search as is used in SESAME) was inadequate and inappropriate for accurately measuring performance in a dynamic system. SESAME can be reviewed as a special case of this non-stationary model.

The model was programmed and tested during FY83. Research is now being done to reduce run times. Tests of a heuristic to approximate pipelines with a negative binomial distribution are promising and in some cases run times for the non-stationary systems are not significantly greater than SESAME series. Other heuristics are also being investigated and a working efficient program should be ready in FY84. Theoretical research will also continue in this area during FY84.

Inventory Models With Learning

Inventory models with learning pertain to the provisioning environment in which the initial estimate of the demand rate is based on engineering estimates, and is then improved as demand experience accumulates. A prototype model for this problem has been developed. A follow-on, applied project will be considered for developing an implementable algorithm based on the prototype. In the interim, the prototype has provided insights useful in formulating provisioning policy.

US ARMY INVENTORY RESEARCH OFFICE
ONGOING STUDY SUMMARY

TITLE: Operational Readiness Oriented Logistics Support Models

IDENTIFICATION NUMBER:
IRO Project No. 260

SPONSOR: DARCOM Directorate for Supply, Maintenance and Transportation, DRCSM-WRS/PMP

PROJECT OFFICER:
Alan Kaplan/Martin Cohen/Meyer Kotkin/Steven Gajdalo

INITIATION/PROGRAMMED COMPLETION DATES:
October 1977/Continuing Project

PROBLEM: Multi-echelon inventory models allow the achievement of system operational availability goals at least cost. A number of models exist in the literature, but none was fully satisfactory for Army use.

OBJECTIVES:

To develop and promote use of improved multi-echelon models such as SESAME and related models.

CURRENT STATUS:

The IRO continued to work through the medium of the Provisioning Technical Working Group (PTWG), which maintains control of SESAME program content by developing change and enhancement proposals and their implementation priorities, and whose members act as focal points for application of SESAME at their Commands.

Some changes were made to the SESAME program, the most important being in the War Reserves area. Pre- and post-processors were provided to improve flexibility of use and to give outputs specifically formatted for the budget process. Additional changes were made in input/output routines for MSC user convenience and several minor program errors were corrected.

A major effort during the year was the development of a revised and expanded SESAME Users' Guide which was published in July 1983. Additional background material was included to give users a better understanding of the programming and budgeting environment in which SESAME is used. Revisions were made to add descriptions of new SESAME capabilities and to improve clarity. Users indicate that it is a much more useful document.

A number of program enhancements were approved for implementation by the PTWG during the year, among them incorporation of the VARI-METRIC technique developed by Logistics Management Institute for working with more realistic variances, a more efficient technique for finding bounds, and use of non-unit increments in the search process. Decision was made to completely re-design

IRO Project 260 (cont)

and re-program SESAME while these and other changes are being put in to improve its flexibility of use at the MSCs, to make it easier to maintain, and to reduce running time. Development of specs began towards the end of FY83; completion of re-design will take place in 4th quarter of FY84.

RELATED STUDIES:

1. Combat PLL/ASL Methodology (IRO Project 283 - Ongoing)

2. War Reserve ADP System Project (IRO Project 281 - Completed)

3. Supply/Maintenance Trade-Off Analysis (IRO Project 287 - Ongoing)

4. SESAME User's Guide, DARCOM Pamphlet 700-18, 29 July 1983.

US ARMY INVENTORY RESEARCH OFFICE
ONGOING STUDY SUMMARY

TITLE: RIMSTOP Implementation

IDENTIFICATION NUMBER:
IRO Project No. 261

SPONSOR: Deputy Chief of Staff for Logistics, Army Assistant Director for Supply Management, DALO-SMP-U

PROJECT OFFICER:
Robert L. Deemer

INITIATION/PROGRAMMED COMPLETION DATES:
May 1978/June 1984

PROBLEM: RIMSTOP has now been implemented at intermediate (SAILS-ABX) sites and DARCOM installations. The large number of low demand items and items demanded during one year and not the next, and vice versa, is causing problems in projecting demand accommodation and other inventory performance measures. Moreover, some inventory managers were not pleased with the kinds of stockage decisions produced by the RIMSTOP model, citing increasing number of lines stocked, decreasing depth of stockage, negative safety levels and number of items with Reorder Point of 1. Before and after comparisons have been difficult to make because of lack of meaningful performance statistics.

