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MODELS FOR AMMUNITION MANAGEMENT

AUGUST 1977

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JOINT CONVENTIONAL
AMMUNITION PROGRAM COORDINATING GROUP
DECISION MODELS DIRECTORATE
ROCK ISLAND, ILLINOIS 61201

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides useful information to ammunition managers on a unique set of nine modern computer models specifically developed to support the conventional ammunition management decision processes. The models have been applied in numerous studies at the request of functional managers. They have provided significant contributions to ammunition management in areas of production base planning and operations, in the planning, programming, and budget cycle, in procurement and in other special areas such as demilitarization. The nine models, all of which are operational and available are:		

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1) The Item Acquisition/Production Trade-Off Model for maximizing item readiness at least cost; 2) The Materiel Acquisition Planning Model for maximizing overall readiness within budget constraints; 3) The Industrial Preparedness Model for mobilization planning (items, components, facilities); 4) The Maintenance Model for least cost layaway and maintenance policy for idle facilities); 5) The Production Facilities Life Cycle Cost Subsystem for least total cost modernization, expansion and workloading of the production base; 6) The Priorities Model for multi-objective management problems (economic and non-economic goals); 7) The Multiple-Bid Evaluation Model for economic analysis of complex procurement actions; 8) The Demilitarization and Disposal Model for integrated demil planning and workloading at least total cost; 9) The Ammunition Packaging/Containerization Life Cycle Cost Model for evaluation from design through disposal

The report further presents the use of these models in an integrated system by which ammunition managers can achieve the maximum overall ammunition readiness in the most cost-effective manner.

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JOINT CONVENTIONAL AMMUNITION PROGRAM
COORDINATING GROUP

REPLY TO
ATTENTION OF:

Rock Island Arsenal, IL 61201

15 August 1977

The JCAP Coordinating Group was formed by the Joint Logistics Commanders with the requirement that it develop, demonstrate and gain acceptance of decision models to improve conventional ammunition logistics management.

This publication is a description of that modeling effort since the inception of the JCAP Coordinating Group. It is written in non-technical language to make it available to the widest possible audience.

The JCAP Coordinating Group has published a series of publications treating each of the models in greater detail.

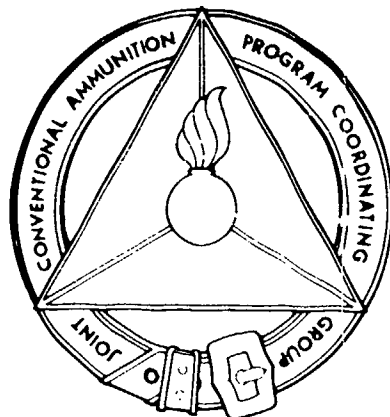
While the models described in this document were to satisfy an ammunition logistics management requirement, they have applicability to other types of management situations which have the same or similar requirements.

This is an approved JCAP Coordinating Group publication.

A handwritten signature in black ink, appearing to read "E. Jordan", written over the typed name.

EDWARD J. JORDAN
Executive Director
Joint Conventional Ammunition
Program Coordinating Group





MODELS FOR AMMUNITION MANAGEMENT

DANIEL R. TURK

JCAP-DM-T703

AUGUST 1977

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**JOINT CONVENTIONAL
AMMUNITION PROGRAM COORDINATING GROUP
DECISION MODELS DIRECTORATE
ROCK ISLAND, ILLINOIS 61201**

ABSTRACT

This special management report presents a unique set of nine computer models specifically designed to assist ammunition managers in their decision making processes. The models serve to summarize the results of development efforts conducted by the Decision Models Directorate of the Joint Conventional Ammunition Program Coordinating Group since its staffing in December 1974. The models represent the realization of the primary modeling recommendations outlined in the 1972 Final Report of the Joint Panel for Development of a Coordinated Management System for the DoD Conventional Ammunition Production Base by the Task Group on Production Base Economic/Decision Models. All of the models are now operational and available. Their value has been demonstrated. Their use has disclosed **over a billion dollars** in cost deferrals, avoidances and savings to ammunition managers during this period.

The report summarizes each model from the manager's viewpoint -- application areas, point of contact, description, and technical facts -- and then concludes with a section on their use in an integrated system for ammunition management. Contributions to the report for its direction, for its information content, and for its final format were made by all personnel of the Decision Models Directorate. They are all gratefully acknowledged by the author.

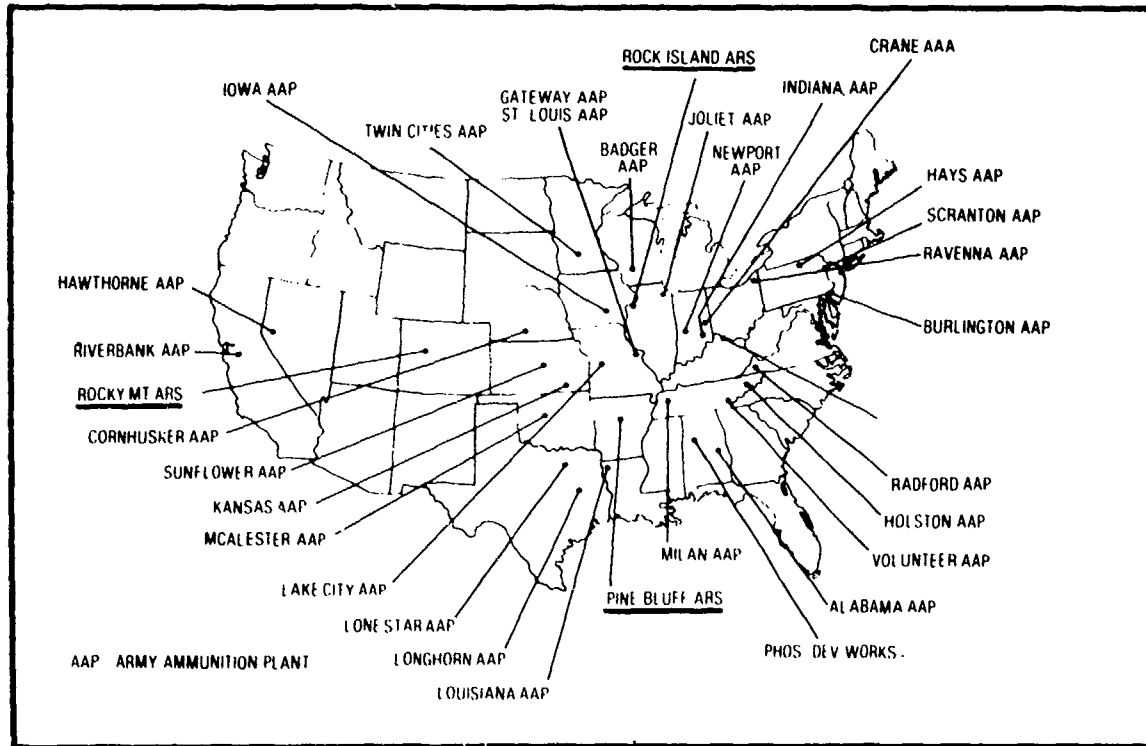
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EXECUTIVE SUMMARY

The purpose of this report is to provide ammunition managers with useful information concerning a unique set of modern computer models. These models were expressly developed to fulfill decision evaluation needs by enabling observation of the consequences of various management options. This information, presented in the body of the report, consists of three sections covering first, the directorate responsible for the models, second, the models themselves, and third the models as an integrated system.

• The first section presents an overview of the JCAP Decision Models Directorate, including its background, structure, and operation. This directorate was established to model the key decision problems that must inherently be addressed and resolved in the management of the large and complex conventional ammunition production base shown on the map. The directorate was tasked to apply modern operations research and decision analysis techniques in order (1) to assure that ammunition managers would have the best decision tools available and (2) to assure that maximum readiness could be attained consistent with logistics and fiscal guidance.



The DoD Conventional Ammunition Production Base

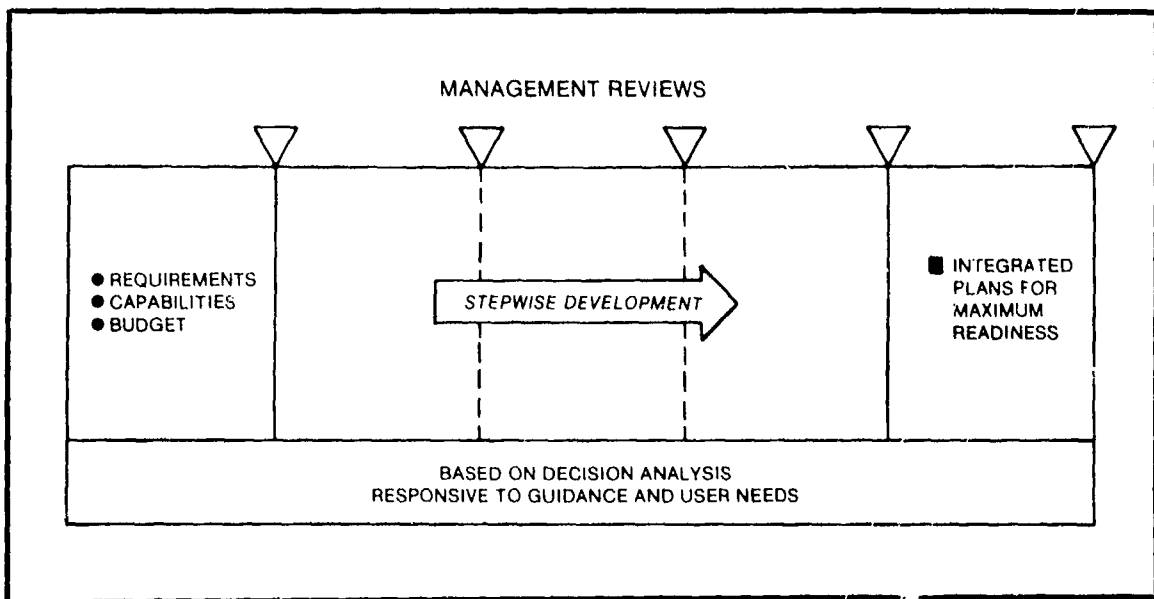
• To accomplish this mission, the JCAP Decision Models Directorate has developed nine models. In the second section of this report a managerial summary is provided on each of the models including their individual application areas, description of operation, technical facts, and points of contact for further information.

All of these models are currently operational and available to be utilized individually or collectively in the management of the areas indicated in the diagram. The general characteristics of decision models, the benefits of the types of analyses they provide and the manner by which they are normally developed under management auspices are also presented in this section. Emphasis is placed on the key management participation steps for direction, approval or change authority before, during and after decision model operations.

