ANNUAL REPORT FOR FY 1970

AMC INVENTORY RESEARCH OFFICE
US Army Logistics Management Center
Frankford Arsenal

July 1970

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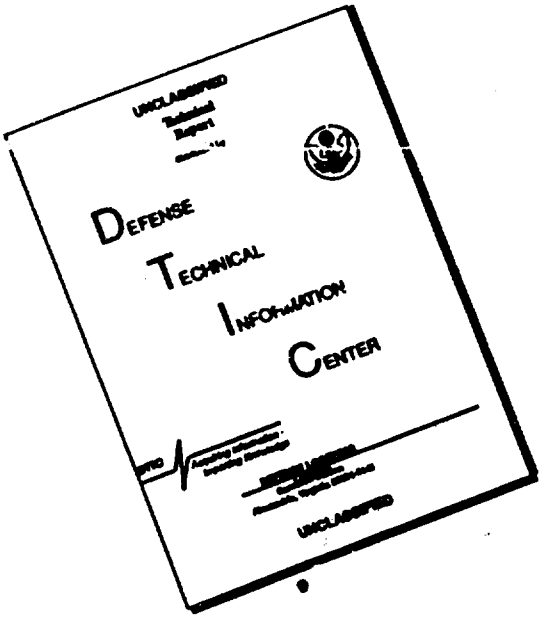

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INTRODUCTION

This is the fifth Annual Report of the AMC Inventory Research Office. It covers activities of the office during the period 1 July 1969 to 30 June 1970.

The first section describes projects worked on during that period and gives their present status. Other activities of the Office and Personnel Notes are covered in Section II. Section III describes the work program projected for FY 1971.

The final section of the report lists IRO publications issued in FY 1970. The IRO Annual Report for FY 1969 lists IRO publications issued during that year; a list of all IRO publications issued prior to that time is included in the Annual Report for FY 1968.

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ABSTRACT

This report describes work done by the AMC Inventory Research Office in FY 1970 and the current status of its projects. The FY 1971 work program of the office is also included.

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SECTION I

Studies Done in FY 1970

1. QUANTITATIVE EVALUATION OF FACTORS INVOLVED IN SAFEGUARD CATALOGING DECISIONS

BACKGROUND:

This study was undertaken at the request of the SAFEGUARD Logistics Command. Because of lead time conderations, that Command found itself in the position of having to make certain decisions on the expenditure of resources on Federal cataloging activities. Initially, the question was simply: at what point in time should the processing rate build-up begin, at what rate should it increase and when and in what manner should the processing rate be stepped down to a sustaining rate level? It soon became evident, however, that there were several courses of action open to the SAFEGUARD Logistics Command and it was decided to attempt to estimate the cost consequences of each of these choices.

WORK ACCOMPLISHED IN FY 1970

This project was started in October 1969 and was completed in February 1970.

The alternatives considered were: (1) assume logistic support by the Army with complete cataloging done; (2) assume logistic support by the Army but with cataloging actions on peculiar items limited to Type 2 (skeleton-type) item identifications; and (3) assume only limited Army support (restricted to remove/replace actions on site) with repair performed by contract. This last alternative made it possible to forego any Federal cataloging action except for a limited number of parts used by the Army in its on-site maintenance.

It was possible to obtain estimates of standard times required to perform the elemental tasks required in the Federal cataloging process and, from these, and from the rate at which cataloging actions had to be processed, to meet the SAFEGUARD expected deployment date, the ten-year costs of each alternative were found. Then the analysis centered on the uncertainties of the situation. Penalty costs and cost advantages were estimated, for example, for doing Federal cataloging only to find that it was done too early (i.e., entry into full Army support delayed) or assuming contractor support for the full 10-year cycle only to find Army support being embarked upon.

Final report on this study was published in February 1970.

2. FORECASTING TECHNIQUES FOR SAFEGUARD REPAIR PARTS BUDGETS

BACKGROUND:

This project was initiated in March 1970 with the objective of developing a methodology for developing gross repair part budget estimates for the SAFEGUARD system during the early time period when configuation of the systems to be deployed is not completely known and before failure rate estimates are developed.