While DARCOM activities are running the LAMBDA-Generator program for computing and updating their shortage-cost parameters, decision has not yet been made as to who will do this for SAILS-ABX installations. Consequently, their shortage-cost parameters have not been updated as they should.

Because of these difficulties, implementation of RIMSTOP in DS4 has been postponed indefinitely.

OBJECTIVES:

Improve performance projection capabilities of the RIMSTOP forecasting module to take into account the large number of low and intermittent demand items.

Alleviate concerns among SAILS-ABX users about RIMSTOP stockage results.

Assist FORSCOM and TRADOC in development of a capability to run the LAMBDA-Generator.

CURRENT STATUS:

Computer analyses were run using data from SAILS-ABX activities to show what would happen if RIMSTOP were to be constrained to produce more "palatable" decisions (i.e. restricting number of lines stocked, deleting negative safety levels, etc.).

IRO Project No. 261 (cont)

Results showed that little was accomplished by doing so, in that supply performance tended to be slightly degraded and costs increased when these changes were tried.

Since displeasure of SAILS-ABX users had seemed to subside as time went on, decision was made by BG Jolemore (DCSLOG) not to change the SAILS-ABX program. More extensive analyses using DS-4 data are to be done, however, before implementation in DS-4 is considered.

Work is in progress to modify the RIMSTOP model to improve its accuracy in projecting demand accommodation and other performance statistics. Several alternatives will be evaluated early in FY84.

Data are being collected from DS-4 activities for further analyses of implementation impact.

Assistance is being given in the development of bridging programs and procedures to allow either FORSCOM or TRADOC to use the LAMBDA-Generator easily, and decision is made as to who will run it.

Technical report describing the LAMBDA-Generator program was published in April 1983.

RELATED STUDIES:

1. "Calculation of Percent Error Tables for Use in the RIMSTOP Implementation," Arthur Hutchison, IRO Technical Report, September 1980, ADA090141.

2. "Evaluation of Several Forecasting Techniques for Retail Level Stockage," Arthur Hutchison, IRO Technical Report, September 1980, ADA090104.

3. "Comparison of RIMSTOP (Retail Inventory Management Stockage Policy) to Current Retail Inventory Policies," Arthur Hutchison, IRO Final Report, November 1981, ADA119428.

4. "Developing Requisition Short Cost Parameters for RIMSTOP (LAMBDA-Generator)," Robert Deemer, IRO Technical Report, April 1983, ADA128370.

US ARMY INVENTORY RESEARCH OFFICE
ONGOING STUDY SUMMARY

TITLE: Evaluation of Provisioning Procedures

IDENTIFICATION NUMBER:
IRO Project No. 265

SPONSOR: DARCOM Directorate for Supply, Maintenance and Transportation, DRCSM-PM

PROJECT OFFICER:
Donald A. Orr

INITIATION/PROGRAMMED COMPLETION DATES:
May 1979/Depends on DARCOM decision on further testing.

PROBLEM: Many Army proponents feel initial support requirements (Spare & Repair Parts), when determined in accordance with DoDI 4140.42 policies, are inadequate to support newly fielded systems at their required operational availability. To bolster or belie this intuition, evaluations of provisioned quantities based on field performance are needed. Although Army policy requires such evaluations (Post Provisioning Review) 360 days after initial deployment of the end item, such analyses have been barely extant at best. A main (but not the only) reason for the dearth of reviews has been a lack of a paradigm and consequent systematic procedures for collecting and analyzing data in a reasonable, feasible manner.

With the advent of SIP and the sophisticated SESAME program, it is feasible to compute part quantities in accordance with .42 or with some cost effective optimal technique. These programs, suitably adjusted, can also evaluate the impact of these support quantities and other possible realized quantities in terms of system availability. Another potentially solvable problem via the program is to assess the impact on quantities and operational readiness when the actual provisioning parameter set (experienced field values of repair times, task distributions, washout and failure rates) differs from the original parameter set used to ascertain initial issue.