- **PLANNING, PROGRAMMING, AND BUDGET CYCLE**
 - Item Acquisition/Production Trade-Off Model
 - Materiel Acquisition Planning Model
- **PRODUCTION BASE PLANNING AND OPERATIONS**
 - Industrial Preparedness Model
 - Maintenance Model
 - Production Facilities Life Cycle Cost Subsystem
 - Priorities Model
- **PROCUREMENT**
 - Multiple-Bid Evaluation Model
- **OTHER**
 - Demil and Disposal Model
 - Packaging/Containerization Life Cycle Cost Model

Model Application Areas

• The third section of this report further describes the application of these models as a fully integrated system for optimal planning and operational management of the entire conventional ammunition production base. The integration embodies rationale that is responsive to logistics guidance and user needs. The system was developed to apply the JCAP models in a sequence of logical and consistent steps starting with ammunition requirements, production capabilities, and the total budget, and arriving at optimal integrated plans for maximum overall readiness. This procedure, depicted below, is further described in step-wise detail in the systems section of this report. The step-by-step approach is essential to obtain and incorporate management guidance and approval throughout the system integration process.



Model System Concept

THE DECISION MODELS DIRECTORATE

• The Decision Models Directorate (DMD) is the organization responsible for the life cycle development of the models presented in this report beginning with concept/feasibility studies in response to model requirements, and extending through formal maintenance of Service accepted models. The purpose of this section is to familiarize the reader with the background, structure, mission, personnel and accomplishments of the JCAP Decision Models Directorate.

BACKGROUND

In 1968, the Assistant Secretary of Defense, Installations and Logistics (ASD (I&L)), requested the Logistics Management Institute (LMI) to conduct a study of the DoD ammunition production base. The LMI study was completed in July 1970 and referred by ASD (I&L) to the Services for review and comment.

While agreeing in principle with the study, the Services expressed reservations about the decision models contained in the study, and recommended that a joint panel be formed to standardize existing management systems and to assure consistency and compatibility among the Services. In April 1971, the Joint Panel (JCAP Panel) was formed and directed to submit a report to ASD (I&L) for approval of recommendations for a coordinated management system.

1968-70	STUDY OF DOD AMMUNITION PRODUCTION FACILITIES BY LOGISTICS MANAGEMENT INSTITUTE(LMI)
1971 MAR	ASD (I&L) REQUESTED SERVICE RECOMMENDATIONS
1971 APR	JCAP PANEL FORMED
1972 MAY	PANEL REPORT SUBMITTED
	• ESTABLISH COORDINATING GROUP • ESTABLISH COORDINATED MANAGEMENT SYSTEM • INCORPORATE MODERN METHODS AND TECHNIQUES
1974 JAN	JCAP ACTIVITY OPERATIONAL
1975 JAN	DECISION MODELS DIRECTORATE STAFFED

Chronology of Significant Events

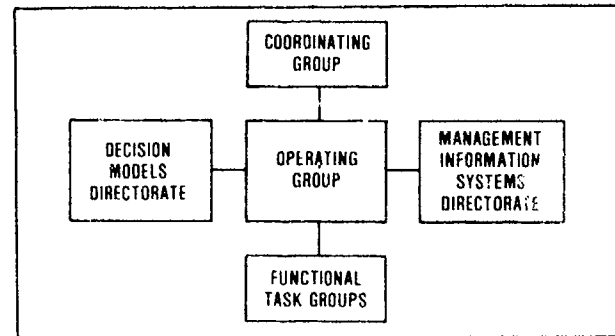
The JCAP Panel Report submitted in May 1972, consisted of 50 recommendations grouped into three areas:

1. Establish a coordinating group made up of the commanders of the Ammunition Commands of each of the Logistics Commands.
2. Establish a coordinated management system consisting of the Joint Operating Policies and Procedures (JOPPS) to facilitate the exchange of data and information in areas of requirements, procurement, production, manufacturing methods and technology, modernization and expansion, safety, security, handling and transportation, packaging and preservation, and manpower and personnel.
3. Incorporate modern management methods and techniques, such as decision models and management information systems, to enhance the decision making process of conventional ammunition management.

The Joint Logistics Commanders (JLC) Charter for the JCAP Coordinating Group authorized the group to coordinate and take action on all production base activities and programs delegated to them by their respective commanders. The objective was to achieve effective, efficient, and economic management and operation of the ammunition production base. The JCAP TDA was established in January 1974 and the Decision Models Directorate was staffed in January 1975.

ORGANIZATIONAL STRUCTURE

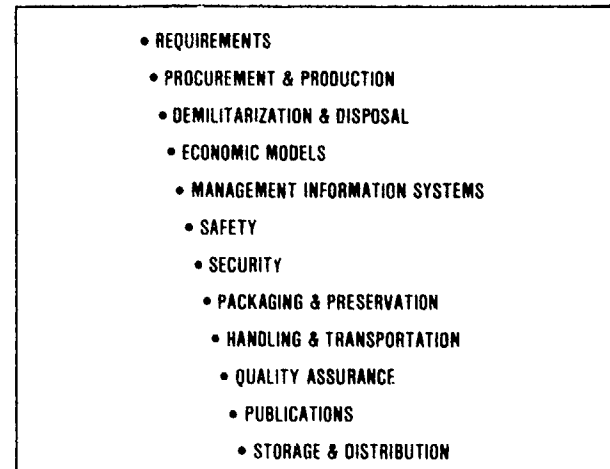
The overall JCAP organization structure is shown on the right. The Coordinating Group (JCAP/CG) consists of General and Flag Officers who represent the Joint Logistics Commanders in approving all policies and procedures for the coordinated management of the conventional ammunition program. This group meets quarterly.



Overall JCAP Structure

The Operating Group (JCAP/OG) is composed of principals, at the 06 or GS-15 level, designated to represent the JCAP/CG. This group meets monthly and directs the activities of the Task Groups and the full-time elements of JCAP, that is, the full-time JCAP staff of 56 people who comprise the offices of the Executive Director, the Decision Models Directorate, and the Management Information Systems Directorate. The Executive Director, as Chairman of the JCAP/OG, directs and controls the full-time JCAP activities, provides day-to-day continuity of the Coordinating Group, and maintains the JCAP office of records.

A breakout of the JCAP functional task groups is shown in the adjoining diagram. These groups provide the functional, commodity management, and technical expertise required to perform assignments in all areas covered by the JCAP charter. The JCAP/OG has authority to establish or disestablish these groups as required. Groups are staffed by Military and Civilian Service representatives from each of the ammunition commands and occasionally from other agencies, such as the Logistics Supply Agency, in the interest of coordinated actions. The total number of individuals in the task groups varies between 140 and 200. Of this number, about 40 percent are working members of the task groups; the remainder are in-depth experts who participate as the occasion demands.



Functional Task Groups

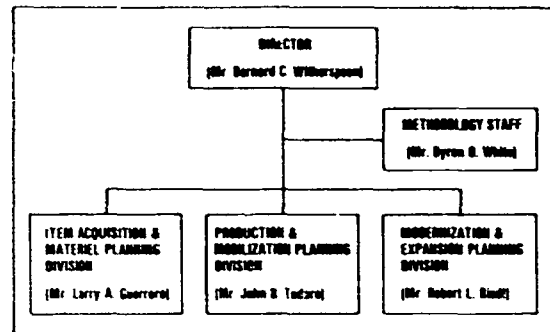
MISSION

The two full-time organizations, the Decision Models Directorate (DMD) and the Management Information Systems Directorate (MISD) work together under complementary missions with ammunition managers to support the conventional ammunition management needs. The DMD, in carrying out its primary mission of model development, is supported by MISD for certain data management functions. This interfacing is discussed further in the MODEL SYSTEM section of this report.

- DEVELOP AND APPLY DECISION MODELS TO SUPPORT THE CONVENTIONAL AMMUNITION MANAGEMENT PROCESS
- ESTABLISH DATA REQUIREMENTS OF THESE DMD MODELS FOR MISD'S CENTRALIZED DATA MANAGEMENT SYSTEM
- CONDUCT STUDIES IN SUPPORT OF THE JCAP/CG MISSION
- PROVIDE TECHNICAL ADVICE AND ASSISTANCE TO JCAP TASK GROUPS AND PARTICIPATING COMMANDS

Summary of DMD Mission

The DMD is made up of the Director's Office, a Methodology Staff, and the three divisions shown on the chart. Each division specializes in a major area of ammunition planning. Their primary mission is the development of the original six models identified in the JCAP Panel Report, plus additional models identified for development by the JCAP/OG. These models and the integrated system provide a basis for ammunition managers to achieve maximum overall ammunition readiness within budget constraints.



DMD Organizational Chart

PERSONNEL

The basic strength of the Decision Models Directorate is provided by its personnel. The Directorate's demanding mission attracts individuals of the highest caliber. A major emphasis is placed on ability to contribute to the capabilities of the DMD models team, especially in the skills required for problem definition and decision analyses. The resulting team consists of individuals from the Cost Analysis community, the Decision Risk Analysis community, the Mathematical Programming community, the Ammunition Production Base Planning community, and the Research and Development community. The scope and diversity of their capabilities is indicated by the following inventory of their talents and skills.

- | | |
|------------------------------------|-------------------------------------|
| • AMMUNITION MANAGEMENT PLANNING | • MATERIEL ACQUISITION |
| • INDUSTRIAL PREPAREDNESS PLANNING | • MOBILIZATION PLANNING |
| • LOGISTICS ENGINEERING | • MODEL DEVELOPMENT |
| • COMPUTER PROGRAMMING | • OPERATIONS RESEARCH |
| • LIFE CYCLE MANAGEMENT | • STATISTICS & MATHEMATICS |
| • RELIABILITY & QUALITY ASSURANCE | • SYSTEMS ANALYSIS |
| • DECISION RISK ANALYSIS | • MAINTAINABILITY |
| • INDUSTRIAL ENGINEERING | • MANUFACTURING METHODS & PROCESSES |
| • ECONOMIC ANALYSIS | • VALUE ENGINEERING |

Inventory of DMD Personnel Talents and Skills

ACCOMPLISHMENTS

The application of these talents under dedicated management in a focused effort on the DMD mission has resulted in the following significant accomplishments:

- **HIGH PAYBACK RATIO** - This ratio, often used as a measure of investment worth, is calculated for the full-time JCAP organization to be in the order of 200 to 1, based on approximately four million dollars invested versus over one billion dollars of documented savings, avoidances and cost deferrals. The bulk of these benefits are attributable directly to decision alternatives for ammunition managers that were disclosed during various demonstration phase operations of the DMD models described in this report.
- **MODEL/SYSTEM DEVELOPMENT** - In its brief full-time existence, the DMD has modeled a dynamic decision process by which ammunition managers can achieve the maximum overall ammunition readiness in the most cost effective manner. The decision models and the model system presented in this report are ready for widespread application, with assistance of DMD personnel, by command and functional managers throughout the conventional ammunition production base.
- **DECISION SUPPORT CAPABILITY** - The model development team has further sharpened its decision modeling development and application capabilities through teamwork with management, direct operational experience, and selected advanced training. Hence, by upgrading its support capability, the DMD is not only able to provide the cohesive team continuity needed in application of DMD models, but also can apply modern management methods and techniques to other critical management problems.