WORK ACCOMPLISHED IN FY 1970

The approach taken was to identify already deployed systems and sub-systems whose characteristics are similar to SAFEGUARD sub-systems, to obtain data on repair parts usage and investment costs of these similar items and to adjust these data to reflect differences between them and the SAFEGUARD sub-systems. Data were obtained from a variety of sources on missiles, computers, command and control systems, support equipment, etc. suitable for developing estimates of annual parts cost per sub-system investment dollar. Some advance data on expected part failure rates for a limited number of parts were obtained through Western Electric Company; these rates will be used to give at least a partial calibration of estimates compiled from other sources.

Data collection had been completed by the end of FY 1970; the project is expected to be completed early in FY 1971.

3. PILOT IMPLEMENTATION OF MANAGEMENT SYSTEM FOR HIGH VALUE ARMY AVIATION COMPONENTS (AMMIP)

BACKGROUND:

A management system for high value Army aviation components was developed in 1964 by the AMC Inventory Research Office as part of the Aviation Materiel Management Improvement Program (AMMIP). The system, which is described in Technical Report TR 64-1, October 1964, includes such features as: actuarial forecasting of component removals, short- and long-range worldwide supply control studies for determining effects of spares levels, pipeline times and rates, failure rates and TBO policy, etc., on aircraft availability; an algorithm for optimal distribution of spares between NICP and field stockage points; and short-term component status forecasts for day-to-day management control.

WORK ACCOMPLISHED IN FY 1970

Most of this year's effort was devoted to continuing the work begun in FY 69 to construct and maintain a viable data base consisting of postcard (ACIMS) transactions for component removals, installations and movements and of DA 1352 Aircraft Status and Flying Hours Reports. Troubles continue to be-devil the system: sporadic reporting, inconsistent data, missing critical entries, etc. Data base analysis was slowed considerably due to the classification of the data, which made processing relatively inefficient. Earlier ideas about developing error correction routines have been shelved, at least temporarily, because of inability to get even the straightforward data base maintenance working properly.

One attempt was made to re-program the AMMIP supply control study on a time-sharing system. A satisfactory one-period program was developed, but work on a time-phased program to produce a format like the DA 1794 had to be suspended due to lack of programmer resources. Interest in a time-sharing supply control study was revived late in the fiscal year, however, and a separate project, described later in this report, was spun off. It carries the title "Dynamic Tables for Aircraft Engine Requirements."

4. REPARABLE ITEMS SUPPLY CONTROL MODELS

BACKGROUND:

The problem being worked on is the extension of Variable Safety Level/ Economic Order Quantity concepts, now widely used on consumable items, to depot reparable items. Serviceable assets are obtained from two sources: repair of unserviceable turned in by the field, and new procurement to replace attrition losses. Now not only demands are variable but so are field returns of unserviceables; there are also set up costs for repair as well as costs of procurement to consider. The concern is to determine the "trigger" points for initiating procurement and repair actions, and to determine the quantities to be procured and repaired, all in such a way as to provide a given level of supply performance at minimum cost.

Work in previous years resulted in development of mathematical optimizing models for two policies, the "Two-Stock" model, jointly by Prof. Galliher of University of Michigan and IRO, and the "Look-Ahead" model, by the IRO. Earlier simulation experiments of these policies yielded inconclusive results.

WORK ACCOMPLISHED IN FY 1970

A much more detailed simulation program was written to provide a more discriminating and flexible test vehicle. The new program makes it possible to test not only the "Two-Stock" and "Look-Ahead" policies, but also a number of others, including the present Army policy, a policy used by the Navy and a number of other composite policies that include various heuristic features. The objective in constructing and testing these semi-heuristic policies is to try and find one that gives results close to those yielded by the best mathematical optimization procedure but which can be implemented more easily.

A considerable number of runs were made by the end of FY 70, but analysis of results is not yet complete. As is frequently the case with complex simulation programs, a large amount of running time had to be expended to assure that steady state conditions had been reached; indeed, the delay in completing the analysis is due in large measure to uncertainty as to whether steady state conditions had in fact been reached in some of the critical runs.