OBJECTIVES:

Phase 1 - To design an evaluative system for detail comparisons of theoretical, hypothetical, and actual provisioning quantities and subsequent operational readiness values. To consider computed SIP, ERPSL models' quantities and real life adjustment thereof. To use the above evaluator on data obtained from pilot tests on selected end items and identify any shortcomings in DoDI 4140.42 procedures.

CURRENT STATUS:
This project has become one phase of an expanded provisioning study taken over by AMSAA. This expanded project is planning.

to study the budgeting process, general problems in provision and fielded systems that are similar to those currently being provisioned. The IRO has been working with MSCs and PMOs on sample data collection plans and evaluative schemes for the M tank. Data on the M1 tank are being collected by PECO Enterprises, Inc., and stored and retrieved thru the INFONET system of Computer Science Corporation.

During FY1983 data was collected thru INFONET on replace and repair actions for the LRUs that constitute the major provisioning cost on the M1. Original failure factors, maintenance task distributions, and replacement task distributions were compared with updated ones from the field data.

Many SESAME runs were made with the old and updated parameter files. The results reconfirmed SESAME as the superior procedure for determining initial issue quantities to be given to the field. SESAME quantities can achieve better availability for less dollars. On the M1, if the user were to use updated parameters, the provisioning dollars would increase 30-80%.

This study indicated that if the user uses SDC data (or similar) to truly update, he can improve, thru SESAME, his provisioning for further deployments of the system. Further "revalidation" of SESAME thru SDC data analyses do not seem necessary.

A report on the results is being written.

RELATED STUDIES:

"Provisioning Methodology Validation Assessment Study," AMSAA Project No. 81-5A.

US ARMY INVENTORY RESEARCH OFFICE
ONGOING STUDY SUMMARY

TITLE: Supply Performance Indicators

IDENTIFICATION NUMBER:
IRO Project No. 278

SPONSOR: DARCOM Directorate for Supply, Maintenance and Transportation, DRCSM-WRS

PROJECT OFFICER:
Edwin Gotwals

INITIATION/PROGRAMMED COMPLETION DATES:
October 1979/May 84

PROBLEM: Presently there are no statistics collected on a routine basis that can give early warning of changes in conditions which might degrade stock availability. Based on findings from the IRO Project 267, "Stock Availability Improvement," it is felt that by monitoring the errors made when estimating key input parameters to the supply control studies, trouble areas can be spotted in time to do something about them.

OBJECTIVES: To identify the model parameters in CCSS whose forecast errors most affect supply performance and to develop a method to monitor these errors.

CURRENT STATUS:
A pilot program will be run at TACOM. They have completed most of the data extract programs and are saving operational data for analysis. The other MSCs have been asked by DARCOM to begin saving data. IRO is consulting with Jet Propulsion Labs (JPL) on a Data Base Management System developed by them and which is now being used at AMSAA. DARCOM has determined that this project will also satisfy the performance monitoring requirements of the Depot Level Reparables Action Plan (DELRAP) and has therefore agreed to provide funding support. These funds will be used to contract with JPL for writing Data Base Management Systems programs for the pilot at TACOM and for developing approaches for a DARCOM-wide implementation. IRO will supply the statistical tracking and evaluation routines.

RELATED STUDIES:
IRO Stock Availability Improvement Briefing, April 1978, (IRO Project 267)

US ARMY INVENTORY RESEARCH OFFICE
ONGOING STUDY SUMMARY

TITLE: Supply/Maintenance Trade-Off Analysis

IDENTIFICATION NUMBER:
IRO Project No. 287

SPONSOR: US Army Communications-Electronics Command, DRSEL-PL-SA

PROJECT OFFICER:
Donald Orr/Alan Kaplan

INITIATION/PROGRAMMED COMPLETION DATES:
November 1980/June 84

PROBLEM: In developing a logistical support concept for a weapon system to be deployed, supply and maintenance decisions are made that impact the life cycle cost of the end item in question. In order to make the most of the Army's investment in dollars and manpower, optimization of the process that leads to initial commitments of stockage, repairmen, test equiment, and transport over several echelons of support is highly desirable.