THE DMD MODELS

The DMD models are a set of computer programs developed specifically to support management of the conventional ammunition production base in answering the questions of how, when, where, and to what extent resources should be planned and committed to best achieve the primary mission, maximum overall readiness, consistent with DoD guidance and base capability.

In performing its special purpose, each DMD model operates under management control. The output from each model supports the decision-making process by identifying a set of the *best available alternatives* for the manager's evaluation and selection. Economic impact and other decision-aiding evaluations are supplied to management for each alternative.

OVERVIEW OF DECISION MODELING

Decision models, better described as decision-aiding models, operate under management control to identify and evaluate decision alternatives to a problem that management wishes evaluated. Thus, *decision models do not make decisions*. These models support the manager's decision process by using computerized techniques to perform the many sorting, matching, counting, and *trade-off* operations that the manager would do himself if he had the agility of the models and the speed and memory of the computer! The choice among alternatives always rests with the manager.

Decision modeling is most beneficial and has the opportunity for the greatest payoff in *large complex organizations*, such as the conventional ammunition production base or a large corporation, where cost-effectiveness operations are paramount and management is continually faced with decisions which have widespread impact. Decisions which seem best for one function often conflict with the best decision for another function. Such cross-functional trade-offs may, in turn, impact upon other "corporate goals" such as base retention, logistics flexibility, etc. Thus, managers at all levels require encompassing evaluations of the best of the many alternatives open to them in order to be most responsive in the coordinated management of the whole organization. The DMD models benefit ammunition managers in this situation by providing them with logical and consistent methods leading to identification and evaluation of the available alternatives.

Decision models employ modern management science techniques involving advanced computational methods (analytical, iterative, simulative, etc.) and often use special purpose software packages to resolve certain types of problems in the most efficient manner. In general, their computer usage involves more memory storage and more computing time but has less input-output operations than the traditional management information type programs. As a general development policy, each DMD model incorporates both an input data conversion module and an output report generator module which, together, enable the model to supplement its output of management decision options with selected ancillary lists of related management information. Thus, the DMD models combine the new with the best of the old in techniques for management report documentation.

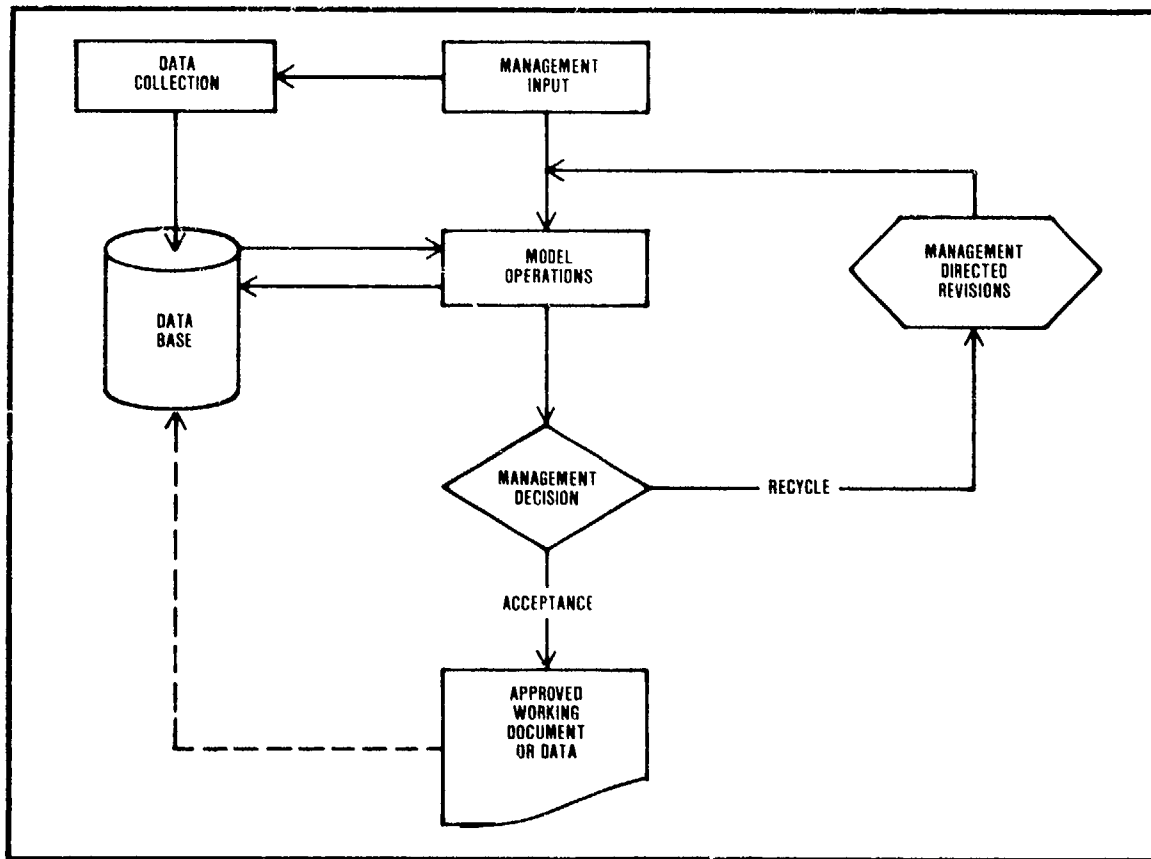
The nine specific DMD models presented in this section all have been developed to address designated topics in ammunition management. Joint-service management teams have guided and monitored model development to ensure that they reflect management's needs in each problem area and to ensure that the models incorporate the flexibility to adapt to changes in fiscal and logistics guidance. In addition, all model development effort has aimed at their *ease of usage by command and functional managers*. The general procedure for management direction and control during decision modeling is described next.

MANAGEMENT CONTROL OF DECISION MODELING OPERATIONS

The DMD models, whether used independently or collectively as a system, operate under management control as shown in the diagram. The general pattern of management involvement and control is simple. Essentially management initiates and directs the operation and then makes decisions based on the outputs. Initially, the management element involved:

- Defines the problem
- Identifies parameters of interest
- Identifies constraints to be considered
- Indicates the scope of the investigation desired
- Coordinates data collection actions

This set of information is denoted simply as "Management Input" in the diagram. In practice, a representative of the Decision Models Directorate responds to the manager by meeting with him and assisting in the preparation and clarification of these topics to insure that the follow-on operations reflect the manager's needs.



Overview of Management Control of Model Operations

Management is also involved in the review of the model or model system output. If more information is required, the process is recycled using management-directed revisions until the manager has all the information he needs for his decision. In most model and model system operations, intermediate solutions and data are stored temporarily in a data base for subsequent recycling actions. When a management decision is made, the approved plan and data are retained for reference (dashed lines) until they are officially updated or no longer required. This is an important feature of the system mode of operation. There, management decisions result in approved data which is stored in an integrated data base, under configuration control, as the planning base line for subsequent system operations.

MODEL SUMMARIES

This section presents summaries that describe each DMD model from the manager's viewpoint. The emphasis is on their *independent* capabilities and applications. Each summary is presented in a standard handbook-like format for ease of reference when comparing with other models and when reviewing the section on the MODEL SYSTEM.

Each summary starts with a boldface heading identifying the model. This is followed by a brief introductory overview stating what the model is and what the model does. The subsection which follows, *Application Areas*, then lists these areas in broad functional terms, such as Industrial Preparedness Planning, to answer the question of where the model might be applied. The next subsection, *Point of Contact*, is provided to enable the manager and/or his staff to communicate directly with the DMD individual responsible for the model. Such communication is encouraged. The next subsection, *Description*, and an accompanying flowgraph, provides the main narrative on the model. It expands on the purpose and capabilities of the model. Its intent is to answer questions about input requirements, about how the model operates, and about what is accomplished for the manager by the model in terms of output and analysis. It also includes any cross-references to the use of the model in system mode operations. The last subsection, *Technical Facts*, lists the official DoD Logistics Model Number, the type of model, the size of problems that it can handle, and identifies its major subprograms.

Model summaries are presented in the order diagrammed below.

- The Item Acquisition/Production Trade-Off Model
 - The Materiel Acquisition Planning Model
 - The Industrial Preparedness Model
 - The Maintenance Model
 - The Production Facilities Life Cycle Cost Subsystem
 - The Priorities Model
 - The Multiple-Bid Evaluation Model
 - The Demilitarization and Disposal Model
 - The Ammunition Packaging/Containerization Life Cycle Cost Model

Sequence of Model Summaries

THE ITEM ACQUISITION AND PRODUCTION TRADE-OFF MODEL

- The Item Acquisition and Production Trade-Off Model (IA/PT) determines the cost of ammunition readiness for each item.
- The IA/PT Model identifies the specific combination of end-item acquisition, component acquisition, and application of Industrial Preparedness Measures (IPM's) to obtain either:
 - The least cost for achieving a fixed level of readiness - or,
 - The maximum achievable readiness for a specified amount of dollars.

APPLICATION AREAS

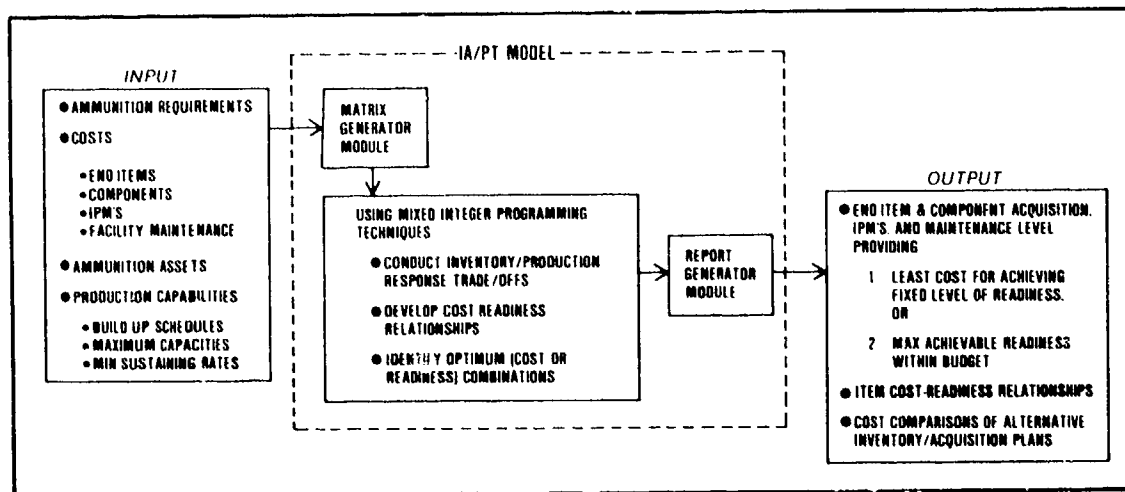
- Budget Planning
- Materiel Readiness and Industrial Production Base Preparedness
- Procurement and Production
- Facilities Modernization and Expansion
- Facilities Layaway and Maintenance
- Input to Program Operating Memorandum (POM) and FYDP

POINT OF CONTACT

Mr. George H. Martin, Item Acquisition and Materiel Planning Division, AV 793-5980

DESCRIPTION

The purpose of the IA/PT Model is to develop the least-cost solutions over the range of feasible readiness levels by considering all available trade-off options that might meet requirements specified by current logistics guidance. The model provides ammunition managers and planners with the complete cost-readiness relationships for an ammunition end item. These relationships, which enable determination of the optimal mix of alternatives for any specified amount of dollars, are an essential input to the Material Acquisition Planning (MAP) Model.