This project is expected to be completed in early FY 1971. Previous intentions of extending the study to other phases of rebuild planning have been dropped, at least temporarily, until implementation implications of current work are better known.

A paper describing the simulation program and some interim results was given at the 25th Military Operations Research Symposium in New London, Conn. 17 June 1970 by Steven Gajdalo.

5. JOINT LOGISTICS REVIEW BOARD ANALYSES

BACKGROUND:

This project was undertaken in December 1969 at the request of Gen F.S. Besson, Jr. The objective is to apply the IRO multi-echelon models in conjunction with the Research Analysis Corporation multi-echelon simulator to study alternative supply support concepts. The two principal concepts to be considered were the Direct Supply Support System (supply from a CONUS depot complex direct to DSUs without intermediate stockage) and "Advanced MASS" (limited stockage of fast moving items in overseas depot, expedited supply of the rest). The IRO models are to be used to determine which items in the USAREUR catalog would be stocked at what locations and in what quantities under various assumptions as to response times and constraints on stockage. The RAC simulator, in addition to developing a variety of performance measures for the current support system, is to be used to estimate the same performance measures given the IRO stockage lists and quantities stocked.

WORK ACCOMPLISHED IN FY 1970

Initial analysis centered on support of the USAREUR divisional DSUs. Demand data of divisional DSU customers and of all customers on the USAREUR Materiel Command were processed and classified, mostly by RAC, in accordance with agreed upon schemes. Estimates of expected pessimistic and optimistic response times for each system were developed and approved for use in the analyses by AMC and by the JLRB, as were other operating characteristics of the alternative systems.

At the time the work began, the IRO model operated only under an S-1,S policy, i.e., each unit issued is replenished as issued. This model was extended to enable calculation to be made of approximately optimal Reorder Points, Reorder Quantities for the two-level case, which is sufficient for the JLRB analysis.

Initial runs were made, using the S-1,S model, to determine where items would be stocked under each support concept and to get approximate ideas of system performance under each. This brought to light the rather unexpected finding that the divisional DSUs account for only a small fraction of the total USAREUR demand and that results are dominated by other customers. Thus, decision was made to break down the other customers to treat the larger ones on the same basis as the divisional DSUs. This is to be done before completing the R,Q part of the analysis.

While analysis is not yet complete certain interim results were found to be useful be the JLRB. At Gen Besson's request, the analysis is to be completed, with target date the end of 1st Quarter FY 71.

A paper describing the evolution of the IRO multi-echelon models and the form of the models used in the JLRB analysis was given by Kruse and Rosenman at the 25th Military Operations Research Symposium at New London, Conn. on 16 June 1970.

6. ADVISORY GROUP ON REVISION OF DODI 4140.11, "OPERATING AND SAFETY LEVELS OF SUPPLY"

BACKGROUND:

This group of supply policy personnel and operations research analysts from Army, Navy, Marine Corps, Air Force and Defense Supply Agency was assembled by OASD (I&L) under the chairmanship of Mr. George Minter to revise DODI 4140.11, which is the policy document governing supply management of consumable items. The objective of the revision is to obtain methodological standardization in Variable Safety Levels and Economic Order Quantities computations for these items in order to provide the basis for more rational budgetary decisions at Service and DOD levels.

WORK ACCOMPLISHED IN FY 1970:

DOD decision to adopt time-weighted requisitions short as the standard performance measure to be used in VSL/EOQ optimization formulas permitted work to go forward to completion. IRO chaired the sub-group that wrote the Cost to Hold section of the DODI and had representatives on the Cost to Order sub group (chaired by Air Force) and on the Decision Rules sub group (chaired by Navy). A draft DODI was assembed and edited by Mr. Minter and received Services and DSA approval later in FY 1970. Steps were then initiated to bring UMIPS response time standards and MILSTEP reporting and analysis procedures into conformity with the time-weighted requisitions short performance measure of this DODI.

Work of the Advisory Group is, for all practical purposes, now completed. Plans for implementing the new DODI are described in next year's work program.

7. ALLOCATION OF STOCKS TO DEPOTS (SIIMS)

BACKGROUND:

The object of this study is to develop a model for allocation of stocks of important items (such as SIIMS*) between CONUS and the various overseas areas when assets are short in a manner that will give the best supply performance obtainable. A time-shared computer program that can be used by the item manager is desired so that allocation schemes and resulting expected supply performance can be obtained quickly.