Currently existing maintenance support of life cycle cost models used by the Army that make repair level and stockage decisions for the user, do not truly optimize by considering the tradeoffs and interactions amongst the repair, supply, and transport processes. There is a need to marry an initial supply support program which makes multi-echelon stockage decisions in a cost-effective manner with an efficient algorithm for allocating repair and test equipment and skilled personnel to the various repair echelons.

OBJECTIVES:

1. To develop a hands-on computer program for making stockage and repair decisions in a multi-echelon environment.

2. Program will operate with input sets similar to SESAME and GEMM models in order to give the user guidance on where to repair, what to repair, where to place test equipment.

3. Program will accept user specified constraints on what are desirable solutions.

4. Program will be "portable" (i.e., it will be easy to adapt for use on a variety of computers.

5. Current state of the art techniques will be applied to quickly develop a product which is significantly better than current computer packages. Subjects for future research and refinement will be identified and treated in a follow-on effort.

IRO Project No. 287 (cont)

CURRENT STATUS:

The IRO has developed a mixed integer program that, in conjunction with SESAME (which produces stockage costs) and a pre-processor (which produces Test Equip/MOS and transportation costs), determines optimal task distribution and placement of TE/MOS. The pre-processor was developed by CECOM systems analysis group.

The OATMEAL program (the integer LP) has been successfully used at CECOM. An enhanced version is now being designed in conjunction with CECOM.

A final report is undergoing peer review.

This project number has also been used to investigate the proper use of ORLA models (including OATMEAL) for test program sets (TPS) decision making. Reports on our findings and recommendations are being made to the TPS management task force. More widespread use of OATMEAL should be forthcoming.

RELATED STUDIES:

AMSAA study - M109 General Test Equipment Requirements Analysis (in progress).

Alan Kaplan paper "The OATMEAL MODEL," Multi-Echelon Inventory Systems Conference, December 1982, Washington, DC.

US ARMY INVENTORY RESEARCH OFFICE
ONGOING STUDY SUMMARY

TITLE: Implementation of RIMSTOP for Reparable Items

IDENTIFICATION NUMBER:
IRO Project No. 291

SPONSOR: Deputy Chief of Staff for Logistics, Army Assistant Director for Supply Management, DALO-SMP-U

PROJECT OFFICER:
Arthur Hutchison

INITIATION/PROGRAMMED COMPLETION DATES:
June 1982/December 1983

PROBLEM: USAREUR has experienced problems with the current AR 710-2 stockage policies when used for levels computations for management of major assemblies. The policy is not applicable to a multi-echelon environment, and is particularly inappropriate when level of operating tempo is variable.

OBJECTIVES:

To develop a stockage model for management of major assemblies in USAREUR.

CURRENT STATUS:

A multi-echelon SESAME-type model and a data base management system were programmed on an IBM Personal Computer. During two trips to USAREUR approximately 50% of the major assemblies in the V Corps and 20% in the VII Corps were input to the data base and stockage lists produced. Materiel Managers in both Corps seem satisfied with the quantities and distribution of stock produced by the model.

Currently waiting decision on implementation and on desired enhancements to the model to include computation of "combat" stock.

A report has been written describing the work done to date.

RELATED STUDIES:

1. "Mathematics of the SESAME Model," Alan Kaplan, IRO Technical Report, February 1980.

2. "On the Optimal Stock Levels in Multi-Echelon Maintenance System," Meyer Kotkin, IRO Technical Report, June 1978.

3. "Major Assemblies Stockage System," Arthur Hutchison, Inventory Research Office (To be Published).

US ARMY INVENTORY RESEARCH OFFICE
ONGOING STUDY SUMMARY

TITLE: Dollars vs Readiness

IDENTIFICATION NUMBER:
IRO Project No. 294

SPONSOR: DARCOM Directorate for Supply, Maintenance & Transportation
Deputy Director for Weapon System Management, DRCSM-W

PROJECT OFFICER:
W. Karl Kruse

INITIATION/PROGRAMMED COMPLETION DATES:
February 1982/January 1985

PROBLEM: Supply management activities within DARCOM are commodity, rather than weapon system oriented. Budget preparation and execution are similarly managed. As a result, it is now not possible to determine the effects of resource investments on the readiness and sustainability of weapon systems.