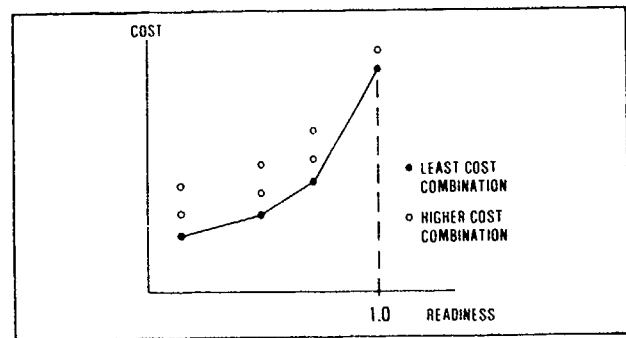


Flow Diagram for the Item Acquisition and Production Trade-Off Model

All the models in this section have flow diagrams similar to the one opposite for the IA/PT Model. On the left in each case are the inputs required by the model, followed by the dashed block enclosing the model itself and terminating with the output block or, the right. Since all the models are operated under management direction, results may be either intermediate, final output data ready for management decisions, or input for another model. The direct outputs from one or more computer runs are analyzed by the DMD for presentation to management in report or plan format.

In the case of the IA/PT, the input - the ammunition requirements - represents both peacetime and mobilization needs for an item. In general, the model finds the lowest cost way to meet these requirements, based on peacetime costs, from combinations of assets on hand, peacetime procurement, and mobilization production using the quantitative cost and assets data together with production capabilities data for all the alternatives under consideration.

From the computational viewpoint the model has three modules. The matrix generator module converts input to a form that can be handled in the calculations. The mixed integer program module then evaluates all elements of the inventory/production trade-offs. The least cost combinations which result for each readiness level comprise points which are connected to form the cost-readiness relationship shown in the accompanying diagram. Then, depending on the mode of operation for the model, the best solution and a prespecified number of next-best alternatives are selected. In one mode, the solutions are obtained by maximizing the readiness achievable for a fixed cost. In the second mode, the solutions represent the least-cost set to achieve a specified level of readiness. The third module of the IA/PT Model, a report generator module, orders and arranges the results into management-cost-readiness analysis to provide a complete cost-readiness analysis for each end item. Each item analysis not only indicates specifically how to spend available dollars for the best effect insofar as that item alone is considered, but also furnishes the complete item cost-readiness relationship information. Each item analysis report is also a subsection of the Conventional Ammunition Cost-Readiness Handbook, a complete report of all item analyses, described further in the MODEL SYSTEM section of this report.



Cost Readiness Relationship

TECHNICAL FACTS

- DoD Logistics Model Number
- Type of Model
- Problem Size
- Major Subprograms

LD 31040

Analytical/Comparative

One end item with up to 34 components, 99 lines and 99 IPM's

Data Conversion Module (FORTRAN)
 Matrix Generator Module (FORTRAN)
 Mixed Integer Decision Module (MPSX/APEX)
 Report Generator Module (COBOL)

THE MATERIEL ACQUISITION PLANNING MODEL

- The Materiel Acquisition Planning (MAP) Model allocates the ammunition budget to end items in such a way that overall readiness can be maximized.
- The MAP Model also contains optional provisions which permit the manager to specify readiness or cost priorities on individual items.

APPLICATION AREAS

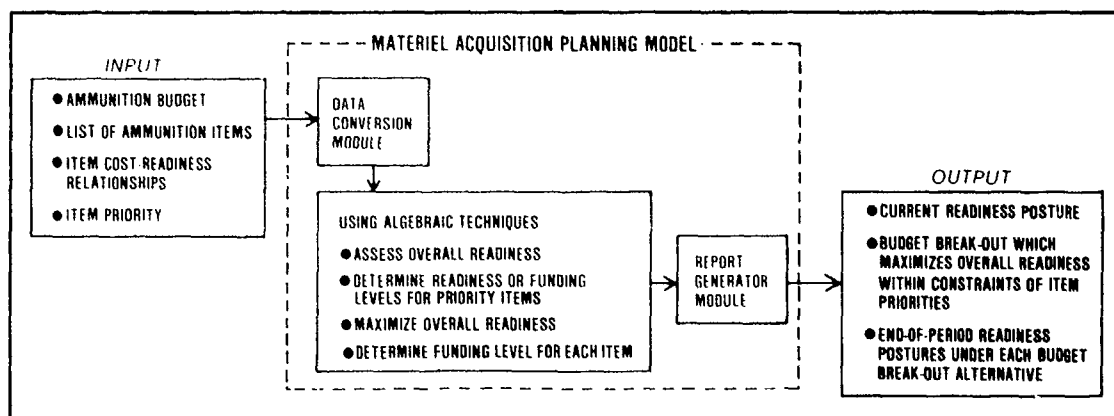
- Materiel Readiness
- Procurement and Production
- Industrial Preparedness
- Modernization and Expansion
- FYDP and POM

POINT OF CONTACT

Mr. Norman V. Hoesly, Item Acquisition and Materiel Planning Division, AV 793-5980

DESCRIPTION

The purpose of the MAP Model is to develop the budget allocation to all end items to maximize the overall readiness. The model's flexibility permits control of the allocation process in accordance with management priorities. This allocation is accomplished in the model using algebraic leveling techniques operating simultaneously on all item cost-readiness relationships supplied as input.



Flow Diagram for the Materiel Acquisition Planning Model

As indicated in the above flow diagram, inputs are the total ammunition budget expected to be available over the planning period, the end items to which these funds are to be allocated, the cost-readiness relationships for each item, and the item priorities. The ammunition budget data must incorporate the total of the expected budgets for all types of funds which were previously applied in the development of the cost-readiness relationship inputs. The MAP Model in combination with the IA/PT Model can provide the most cost-effective allocations under expected budget constraints to achieve maximum overall readiness. That is, the IA/PT and MAP Models can be used in combination to provide high level management with the economic information necessary to establish an "ammunition only" Program Operating Memorandum (POM) and an "ammunition only" Five Year Defense Plan (FYDP) that are consistent with logistics guidance. In this application the models determine the best mix of production response and inventory to meet

readiness objectives over the period addressed in the POM and FYDP, taking into consideration:

- Alternative layaway plans
- Improvements in mobilization production response
- Component stockpiling

The "Ammunition Budget" for the above applications must be the total of the ammunition-oriented budgets of all involved type of funds, whether operating, maintenance, procurement, production, construction, or other.

Functional managers may apply the MAP Model for budget allocation decisions where the funding is of, say, only 1 or 2 categories, or for investigative analyses to determine effects on readiness caused by shifts in item priorities or prescribed funding levels.

Item priority can be input in several ways. For example, all items can be considered equal in priority. This is the default mode of operation. Another option permits ranking of all items in accordance with a management-directed priority scheme. Alternatively, management may prespecify that certain items be assigned specific funding levels, or that selected items be funded in such a way that they achieve specific levels of readiness. The MAP Model allocates accordingly for any of these options.

In its operation, the MAP Model first assesses overall readiness, based upon individual end item cost-readiness inputs, by ranking items according to current readiness levels. Then, it allocates funds in accordance with management priorities. For items of equal priority, the model assigns funds to items of lowest readiness until all funds are allocated. A "weakest link" approach is used. Unless priorities are specified, the readiness of all items is assumed to be equally important and the minimum readiness attained is used to represent the overall readiness for all items. In this manner, maximum readiness is attained subject to the budget and priority constraints.

The Report Generator Module formats management-oriented output which provides:

- (1) The current ammunition readiness by item.
- (2) The specific budget break-out by item which maximizes overall readiness when *unconstrained* by item priorities.
- (3) The specific budget break-out by item which maximizes overall readiness within the constraints of management priorities.

When applied in the integrated system, the MAP Model provides the budget allocation to each item to achieve maximum readiness.

TECHNICAL FACTS

- | | |
|------------------------------|---|
| • DoD Logistics Model Number | LD 31041 |
| • Type of Model | Analytical/Algebraic |
| • Problem Size | Up to 1000 items simultaneously |
| • Major Subprograms | Data Conversion Module (FORTRAN/COBOL)
Computation Module (FORTRAN)
Report Generator Module (FORTRAN/COBOL) |

THE INDUSTRIAL PREPAREDNESS MODEL

- The Industrial Preparedness Model (IPM) provides ammunition end-item requirements, component requirements, and facility capability information for mobilization planning.
- The IPM determines basic and alternative mobilization production schedules by item, component, and facility.
- The IPM identifies all production shortfalls requiring post-M-day base expansion for mobilization conditions.
- The IPM consolidates this information in the Production Base Plan/Production Base Analysis (PBP/PBA) report.

APPLICATION AREAS

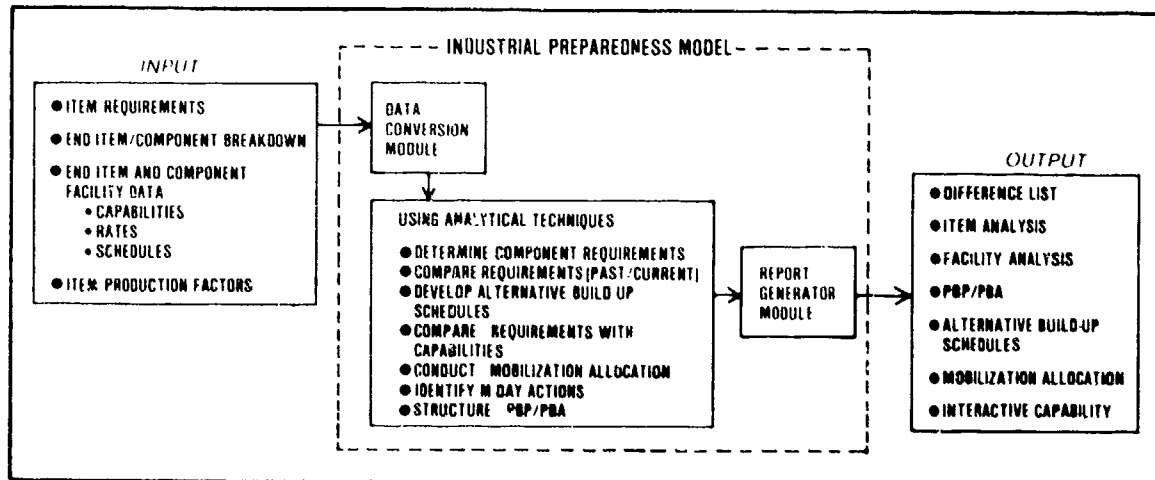
- Industrial Preparedness Planning
- Facilities Analysis
- The PBP/PBA
- Budget Planning
- Requirements Analysis

POINT OF CONTACT

Mr. Kenneth W. Maly, Sr., Production and Mobilization Planning Division, AV 793-5666

DESCRIPTION

The purpose of the Industrial Preparedness Model is to investigate available management options for industrial preparedness planning to meet mobilization requirements imposed by official logistics guidance. To achieve this objective, the IPM, as shown in the accompanying flow diagram, converts detailed input information on all items and facilities in the ammunition production base into management reports and planning documents. A major document - the PBP/PBA - merits further definition. The PBP describes the capability of the ammunition production base to respond to DoD mobilization requirements as defined for the *first* year of the Five Year Defense Plan, whereas the PBA presents the status through the *fifth* year.