WORK ACCOMPLISHED IN FY 1970:

This turned out to be a rather stubborn technical problem, involving a transient as opposed to a steady-state kind of analysis. A reasonably efficient allocation algorithm was finally developed which considers the options of shipping all assets now to the overseas areas or witholding some for later emergency shipment. The quantities to be shipped to each area and to be witheld are calculated by the algorithm to minimize expected backorders.

This work was finished in June and a report is in preparation for distribution in FY 1971. Some operational tests at NICPs are planned before implementation.

*SIIMS means Secondary Items Intensive Management System, which superseded OASIS.

8. CONTAINER REQUIREMENTS AND SHIPPING FREQUENCIES UNDER THE DIRECT SUPPLY SUPPORT CONCEPT

BACKGROUND:

This project was initiated in March 1970. The Direct Supply Support Concept, which is to be tested with two USAREUR divisions beginning 1 July 1970, involves supply support of divisional DSUs direct from a CONUS depot complex with no intermediate stockage points. Stocks of items carried on the DSU Authorized Stockage Lists are to be replenished by containerized shipments direct to the DSUs. The objective of this study is to determine the cost implications of using various container sizes, shipping schedules and "holdover" or release policies on partially full containers.

WORK ACCOMPLISHED IN FY 1970:

Analysis was done on demand data obtained from the test divisions by Research Analysis Corp. to determine the statistics (mean, variance, etc.) of weekly volume and weight of divisional requirements. Container shipping schedules and cost data were obtained from MTMTS. These were used in a computer simulation program to determine the costs of using 20 foot, 40 foot and mixes of 20 and 40 foot containers (the sizes determined to be the most feasible commercially available) under various holdover policies. Three relevant cost factors were considered: Transportation, Pipeline and Theatre inventory costs. The last cost element was developed by calculating the "equivalent performance" Divisional safety level required for any Test Shipping policy. Equivalent performance in this case implies fixed stockout probability.

Sufficient simulation runs were completed by the end of June to provide the required analyses for policy recommendations. Report on this project is in preparation and will be distributed early in FY 71.

9. DYNAMIC TABLES FOR AIRCRAFT ENGINE REQUIREMENTS

BACKGROUND:

DCSLOG and AMC Headquarters have for some time been dissatisfied with the DA 1794 and the DODI 4140.24 stratifications as the media for determining aircraft engine requirements and for depicting budgetary needs. DCSLOG has used its own form, called Dynamic Tables, for these purposes but with some difficulty because of differences in computational ground rules. AMC Headquarters requested in March 1970 that the IRO attempt to resolve these computational differences. This happened to coincide with DOD establishment of a Sub-Task Group under Mr. R. J. Dintaman, OASD(I&L) to develop a standard methodology and formats to be used by Air Force, Navy and Army for computing aircraft engine requirements and budgets. IRO was, therefore, also asked to work with that Sub-Task Group.

WORK ACCOMPLISHED IN FY 1970

IRO developed a revised requirements study embodying the essential display features of the DCSLOG Dynamic Tables and the requirements time-phasing features of the DA-1794 but based computationally on the IRO AMMIP model. AVSCOM, AMC Headquarters and DCSLOG felt that the proposed study would be satisfactory to them and that it also should be proposed as the standard tri-service requirements study. The Sub-Task Group felt, however, that it was perhaps too advanced a concept to be implemented immediately, and settled on a simpler study for the time being. It was agreed within the Army, then, that IRO would program a time-shared version of the new Dynamic Tables requirements study. This is a much more detailed study than the proposed DOD standard study but transliteration to the DOD study would be a simple task. Additionally, the Sub-Task Group recommended to DOD that it be authorized to continue in existence to work towards developing a more advanced standard study along the lines proposed by IRO.

Working arrangements were made with AVSCOM to assure that their requirements would be satisfied in the new format and that the time-shared software would be able to handle the types of "what if?" questions they would most likely be asking in an inter-active study. Dr. N. Bernstein, a recent PhD in Computer and Information Science was hired for the summer to assist in the software development. Expectations are that a working program will be ready for AVSCOM's experimental use by the end of the summer.