In recent years, the DoD and Congress have begun to press for use of management techniques that will allow estimates to be made of how changes in amount and allocation of resources would affect weapon system readiness. Data sources are not organized for ready access nor are management models adequate for this purpose.

OBJECTIVES:

To develop methodology for determining how materiel readiness/sustainability could be expected to change as dollars invested in various resources (float end items, repair parts, test equipment, maintenance personnel, etc.) are changed.

CURRENT STATUS:

Work was suspended after a preliminary analysis was done, as a result of a DARCOM decision to manage this effort within the framework of a Weapon System Functional Coordinating Group (FCG). The FCG was established in October 1983 and a meeting was held at IRO to define the groups charter. It was decided to build upon ongoing work in War reserves and Combat PLL/ASL for the long term approach to weapon system management, and to use the IRO weapon system Supply Performance Analyzer to make wholesale level decisions in the short term. We will continue to keep in touch with the efforts of the Air Force and Navy through the DoD Supply Management Policy Group.

RELATED STUDIES:

1. "Operational Readiness Oriented Logistics Support Models," IRO Project No. 260, (ongoing).

IRO Project No. 294 (cont)

2. "Supply/Maintenance Trade-Off Analysis," IRO Project No. 287 (ongoing).

US ARMY INVENTORY RESEARCH OFFICE
CANCELLED STUDY SUMMARY

TITLE: Treatment of Item Essentiality in CCSS

IDENTIFICATION NUMBER:
IRO Project No. 286

SPONSOR: DARCOM Directorate for Supply, Maintenance and Transportation, DRCSM-WRS

PROJECT OFFICER:
W. Karl Kruse

INITIATION/PROGRAMMED COMPLETED DATES:
June 1981/June 1983

PROBLEM: Since implementation of DoDI 4140.39 within the Army, the MSCs have been uncomfortable with the low safety levels (SL) produced by the CCSS for higher cost, low demand items.

Although an item essentiality weighting factor can be applied in the computations, the model has been implemented without this feature. Consequently, the model tends to produce SLs which are quite sensitive to the annual dollar value of demand.

OBJECTIVES: The original objective of this project was to develop an item essentiality weight for each item to be used in the SL calculation. However, recent research at IRO in multi-echelon inventory models has caused us to rethink the study objective. There is now reason to question the basic formulation of the DoDI 4140.39 model itself. The model of the DoDI views the wholesale system in isolation from the rest of the supply system. When the wholesale level is viewed as the top level in a simple two-echelon system, it is found that the optimal wholesale stockage is not nearly as sensitive to dollar value as the DoDI 4140.39 policies stipulate they should be. Since this is a fundamental problem which cannot be corrected with essentiality weights, we have redefined the objective of the study so as to consider the wholesale stockage policies in a multi-echelon context.

CURRENT STATUS:
Decision was made early in FY83 to carry on all work on this problem within the framework of the DoD Supply Management Policy Group and the DARCOM Weapon System FCG.

RELATED STUDIES:
1. Operational Readiness Oriented Logistic Support Model (ERPSL) (SESAME), IRO Project 260.

2. Dollars vs Readiness, IRO Project 294.

US ARMY INVENTORY RESEARCH OFFICE
LOGISTICS MANAGEMENT ASSISTANCE

In addition to its formal work program, the IRO provides assistance upon request to DARCOM Headquarters and its Commands, and to other DA and DoD activities. The assistance involves work of a short term nature, generally requiring no more than a few man-months of effort. Some of the tasks worked on in FY1982 are described below.

CCSS Functional Coordinating Groups - The IRO continues to provide representation on the FCG's for Supply Management, Maintenance Management, Provisioning, War Reserves, and Mobilization. This involves attendance at meetings where System Change Requests are evaluated and doing short term studies on problems of immediate interest to the Groups. Two special tasks were trouble shooting with ALMSA and several MSCs to find computer program problems that were delaying implementation of the IRO Depot Redistribution Model and assistance to ALMSA on programming the mathematical subroutines for implementation of the IRO Minimum Buy Model.