Flow Diagram for the Industrial Preparedness Model

The IPM, in addition to its main processing programs, provides ammunition managers with quick response *interactive* mode linkages to the Industrial Preparedness Data Base. This feature, which enables *direct query, analysis, and PBP/PBA updating*, is accomplished by supplementary computer programs that interact on-line with the data base using English language entries at remote communication terminals.

The input data listed in the diagram is of two major types:

- (1) End-item requirements, and
- (2) Facility capability data such as production buildup curves, leadtimes, minimum sustaining rates, item production factors, etc.

After the data is converted to proper format for processing, the main computation module processes the data as shown in the diagram by starting with determination of the component requirements and ending with structuring of the PBP/PBA. This step consists of a series of subprograms, each working with a segment of the Report Generator Module to produce the outputs listed. These subprograms and the reports they produce are described in the following paragraphs:

The *Requirements Difference List Report* is developed from the output of the requirements subprogram. This program calculates "new" requirements for component production to satisfy the "new" mobilization end-item requirements for each Service and selected allies. These new requirements are input to the IPM as item requirements. The calculations on these requirements data utilize the end-item/component breakdown data and the item procurement factors data developed by industrial management. The resulting newly-calculated requirements are compared to previously-calculated, or "old," requirements resident in the data base and a difference report is created. This report enables ammunition managers to assess the implications, at both end-item and component level, caused by new requirements guidance.

The *Item Analysis Report* of the IPM presents the results of the item analysis subprogram. This program is operated many times during the annual mobilization planning cycle in support of industrial management's day-to-day needs for investigating impacts of various alternative buildup schedules, updates to guidance, and user-directed inquiries. Thus, each individual run is a variation of the item analysis eventually presented in the PBP/PBA. The item analysis program, by operating with basic buildup schedules and feasible improvement alternatives, compares various sets of requirements with capabilities and then conducts mobilization allocations to eligible facilities. In addition, it computes the retention level, the modernization level, and the investment level, all of which are special measures utilized in mobilization planning. After the allocation portion, any remaining mobilization deficits indicate a need to plan for establishment of post-M-day (currently non-existent) facilities.

The *Facility Analysis Report* presents the results of the facility analysis subprogram. The information previously determined by the item analysis program is selectively structured to provide complete mobilization information by facility. This includes all identification data, production equipment and layaway data, and the mobilization production assignments by item, as applicable to each facility. The item analysis and facility analysis programs produce all information needed to structure the combined PBP/PBA report.

The programs in the IPM, operating in conjunction with the data base, provide additional capabilities for selected information extraction and presentation. For example, a *Production Shortfall Analysis Report* is available. This report identified all those instances in which the total production capability for a given item is less than the planned item requirements.

In summary, the IPM with its interactive capabilities provides management with many flexible and responsive tools useful in managing the ammunition production base.

TECHNICAL FACTS

- DoD Logistics Model Number LD 31042
- Type of Model Analytical/Comparative/Interactive
- Problem Size Sufficient to account for all facilities, end items and components. Currently these are:
436 Facilities, 581 End Items, 274 Component LAP,
632 Metal Parts, 117 Propellant & Explosives
- Major Subprograms Data Conversion/Interfacing Module (COBOL/SYSTEM 2000)
Main Processing Module (COBOL)
Report Generator Module (COBOL)
Data Base (SYSTEM 2000)

THE MAINTENANCE MODEL

- The Maintenance Model determines the least cost layaway and maintenance policy for mobilization readiness of a facility or line.

APPLICATION AREAS

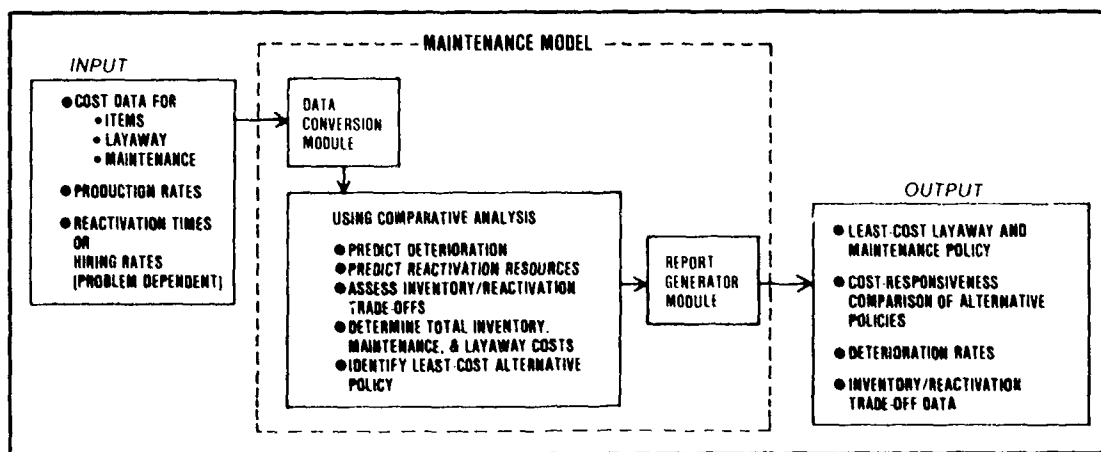
- Industrial Preparedness Planning
- Facilities Maintenance Management

POINT OF CONTACT

Mr. Craig D. Porter, Production and Mobilization Planning Division, AV 793-5666

DESCRIPTION

The purpose of the Maintenance Model is to develop least cost and other alternatives for layaway and maintenance decisions affecting mobilization and readiness planning for a specific plant, facility or line. To achieve this objective the Maintenance Model, as indicated in the accompanying flow diagram, utilizes the layaway, maintenance, and item unit costs along with detailed facility data to produce planning trade-off information. The output of this model enables management to compare alternative maintenance policies with peacetime inventory acquisition for a pre-determined mobilization requirement.



Flow Diagram for the Maintenance Model

Input data for the Maintenance Model includes layaway costs and maintenance costs for each maintenance policy, the production unit costs of the items under consideration, item production rates, and either manpower hiring rates or estimates of reactivation times. This input data is converted for processing by the data conversion module and made available to the main computation module.

The main computation module computes facility deterioration over time, based on previous facility experience. This in turn allows prediction of reactivation resources, i.e., reactivation times for each policy. The total cost for each policy is determined based on the input layaway and maintenance costs, and costs for additional inventory required to offset decreases in readiness due to increased reactivation times. The report generator module produces a report showing the least-cost layaway and maintenance policy, the cost-responsiveness comparison of all alternative policies, the deterioration rates for each policy, and the inventory/reactivation trade-off data for each policy for the specific plant, facility, or line analyzed. In addition to individual model runs for special management investigations, the Maintenance Model generates all the maintenance-oriented Industrial Preparedness Measures utilized throughout the integrated system. In summary, the Maintenance Model enables ammunition managers to relate layaway and maintenance costs to individual plant/facility readiness postures.

TECHNICAL FACTS

- DoD Logistics Model Number LD 31045
- Type of Model Algebraic/Alternative/Comparison
- Problem Size One Facility, Plant, or Line
- Major Subprograms
 - Data Conversion Module (FORTRAN)
 - Main Computation Module (FORTRAN)
 - Deterioration Reactivation Manhour Calculation
 - Hiring Requirements
 - Deterioration Estimate Curve-Fitting
 - Report Generator Module (FORTRAN)

THE PRODUCTION FACILITIES LIFE CYCLE COST SUBSYSTEM

• The Production Facilities Life Cycle Cost Subsystem identifies and evaluates the total cost of site-specific alternatives for modernization, configuration, and workloading of the ammunition production base.

APPLICATION AREAS

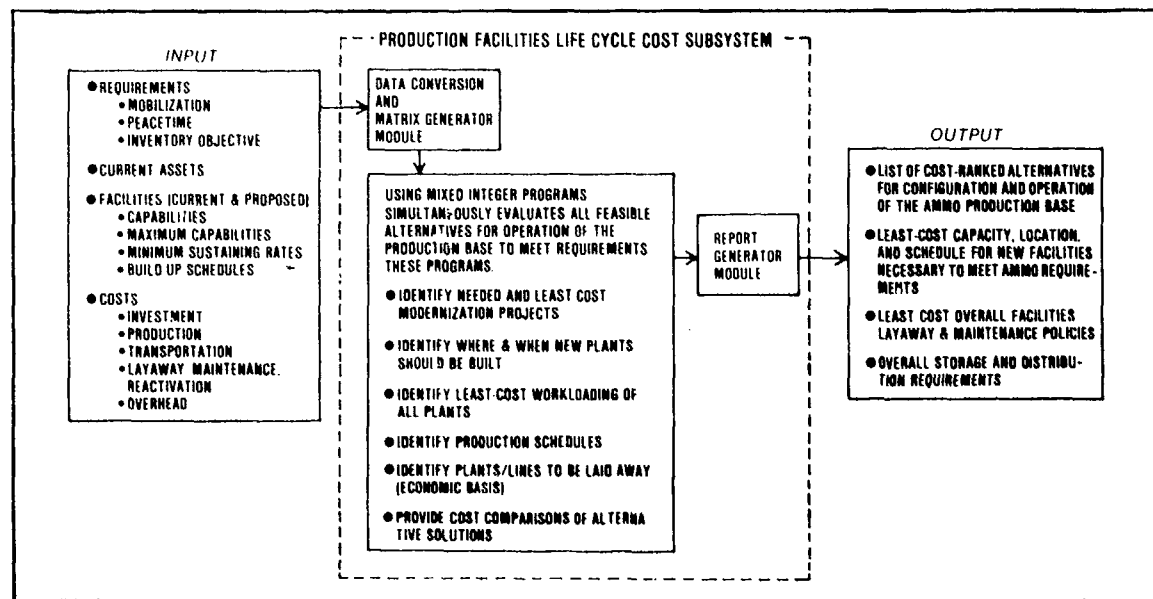
- Industrial Preparedness Planning
- Production Base Configuration, Modernization, and Workloading
- Facility Layaway and Maintenance
- Site Selections (New Facilities)
- Ammunition Distribution and Storage
- Budget Planning

POINT OF CONTACT

Mr. Albert J. Patsche, Modernization and Expansion Planning Division, AV 793-5292

DESCRIPTION

The Production Facilities Life Cycle Cost Subsystem determines how, when, where, and to what degree the ammunition production base should be modernized, expanded, and operated to produce ammunition requirements at the lowest overall cost. This provides management with flexible economic decision tools responsive to a variety of management investigations. The net requirements of each item are major "driving forces" in the model which, together with the economic trade-offs, control the size of the base and configure it for modernization, expansion, and operation. The key point is that the model will determine the facilities to build and operate to produce ammunition requirements at the minimum total cost.