10. COST TO ORDER

BACKGROUND:

This study began in July 1969 in response to DOD request, related to the revision of DODI 4140.11, that each Service up date its Cost to Order to use in VSL/EOQ computations. These costs are to be determined in accordance with guidelines developed by the DODI 4140.11 Advisory Group.

WORK ACCOMPLISHED IN FY 1970:

Because of its relatively low priority (revised costs are not needed until the completion of ALPHA implementation) this project was worked on only intermittently during the year. Data were obtained from Aviation Systems Command, Army Electronics Command and Army Tank Automotive Command with the last-named being used to develop what seemed to be representative Cost to Order for procurement actions of less than $2500, between $2500 and $10,000 and over $10,000. Difficulties were experienced, however, in obtaining satisfactory data for Basic Ordering Agreements; this is the remaining task to be completed.

Draft report was written omitting BOA costs but decision was made to hold up publication until BOA costs are obtained. This portion of the work will be done as soon as the schedule for higher priority work permits.

11. PRODUCTION LEAD TIME FORECASTING

BACKGROUND:

The objective is to develop improved methods for forecasting the time to first significant delivery and through to contract completion for use in repair parts supply control studies. The most commonly used method today (using a moving average of experience by FSN) has been found to give large errors. Attempt will be made to relate expected production lead time to item characteristics such as unit price, complexity, class of materiel, etc. An estimating relationship for taking into account the condition of the economy will also be sought.

WORK ACCOMPLISHED IN FY 1970:

This study, because of its relatively low priority, did not resume until February 1970 and was worked on only intermittently since then. Data on approximately 10,000 procurement actions were obtained from Aviation Systems Command and were subjected to preliminary regression analyses. Present forecasting methods were found to under-estimate the expected Production Lead Time by about 30 days but standard deviation of the forecast error as quite large. An estimating relationship has not yet been found, however, that gives significantly better results.

Work will continue on this study into FY 1971 as resources permit.

12. MULTI-ITEM INVENTORY MODELS

BACKGROUND:

This was set up as a separate project in January 1970 when earlier research under the Advanced Inventory Models project indicated that an implementable model could probably be developed.

Current VSQ/EOQ models consider one item (one FSN) at a time and calculate the safety level and order quantities that will yield a desired level of supply performance at minimum variable cost/year for each individual item. If it happens, however, that there are groups of items of like characteristics that could be bought simultaneously, it is likely that procurement costs could thereby be significantly reduced. This, however, would result in buying some items in the family before their reorder points have been reached, thus increasing the holding costs. This joint procurement action would also change the expected backorders. The object of this project, then, is to develop an optimizing model for determining when the advantages of joint procurement of repair parts justifies ordering some items before they reach their reorder warning points.

WORK ACCOMPLISHED IN FY 1970:

A model was developed which permits calculation not only of the R and Q for the items of an N-item family but also their "Can Order" points. The policy is to track assets until the Reorder Point of one item is reached. When this occurs, all family members whose assets are at or below the "Can Order" point are also procured; the amounts procured of each item are Q plus the Reorder Point deficit, if any. These trigger points are computed for each item so as to provide a given supply performance at minimum total operating costs per year.

Work began towards the end of the fiscal year to write a computer simulation program to test the new model and to obtain estimates of the savings that would result from its implementation. This work will continue into FY 1971.

13. AGGREGATE MEASURES OF SUPPLY PERFORMANCE

BACKGROUND:

This had been reported as a completed study in the FY 1968 Annual Report but a Final Report has not yet been published, even though results and major conclusions were briefed to an inter-service group. The major finding concerns methodology for projection of inventory positions and budgetary requirements when forecast errors are present. Completion of the report was given a low priority since results could not be used while DOD was in process of pushing for the implementation of DODI 4140.24 by all services; thus, higher priority work constantly interfered with publication.

WORK ACCOMPLISHED IN FY 1970:

Very little was done beyond some re-programming of STOSIM, the stochastic stratification simulation program, in anticipation of doing some reinforcing runs. Now that DODI 4140.24 has been implemented, the project will be revived and a final report will be published during the first half of FY 1971.