Assistance to DARCOM Headquarters and its MSCs - Assistance was given to all MSCs to enable them to implement the Weapons System Supply Performance Analyzer (SPA) in time for an upcoming budget cycle. DARCOM has made use of the Weapons Systems SPA mandatory for all budget submissions. Assistance involved getting the SPA to run on each MSC's computer and training budget personnel on running the programs and interpreting program outputs.

A TACOM Supply Performance Improvement Team visited IRO on several occasions to discuss their problems. Many of the problems involved the supply management/procurement interface. One interesting area we discussed concerned the use of options contracts, as a result of which some new research work was initiated.

Advice was given to an AMCCOM team that was doing an economic analysis of plans to put a sophisticated M1 Tank Transmission Automatic Test Set at Anniston Army Depot.

Dr. Orr chaired the Test Program Sets (TPS) Models sub-committee of the DARCOM Automated Testing Management Automation Committee. A set of recommendations on development and evaluation of TPS requirements was given to the main Committee. The sub-committee is still in existence, awaiting further tasking from the DARCOM committee.

Mr. Kotkin gave assistance and advice to the 9MM Handgun Project Manager on development and economic analysis of maintenance support alternatives for that weapon. The outcome was highly successful in that the support plan finally selected was approved by DARCOM, DADCSLOG, Joint Chief of Staff, and Deputy Secretary of Defense.

In response to request from Under Secretary of the Army Ambrose, Mr. Kaplan assisted in preparing a briefing on the SESAME model and its implementation. This was given by Mr. Heinbach, DARCOM Deputy Director for Supply, Maintenance and Transportation. Mr. Kaplan later gave a separate briefing to Mr. Ambrose on technical features of the SESAME model.

Assistance to Department of Defense

Mr. Kaplan chaired a tri-Service Working Group of the DoD Provisioning Policy Group that was charged with recommending needed revisions to DoDI 4140.42, "Determination of Initial Requirements for Secondary Item Spare and Repair Parts." Recommendations were developed and accepted by the Services and DoD.

Messrs. Kaplan and Kruse continued to furnish Army operations research representation on the DoD Supply Management Policy Group. The most important task of the group is to decide how to bring management by weapon system into the supply management process during the replenishment phase. Work of the group is still of an exploratory nature.

Messrs. Deemer and Gotwals gave assistance to Defense Logistics Analysis Office on their study of cargo forecasting methods of the Military Sealift Command, the Military Airlift Command, and the Military Traffic Management Command.

At DoD request, IRO furnished a critique of the Boeing methodology and results in connection with their DoD contract to do research on forecasting techniques. Boeing continued to use the IRO demand data base for empirical evaluation of forecasting models.

Other Consulting Assistance

Dr. Orr provided additional assistance and performed requested SESAME analyses in support of Manpower and Logistics Analysis (MALA) for the AAH aircraft and the M1 Tank. This work demonstrated again the need for a standard methodology for analyses of this kind.

As an offshoot of work for USAREUR on the Major Assemblies Management Model (see Project 291), Mr. Hutchison performed analyses for 200th Theatre Army Materiel Management Center on effects of changing deployment and maintenance policies on M1 Tank support requirements. Analyses were done via telephone and mail.

Mr. Deemer, at Army DCSLOG request, reviewed stockage list methodology for Organizational Clothing and Individual Equipment items. Methodology had been developed by the Logistics Evaluation Agency.

Mr. Rosenman joined an Army technical team in a visit to Aachen, Germany for the Joint U.S./Germany Maintenance Talks. He gave talks on SESAME and Combat PLL/ASL methodology. With Wayne Copes, AMSAA, he also consulted with the USAREUR DCSLOG on Combat PLL/ASL problems and visited DARCOM Europe and the NATO Maintenance and Supply Activity to discuss problems on which AMSAA might be able to furnish assistance.