Flow Diagram for the Production Facilities Life Cycle Cost Subsystem

The general logic of the Production Facilities Life Cycle Cost Subsystem is indicated by the accompanying flow diagram. Complete input data on the requirements, assets, current and proposed facility capabilities, and relevant costs are used to obtain the outputs shown. The outputs indicate the most economic options available for modernization, expansion, and operation of the production base. The manner in which this is accomplished is expanded below.

For each candidate facility or line, whether existing, project-improved or new, production capability data and cost data must be obtained. This means that item production buildup schedules, maximum capabilities and minimum sustaining rates are needed for each line. Costs for investment, production, transportation, layaway, idle facility maintenance, reactivation, and overhead costs by item are also required for each candidate line. Overhead cost is treated either as a function of the level of plant activity or as a fixed unit cost as appropriate for the facility. Since the model also considers all components associated with the end items, similar facility and cost data are needed for each component.

The input data is read into the data conversion and matrix generator module. This module converts the data to proper format for use in a large-scale mixed-integer programming model and also sets up the problem structure for solution. This problem structure can be preserved thereby enabling reruns of the basic problem with variations in cost or facility data as needed.

The main computation module evaluates feasible combinations of base modernization, expansion, configuration, workloading, and maintenance in arriving at the total least-cost solution of the problem. The computation initially identifies a least-cost plan that shows:

- (1) Which plants should be built and/or operated
- (2) Construction and production schedules for each candidate line
- (3) Which current producers should be laid away.

Cost comparisons and rankings of alternative solutions are also obtained.

These outputs are converted by the report generator module into the management-oriented output illustrated at the right in the diagram.

In addition to the above applications, the Production Facilities Life Cycle Cost Subsystem operates in the integrated system to determine site-specific modernization, expansion, configuration, and workloading of the ammunition production base.

TECHNICAL FACTS

- DoD Logistics Model Number LD 31043
- Type of Model Mixed Integer Programming
- Problem Size The size of the problem is strictly a function of the number of plants and depth of analysis desired. Twenty seconds of computer time and 126k bytes of storage to several hours and 300k bytes is the range which may be expected.
- Major Subprograms Data Conversion and Matrix Generator Module (FORTRAN)
Mixed Integer Decision Module (MPSX/APEX II)
Report Writer Module (FORTRAN/COBOL)

THE PRIORITIES MODEL

- The Priorities Model evaluates and orders decision alternatives, such as various schedules of projects, for maximum planned growth to multiple management goals.

APPLICATION AREAS

- Command Objectives
- Project and Program Management
- Review and Analysis
- Goal Growth Management

For programs with mixtures of

- Productivity-oriented goals (readiness, surge, capacity, etc.)
- Social impact goals (safety, environment, etc.)
- Economic-oriented goals (payback, etc.)

with concurrent consideration of

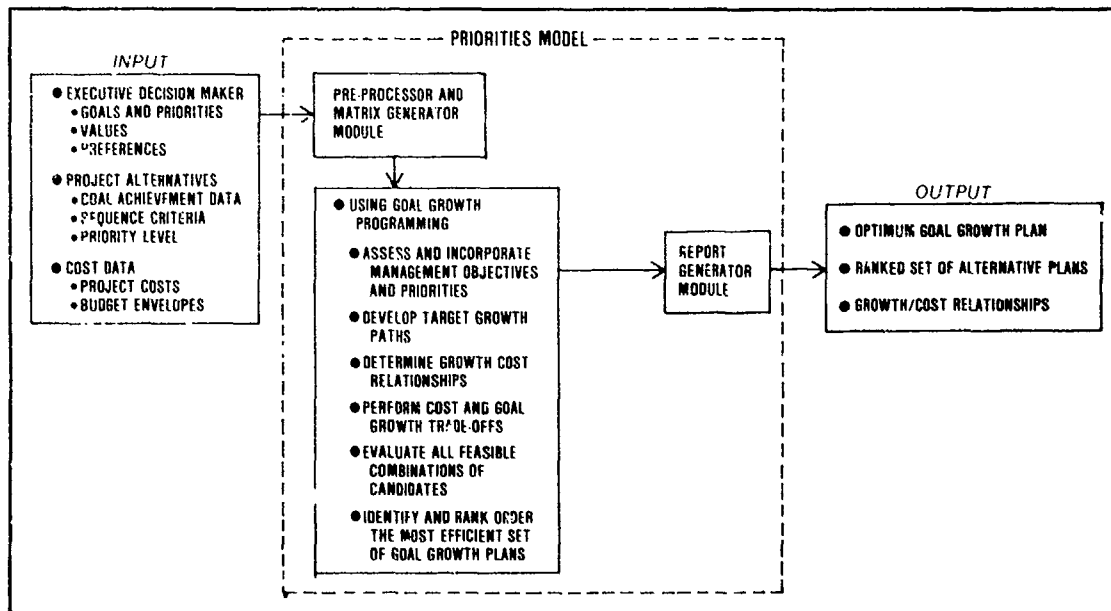
- Broad priority levels (guidance, project sequence, etc.)
- Goal priorities (management preferences), and
- Practical resource constraints (budget, manpower, etc.)

POINT OF CONTACT

Mr. Daniel R. Turk, Modernization and Expansion Planning Division, AV 793-5292

DESCRIPTION

The purpose of the Priorities Model is to answer the questions of how, when, where, and in what amounts resources should be allocated to competing options in order to maximize overall goal attainment in accordance with priorities established by management. The model, in achieving this objective, utilizes a new technique, GOAL GROWTH PROGRAMMING, which reflects both short-range and long-range management priorities. An overview of the input requirements, of the main processing steps and of the output is indicated in the accompanying flow diagram.



Flow Diagram for the Priorities Model

Input operations are initiated with a goals and priorities assessment phase to obtain the goals and priorities of the decision maker and to obtain ranges of values and preferences he wishes placed upon them. This subjective management data plus values of current goal status are then input to the model. The pre-processor generates a set of target goal growth paths which are presented to the manager for review and adjustment. The approved target growth paths serve as major driving forces in subsequent model operations. The input data set is completed with data on costs and goal achievement for each competing project and the total expected budget. This additional information is sufficient for a second stage of the pre-processor to obtain an initial estimate based on weighted average contributions to goal growth. This preliminary solution serves two purposes. First, it provides the manager with another opportunity to review and adjust target growth paths. The second purpose is to serve as a starting point for subsequent improvement by the main computation module. The matrix generator subprogram sets up the problem for solution using commercially available mixed-integer software packages.

Upon approval or revision of the set of target goal growth paths and budget variations, the main computation module computes the best goal growth plan and a pre-specified number of alternative plans. All plans are rank ordered in terms of overall goal achievement. These plans are converted by the report generator module into tabular and graphical format.

The Priorities Model may be applied to decision alternatives at any authority level or planning, programming and budget level where goals have been established. Such applications of the Priorities Model provide decision analyses which are logically consistent with *Management by Objectives* (MBO) principles.

TECHNICAL FACTS

- DoD Logistics Model Number LD 37254
- Type of Model Multi-objective/additive-weighting growth model
- Problem Size
 - Growth Plans - 1 year to 20 years
 - Number of Goals - Up to 9 per run
 - Number of projects for various planning periods (or alternatives)
 - 50 for 20 year plans
 - 100 for 10 year plans
 - 200 for 5 year plans
 - 999 for 1 year plans
- Major Subprograms
 - Subjective Assessment Programs
 - Policy Simulation (KSIM)
 - Probability and Preference Analysis (PAPA)
 - Pre-Processor and Matrix Generator Module
 - Graphics (SIMPLOT)
 - Processing (FORTRAN)
 - Main Computation Module (MPSX/APEX)
 - Output Report Module (FORTRAN/COBOL)

THE MULTIPLE-BID EVALUATION MODEL

- The Multiple-Bid Evaluation Model identifies least-cost alternatives in multiple-bid procurements at various levels of protection of the production base.

APPLICATION AREAS

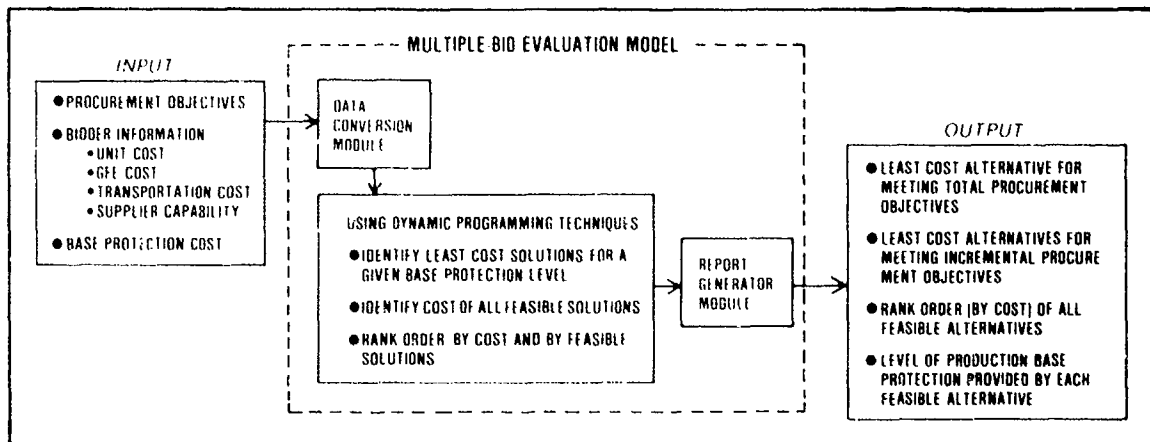
- Procurement and Production
- Production Base Retention Planning
- Budget Planning

POINT OF CONTACT

Mr. Craig D. Porter, Production and Mobilization Planning Division, AV 793-5666

DESCRIPTION

The purpose of the Multiple-Bid Evaluation Model is to enable management to evaluate the economic and base protection impacts of available alternative solutions for complex procurement actions involving large numbers of multiple-bidders, multiple-bid levels, and multiple buy periods. The model can be used for single or multiple item buys. The sequence of steps by which the model achieves this objective is shown in the accompanying flow diagram and is further described below.