14. PROVISIONING

BACKGROUND:

The IRO work program for FY 70 included this project, the prime objectives of which are to (1) develop a model to determine which repair parts should be selected as such during the provisioning process and (2) revise the provisioning rules in TM 38-715-1, which are based on a study done about 10 years ago.

WORK ACCOMPLISHED DURING FY 1970:

No real work was done on this project because of shortage of personnel. However, AMC Headquarters, in early June 1970, requested that the project be initiated immediately, which was done. Basic literature survey was completed. Preparation of a detailed work statement was begun delineating scope of the work to be done and approaches to be taken; this is to be presented to AMC Headquarters early in July 1970 for approval.

15. ADVANCED INVENTORY MODELS

BACKGROUND:

This section describes research work, which is not project oriented, done by the IRO or under its auspices. The objective is to seek a better understanding of the inter-actions that occur in complicated logistic systems, and to find ways, models and optimization techniques, to account for them. The expectation is that this work will result in spin offs which are project oriented or will provide understanding helpful to better decision making. About 20% of the IRO effort is devoted to research of this kind.

WORK ACCOMPLISHED IN FY 1970:

Professor Edward A. Silver (now at Waterloo University in Canada) finished his consulting association with the IRO during this year. Research was done jointly with him on optimal inventory control rules for items having primarily small demand transactions with occasional very large transactions, a not uncommon characteristic of many Army items. Professor Silver published a theoretical paper on the characteristics of such items and the approaches to optimization of their control rules in the Canadian Operational Research Journal (July 1970 issue). A technical report was then published on the optimal decision rules for items with stuttering Poisson demand, a special case of the type of item considered. It was jointly written by Professor Silver and by Mr. Deemer and Miss Ho of the IRO; publication in the CORJ is also expected.

Several other investigations were made, motivated by issues raised during discussions of the DODI 4140.11 Advisory Group. Two Technical Reports by Alan Kaplan and one by Miss Chung-Mei Ho were published dealing with the characteristics of performance measures for R,Q inventory models. All three papers were accepted for publication in professional journals, two by the Naval Research Logistics Quarterly and one by Management Science. It is of interest to note that a related paper "Much Ado About EOQ" by Victor Presutti of the Operations Analysis Office, Air Force Logistics Command, which was motivated by the same discussions, will also appear in the NRLQ, and that in general a much closer coordination of research efforts between members of the Advisory Group has resulted from their association with the DODI 4140.11 project.

Research on optimization techniques for use in multi echelon support models continued. A much improved algorithm for use with the AMMIP model was developed by Karl Kruse and has been published as a Technical Report. Other technical advances were made in the course of the developmental work done on the models used in the Joint Logistics Review Board Analyses. These will be described when results of the JLRB work are published sometime during the 1st half of FY 1971.

Work was resumed to get the Tank-Automotive Command transaction data base back into useable condition. This is a series of magnetic tapes on which IRO has been collecting all demand and return transactions on 70 selected TACOM items since January 1960. It is used for continuing studies of demand forecasting techniques. The data base is now in shape for new investigations in FY 1971.

SECTION II

OTHER ACTIVITIES DURING FY 1970

Some considerable amount of consulting and management assistance were provided by the IRO staff to DA, AMC and the Commodity Commands. Typical of this type of assistance are the following:

Development of Theatre Authorized Stockage Lists Based on Variable Stockage Criteria

IRO, in conjunction with Logistics Management Institute and Research Analysis Corp., is performing various analyses for DCSLOG of TASLs developed by different methodologies. USAREUR data are being used to prepare and evaluate TASLs for the MATCOM. This work, which began in June 1970, may develop into a formal project later on.

Economic Retention Models

Assistance was given to a number of NICPs who were implementing these models, developed last year by the IRO. Computer logic for the models was prepared for the AMC Automated Logistics Management System Agency for implementation under ALPHA.

ALPHA

IRO continued to furnish assistance to the ALMSA as requested on problems that arose during programming of the "Hard Core" supply management applications. IRO continues to have a representative on the ALPHA Supply Management Coordinating Committee.