Mr. Kaplan and Dr. Orr gave modelling assistance to Air Force Logistics Command on how the mixed integer programming methodology used in OATMEAL (see Project 287) could be applied in the Air Force Level of Repair model. Computational tests were performed for AFLC on the Boeing computer and proved to be very encouraging. Use of the MIP methodology would significantly improve capabilities of the AFLC model.

Mr. Rosenman, along with Art Groves and Harvey Lee, AMSAA, visited RAND to learn more about their AURA (Army Unit Readiness/Sustainability Assessor) model. This model, a large Monte Carlo simulation, had been developed by RAND under DoD auspices. Decision was to be made by DADCSLOG as to whether the Army should take over sponsorship of the model. As result of this visit, decision was made to bring the model in-house at AMSAA and to make it available there for use in support of Army logistics analyses.

Advice was given to a new Concepts Analysis Agency organization that will be working in the logistics area. Their initial area of concern is expected to be evaluation and application of multi-echelon models.

Assistance was given by IRO and AMSAA to an Army Captain who is enrolled in the graduate program in operations research at Georgia Institute of Technology. He is doing his thesis in an area suggested by and of great interest to us; how independent arising from reliability failures and dependent failures coming from combat damage can be combined for use in stockage models. AMSAA gave him data on combat failures from their SPARC program. We gave him the SESAME program and a multi-echelon simulation program to use in establishing and evaluating combined stockage lists. His work is to be finished early in FY84.

US ARMY INVENTORY RESEARCH OFFICE
PROFESSIONAL ACTIVITIES

Article by Sally Frazza and Alan Kaplan "Empirical Inventory Simulation: A Case Study," appeared in the January 1983 issue of Decision Sciences.

Article by Mr. Rosenman, "Management of an OR/MS Activity by Peer Review," was accepted for publication by Interfaces. It will appear in late 1983.

Ed Gotwals gave a paper "Forecasting Repair Part Demand in the Army Wholesale Supply System," at the 3rd International Symposium on Forecasting, held in Philadelphia on 6-8 June 1983. Ed is also participating as a panelist in the on-going "The Forecasting Workshop in Print," sponsored by the Journal of Business Forecasting Methods and Systems. This Workshop was established to enable modellers and practitioners in forecasting to get advice on problems from a panel of experts.

Meyer Kotkin gave an invited paper, "The Fixed Asset Vector Problem (FAVP) for Dynamic Multi-Echelon Inventory Systems for Repairable Items," at the Joint National ORSA/TIMS meeting held in Chicago on 25-27 April 1983. He also served as referee for articles submitted for publication to Management Science and Naval Research Logistics Quarterly.

Messrs. Kaplan, Kruse and Rosenman took part in the DoD Multi-Echelon Inventory Systems Conference at the Center for Naval Analyses on 9-10 December 1982. Papers were given by Kaplan on the OATMEAL model and by Kruse on IRO heuristics that have been found to work well in the SESAME model.

Mr. Rosenman gave a talk on the SESAME model at the Fort Lee, VA Chapter of Society of Logistics Engineers on 16 March 1983. At request of Deputy Under Secretary of the Army (Operations Research), he also served as head of an Army Systems Analysis Peer Review Team to evaluate a study done by the Combined Arms Systems Analysis Activity as a part of the Army Aviation Mission Area Analyses. Team members were Lyle Suprise, Army Engineer Study Center, and Prof. Wesley Harris, MIT. Review was successfully accomplished.

US ARMY INVENTORY RESEARCH OFFICE
REPORTS

Published

"Forecasting Methods for Parts Support of Depot Overhaul," Edwin Gotwals and Karl Kruse, July 1983 (Interim Note F-61).

"Annual Report FY82," January 1983 (ADA125823).

"Developing Requisition Short Cost Parameters for RIMSTOP (LAMBDA-GENERATOR)," Robert Deemer, April 1983, (ADA128370).

In Peer Review

The OATMEAL Model.

Sortie Duration & Helicopter Component Failures (Ready to be published after corrections are made).

Major Assemblies Stockage Model.

Test of Poisson Failure Assumption (Ready to be published after corrections are made.)

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