Flow Diagram for the Multiple-Bid Evaluation Model

input data for the model includes the procurement objectives (items, quantities, and time periods), bidder information (all costs associated with selecting a specific bidder), and base protection costs. These base protection costs are total costs of layaway and maintenance of Government-furnished equipment at those facilities which are not selected for a portion of the contract. The data conversion module accepts the verified input data and converts it into usable form for the main processing module.

The main processing module uses dynamic programming techniques to identify least-cost and alternative solutions. Dynamic programming is an efficient solution technique for multi-stage problems. In the model, the method used employs an approach in which any two bidders are considered. Then, only those bids made which can enter into the final solution are carried forward as a combination to compete against the next bidder. This procedure is repeated until a final combination is obtained. This final combination represents the least-cost solution. During the process, additional information is obtained which enables the model to identify the cost of *all* feasible solutions, to then rank order them by cost, and to supply additional breakout of information for management review and analysis.

The report generator module converts this information into the management-oriented output as illustrated at the right in the diagram. This report provides management with complete cost-ranked sets of alternatives for meeting total or incremental procurement objectives. The latter is particularly useful if requirements are reduced after the bids have been submitted. The report also presents the least-cost solution for each possible total number of suppliers and the options available for various levels of base protection.

TECHNICAL FACTS

- DoD Logistics Model Number
- Type of Model
- Problem Size

- Major Subprograms

LD 31044

Dynamic Programming

The model will handle complex procurement problems of up to 3 time periods or 3 items for any combination of bidders and bid levels.

Data Conversion Module (FORTRAN/COBOL)
Main Computation Module (FORTRAN)
Report Generator Module (FORTRAN/COBOL)

THE DEMILITARIZATION AND DISPOSAL MODEL

- The Demilitarization and Disposal Model determines the least total cost plan, and alternative plans, for ammunition demilitarization and disposal.

APPLICATION AREAS

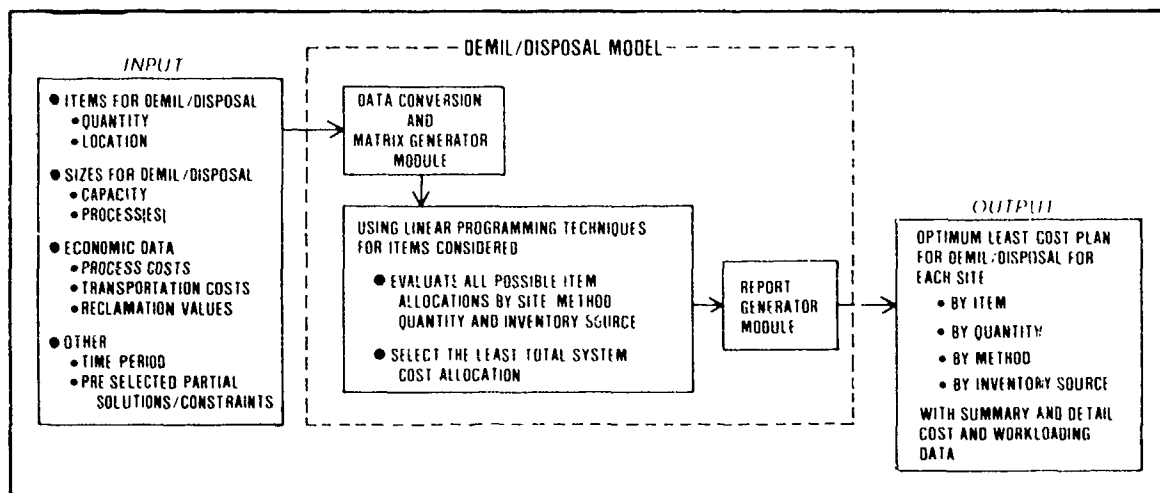
- Demilitarization and Disposal Planning
- Demil Transportation Planning
- Inventory Management
- Workloading and Plant Operations

POINT OF CONTACT

Mr. James P. Watson, Modernization and Expansion Planning Division, AV 793-5292

DESCRIPTION

The purpose of the Demilitarization and Disposal Model is to answer the questions of how and where to demil/dispose and what amount of resources are required for least total cost. The accompanying flow diagram provides an overview of how the model achieves this objective.



Flow Diagram for the Demilitarization and Disposal Model

Input data is required on the quantity and location of all items intended for demil/disposal. Data specifying each site, its location, and each process (washout, burning, etc.) at that site is required for all demil/disposal facilities. Economic data is required for the cost of each process at each site, for the costs of transportation over all routes involved, and for the reclamation values by item and process. Other data needed are the time period to be covered by the plan and any management overrides, constraints, or special instructions for sensitivity analysis.

All input data is edited by the data conversion module. The matrix generator module generates an input data file and a matrix structure that incorporates all relationships in the problem. These in turn are input to a commercial linear programming software package which processes the main computations.

The main computational module evaluates possible item allocations by site, by method, and by quantity for all items at the various origins. Trade-offs are made until the optimal (least-cost) allocation is obtained. This solution represents the total minimum cost allocation, that is, the minimum sum of process costs plus transportation costs minus the reclamation values.

The report generator module utilizes this information to produce a disposal plan. The model output provides planning information for each demil activity. This includes a breakout of its allocation by item in terms of tonnage, number of shifts, demil method, and quantity from each originating location. The plan displays the net cost, the transportation cost, the process cost, and the reclamation cost for each of the items allocated to that facility.

TECHNICAL FACTS

- DoD Logistics Model Number LD 37255
- Type of Model Mathematical Programming
- Problem Size All applications up to a maximum of 36 inventory locations, 35 demil sites, 9 demil/disposal methods, and up to 9999 types of items.
- Major Subprograms Data Conversion Module (FORTRAN/COBOL)
 Matrix Generator Module (FORTRAN)
 Linear Programming Module (MPSX/APEX)
 Report Generator Module (COBOL/FORTRAN)

THE AMMUNITION PACKAGING/CONTAINERIZATION LIFE CYCLE COST MODEL

- The Ammunition Packaging/Containerization Life Cycle Cost Model evaluates ammunition packaging and containerization alternatives on a total life cycle cost basis.

APPLICATION AREAS

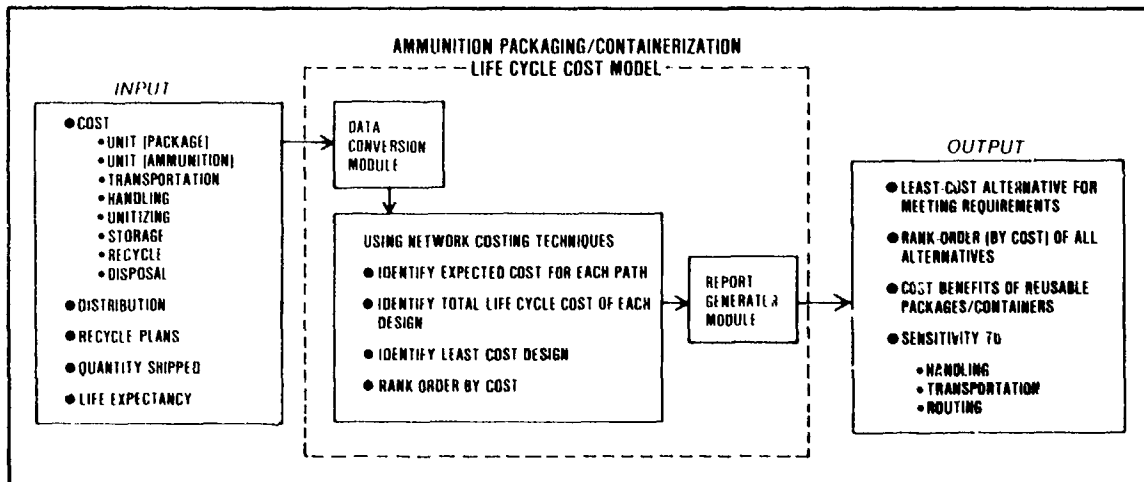
- Ammunition Packaging/Containerization Analysis
- Ammunition Cost
- Ammunition Distribution System

POINT OF CONTACT

Mr. Norman V. Hoesly, Item Acquisition and Materiel Planning Division, AV 793-5980

DESCRIPTION

The Ammunition Packaging/Containerization Life Cycle Cost Model evaluates the *total economic impact* of alternative configurations planned for use in ammunition packaging and containerization over the life cycle from design through disposal. Network costing techniques which evaluate and rank order all alternative designs by total life cycle cost are used to accomplish this. An overview of model inputs, operation and outputs is presented in the diagram.



Flow Diagram for the Ammunition Packaging/Containerization Life Cycle Cost Model

Various types of inputs are required by the model. The cost inputs include the unit costs of each packaging/containerization design, the unit cost of the related ammunition; transportation, storage, and handling cost for each segment of the distribution network, unitizing cost, disposal cost, and recycle costs.

In addition to costs, the planned distribution paths, disposal or reuse plans, expected production quantity, and economic life of an item are used. The probabilities of usage of each path from the sources of supply to the intended users are input in accordance with logistics design guidance and analyses of historical data. Recycle probabilities and costs are required for designs where reuse is anticipated. Total quantities of ammunition to be shipped are required as input to provide a common basis for comparisons of alternative designs. All life expectancies of packaging/containerization designs/methods are input as probabilities. Also required are any special one-time costs such as for research and development cost, or cost of special handling equipment.

In operation, the main computation module determines the expected cost for each segment in the distribution network and accumulates these costs to provide the total expected cost of each alternative design. The losses resulting from end-item damage due to packaging/containerization deterioration and all recycle and disposal costs are included. One-time costs are treated by algorithms outside of the network costing routines. After the total life cycle cost of each alternative has been determined, the module rank orders the alternatives by cost.

The report generator module structures the data into easy-to-read format for summary and comparison. The model output identifies the least cost design, the rank order by cost of all designs, and the life cycle cost of all designs.

TECHNICAL FACTS

- DoD Logistics Model Number LD 37256
- Type of Model Simulation/Network Analysis
- Problem Size Up to 99 alternatives
- Major Subprograms Conversion Module (FORTRAN)
Main Computation Module (FORTRAN/VERT)
Report Generator Module (FORTRAN)

THE MODEL SYSTEM

The JCAP Model System provides the ammunition manager and his organization with a management tool which identifies the best alternative plans for achievement of the highest possible overall readiness through integration of the main factors which bear on the management decisions involved. The system:

- Incorporates management judgment and priorities in defining and evaluating decision alternatives.
- Is a coordinated set of procedures and computer models which provides, individually and collectively, support to the planning and control missions of command and functional managers of the conventional ammunition production base.
- Analyzes and compares decision alternatives based on the objective of obtaining the highest possible overall ammunition readiness consistent with requirements guidelines, budget constraints, and base performance data.
- Can be operated, in phase with the annual planning, programming, and budgeting cycle, to assist management in integration of budget planning, modernization and expansion, layaway and maintenance, plant workloading, production and procurement, and mobilization planning.
- Applies modern analytical methods in conjunction with modern data base management to develop and evaluate alternative approaches to the complex operational problems of ammunition base management.