AVSCOM Organization Study

IRO contributed a representative to the team doing this study. His participation lasted for about 2 months.

Tank Automotive Command Depot Loading Problems

A survey investigation was made of TACOM problems involved in coordinating the scheduling of major item and major component rebuild with positioning of repair parts, and on related problems. Preliminary recommendations for improvement of coordination were made; there appears to be no need for a more intensive study at this time.

PERSONNEL NOTES

Three civilian staff members left this year: W. Wade Williams to the MIT Artificial Intelligence Lab., Jerzy Niemirow to an engineering position at Frankford Arsenal and John Denham, resigned for reasons of health.

New civilian hires: Bruce A. Kirkpatrick, from Arthur Young, Inc. (and formerly with MUCOM Headquarters and before that, the Ordnance Supply Analysis situated at Raritan Arsenal),Peter Fatianow from General Electric Co., Apollo Systems Dept., and Dr. Noel Bernstein, PhD in Computer and Information Sciences from the University of Pennsylvania (for the summer only).

E-5s Fred Hoette and Frank DeRosalia (Math-Stat Assts under the Army's Scientific and Engineering Program) finished their Army service during the year. E-3 Larry Wheelock and E-2 Larry Cain came in as their replacements.

Alan Kaplan was named Acting Technical Director. He worked only part-time during the period Jan. 70 to May 70 while completing the residency requirements for the PhD degree in Operations Research at the University of Pennsylvania.

Alan Kaplan participated as a member of the panel on Simulation at the Army Operations Research Symposium, held at Duke University 20-21 May 1970.

Messrs. Kruse, Rosenman and Gajdalo presented papers at the Logistics Working Group at the 25th Military Operations Research Symposium held at New London, Conn., 16-18 June 1970.

SECTION III

WORK PROGRAM FOR FY 1971

1. NEW PROJECTS

The first series of projects listed below has to do with techniques to be implemented within the ALPHA system. Most of these implementation tasks stem from the issuance of DODI 4140.11, "Operating and Safety Levels of Supply." This DODI prescribes service-wide standard approaches to the management of non-reparable items. It imposes, for the first time, a standard measure of supply performance for these items and, in so doing, prescribes the way in which the budgets are to be computed and the manner in which funds are to be allocated to the items. These new approaches necessitate a new method of computation of Variable Safety Levels and Economic Order Quantities; they also make it necessary that compatible techniques be implemented for other types of items managed by the NICPs and that certain analytical tools, soon to be made possible by the existence of the ALPHA data base, be made available for NICP use.

In all of the above implementation tasks, the IRO expects to work in close conjunction with the ALMSA. The implementation package developed by the IRO is expected to consist of guidance for ALMSA systems analysts and programmers and the computer algorithms for the actual computations where required. The degree of detail of the guidance will depend on the ALMSA's requirements and desires.

The DODI 4140.11 projects are as follows:

a. Variable Safety Level/Economic Order Quantity Model

The MIT model, already programmed for implementation under ALPHA, will be superseded by a new model as called for by DODI 4140.11. The MIT model uses dollar value of time-weighted backorders as its performance measure; DODI 4140.11 prescribes that time-weighted requisitions short be used. Thus, new formulas are needed. More important, the MIT model allowed all items within a given group (i.e.,LDV items) to be managed at the same availability or level of protection. This is not possible under the new formulation, where each item's availability is allowed to seek its own level. Methods for constraining availabilities to inhibit undesirable imbalances will have to be developed as part of the implementation.

b. IMPACT Requirements and Budget Simulator

DOD policy, upon implementation of DODI 4140.11, will be to give each Service a target performance measure to be achieved and will ask NICPs to prepare budgets based on the target. This will require the running of simulated supply control studies to determine the requirements levels needed to achieve the target performance. DOD review of these budgets may result in revision of the performance target, particularly if it turns out that funds are not adequate. When budget "marks" are made, the simulated supply control studies again have to be run to find those values of

the "knobs" that control the VSL/EOQ parameters to allocate the funds across the items in order to achieve the new target at minimum cost.

The IMPACT simulator to be designed for this purpose will operate directly from the ALPHA data base and will have the necessary compatibility with the regular supply control study processes and with the DODI 4140.24 stratification programs.

c. Insurance Items Model

The model developed by the IRO last year is to undergo a pre-implementation test in conjunction with the Missile Command. Insurance item data will be used in a simulation program to compare performance of the IRO model with currently used procedures.

If test results are satisfactory, computational algorithms will be furnished to the ALMSA. Consideration will also be given to extending the Insurance Items methodology to other classes of low demand items.

d. Reparable Items Model

The model under consideration here is for use in supply control studies for depot reparable items whose attrition rates are not insignificant so that new procurement, in addition to repair, must be used for replenishment. Simulation runs now in progress at IRO to compare the performance of a number of models should be finished by the end of CY 1970 so that selection may be made at that time of the best model to implement. Computational algorithm for use in supply control study programs will be furnished to the ALMSA.

e. Program Factor Analyzer

Previous IRO work and research of others like George Washington University has shown that demand rates do not change proportionally with the Program Change Factor. This assumption is, however, built into the ALPHA supply control study system. Information carried in the ALPHA data base can be used to determine the nature of the demand/PCF relationship for each NICP and to track this relationship on a continuing basis. IRO will develop a regression analysis program for this purpose.

f. Variance-to-Mean Ratio Analyzer

The ALPHA supply control study system uses a regression equation for estimation of the VMR for the Variable Safety Level computation that was developed by MIT and tested over a period of time by the IRO. This equation is based on demand data for a sample group of TACOM items. Existence of the ALPHA data base now makes it possible to derive VMR regression equations for each NICP based on their own demand data and to track these equations automatically to indicate where revision is necessary. IRO will develop the program for this purpose.

g. Forecasting Cross-Over Model

New items enter the system with a demand rate forecast based on Maintenance Factor. As time goes by, demands begin to emanate from the field until, ultimately, decision is made to allow the demand experience to supersede the Maintenance Factor estimate. This decision is now made rather arbitrarily. It is believed that a Bayesian type model can be developed and implemented using the ALPHA data base that will provide a much better basis for this cross-over. The model should also be applicable to other types of migration decision problems that are included in the current ALPHA system. Decision logic and algorithms will be developed by IRO for ALMSA implementation.

h. Stock Rationing Model

This model, described in IRO report published in March 1968, provides a methodology for calculating reserve levels for conserving assets for anticipated high priority demands when stocks begin to get low. Implementation under ALPHA had been deferred due to the need for "freeze" of the Demand, Return, Disposal History File programs. Implementation of the model as part of the DODI 4140.11 package is desirable because of the complementary role played by the stock rationing procedure. IRO will provide necessary decision logic to the ALMSA.

i. Supply Control Study History Analyzer

Logic will be developed by IRO to produce analyses from the Supply Control Study History File and associated data within the ALPHA data base. The general idea is this: each time a study is made, there is an expectation that the inventory will be in a certain position when the end of the Procurement Lead Time is reached. This analyzer program will examine the deviation of the actual inventory position from the expected and will estimate how much of the deviation is due to demand forecast error, failure of materiel to arrive when expected, failure to take supply action on time, etc. A graphical plot program will also be developed.

2. CARRY-OVER PROJECTS

The following projects, which were worked on in FY 1970, will be carried over to FY 1971; their expected completion dates are shown:

	PROJECT TITLE	EXPECTED COMPLETION
a.	Pilot Implementation of Management System for High Value Aviation Components	Dec 70
b.	Reparable Items Supply Control Models	Jan 71
c.	Joint Logistics Review Board Analyses	Sep 70
d.	Dynamic Tables for Aircraft Engine Requirements	Aug 70
e.	Cost to Order	Sep 70
f.	Production Lead Time Forecasting	Oct 70
g.	Multi-Item Inventory Models	Jan 71
h.	Provisioning (Phase 1)	Nov 70
i.	Aggregate Measures of Supply Performance	Jan 71
j.	Advanced Inventory Models	Continuing

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13. ABSTRACT

This report summarizes work done by the USAMC Inventory Research Office in FY 1970 and contains the proposed Work Program of that office for FY 71.

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