SYSTEM CONCEPTS - AN OVERVIEW

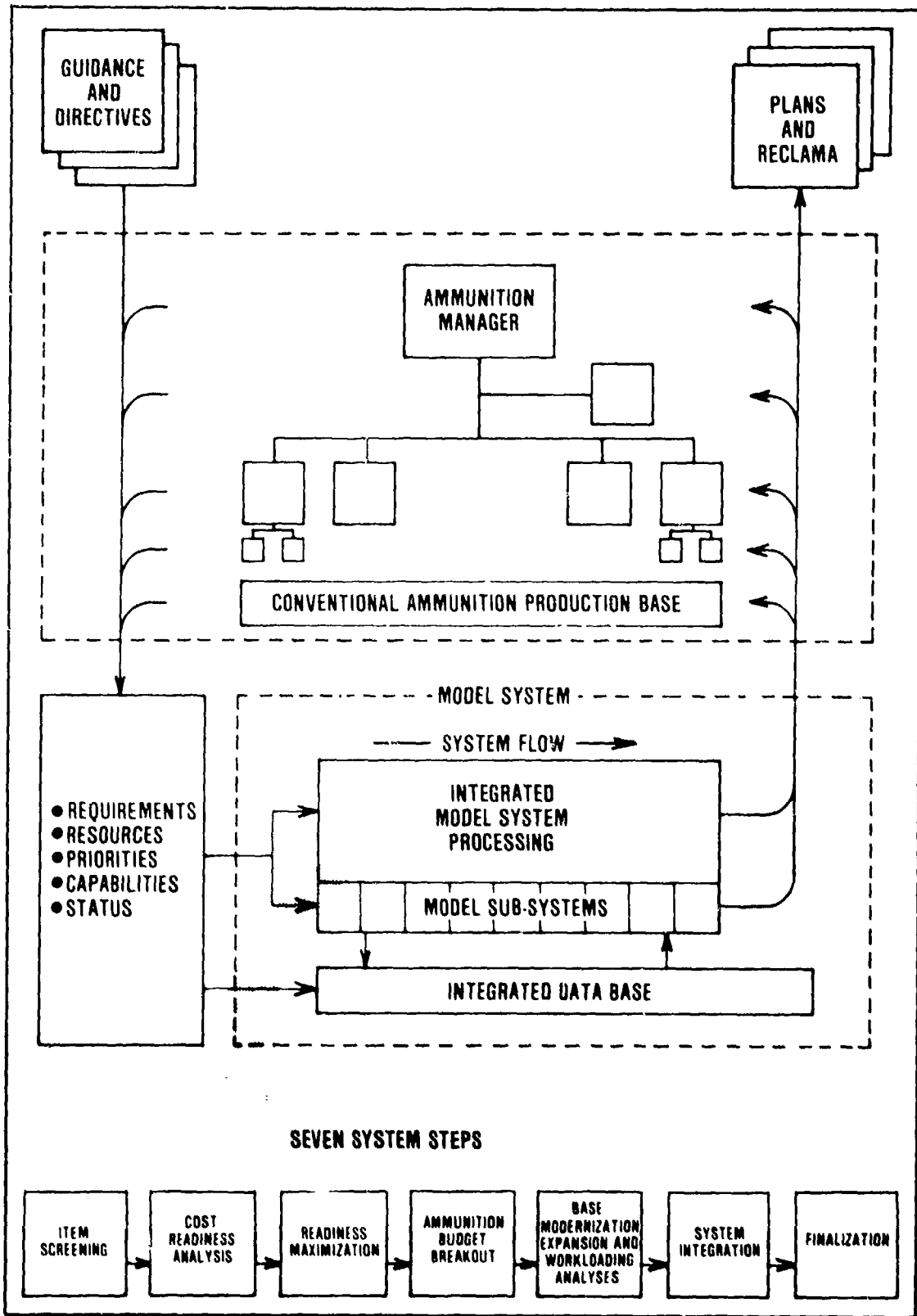
The relationships of the model system to management are graphically portrayed in the diagram. Logistics guidance and planning documents, in various stages of development, enter at the top left into the ammunition management system block (dashed lines). This information is acted upon in turn by the ammunition management system in a sequence of time-phased actions and prescribed roles and responsibilities. The participants in the ammunition management system transform such higher authority guidance into appropriate requirements data, resources data, and the priorities and preference data that comprise the set of management inputs which, together with capabilities and status data from the production base, drives the model system in its search for best alternatives.

The model system in the lower dashed block then processes this broad set of management inputs and "hard" status and capabilities data in conjunction with the integrated data base. This data base provides supporting data management functions, i.e., storage, retrieval, and linkages to other existing management information data bases.

Rationale for the integrated model system processing is based upon the seven system steps at the bottom of the diagram. They comprise a set of interlinked procedures and programs which arrive at the best management alternatives. In-process management reviews, feedback paths, and recycling actions occur until final plans are agreed upon. Management approved plans or reclama follow the upward arrow and result in formal submissions to higher authority.

The overview is introductory. The more detailed explanations which follow explain how the model system supports the Ammunition Manager, how management reviews direct and control the system, what each step accomplishes and so forth. The following "quick map" of model system topics indicates their order and coverage in the sections that follow:

- **BACKGROUND** - How the model system supports the Single Manager (SM) mission with outputs that satisfy ammunition management planning needs.
- **SYSTEM INTEGRATION** - How the model system steps, reviews, and documentation combine to form an integrated system.
- **SYSTEM STEPS** - What each step involves and accomplishes in developing an integrated plan.
- **SYSTEM REVIEWS** - How each review provides management direction and control of the system process.
- **SYSTEM DOCUMENTATION** - How the system documents support management, record decisions and provide internal guidance.
- **INTEGRATED DATA BASE** - How modern data base management techniques insure consistency of information in management reports and model operations.



Model System Relationships to Management

BACKGROUND

Development of an integrated model system, always a long-range mission objective, achieved priority status during JCAP-DM's planning for support of the Single Manager for Conventional Ammunition. The model system described here is based upon the models described in the previous section, all of which are operable. System integration thus became a dominant design factor. Three basic deductions were made from observation of current and interim planning documents for the transition to SM that influenced the model system design. These deductions were:

- First, some form of *master management plan* is needed to serve as the baseline planning document. To be explicit and consistent, the proposed document was simply titled, "Integrated Ammunition Management Plan (IAMP)"

- Second, a formal document would be advantageous during the planning cycle for the *consolidated reclama* mentioned above. This document, a total conventional ammunition program impact statement fulfilling this need, was simply titled "Ammunition Program Analysis and Resource Review (APAAR)" to parallel a similar DARCOM document.

- Third, from a systems point of view it was observed that a *newly-structured set* of documentation and reviews would be needed to gain maximum benefit from the model system steps as an ammunition management tool during development of the IAMP. The manner in which these proposed plans, reports, and reviews support the SM is a key systems integration concept.

The importance of these observations depends not on the names here for these reviews and documents but on the *integrated system concepts* and the fact that the model system can support this type of management review system in coordination with the Planning, Programming and Budgeting cycle.

The end result, the IAMP, enables consolidation into one document, the ammunition manager's annual internal planning, programming and budgeting guidance/plans developed for functional managers as a result of the internal review decisions and his major planning submission to higher authority in performance of his ammunition management mission over three major activities of the conventional ammunition production base. These activities are:

- *Industrial Preparedness Planning* - Those activities conducted to establish, maintain and retain responsiveness to ammunition materiel requirements in the event of an emergency, i.e., *mobilization planning*.

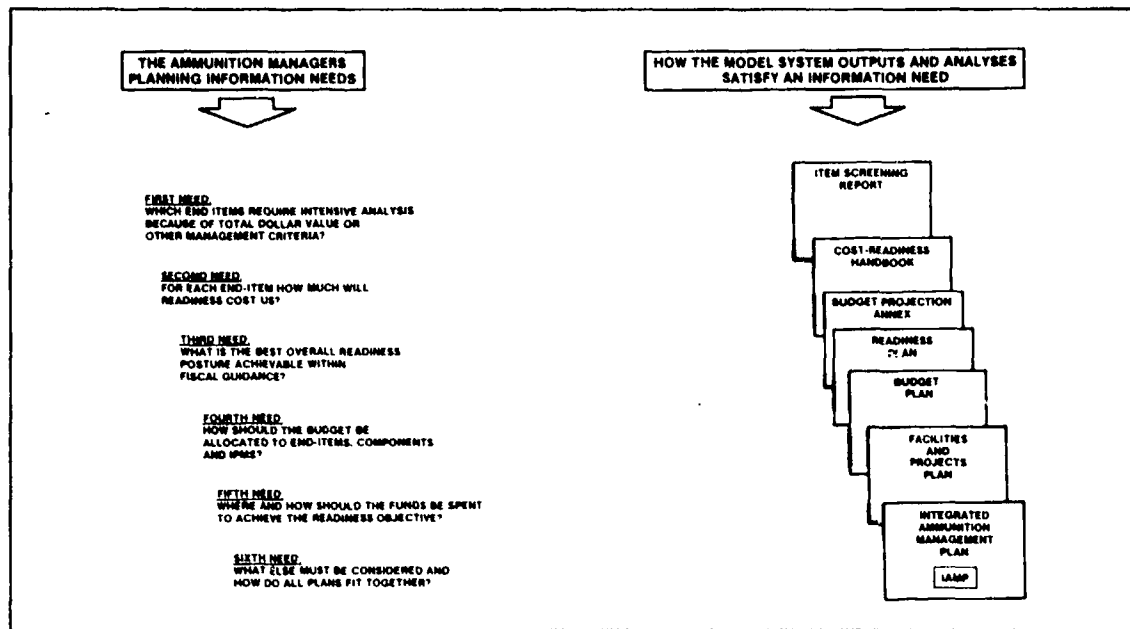
- *The Production Base Support Program* - Those activities conducted to develop, maintain and retain an effective and efficient ammunition production base, i.e., *the integrated investment and maintenance planning* for conventional ammunition production facilities.

- *Industrial Preparedness Operations* - Those activities conducted to manage and sustain the active ammunition production and logistics bases in the most cost-effectiveness manner, i.e., *operational planning* for current requirements.

RELATING INFORMATION NEEDS TO MODEL SYSTEM OUTPUTS

Six basic planning information needs, expressed as questions, drive the integrated model system operations and provide the rationale on which to structure appropriate supporting documentation. The model system outputs and analyses indicated in the diagram at the top of the next page assist the manager in answering each of these questions in sequence during model system operations.

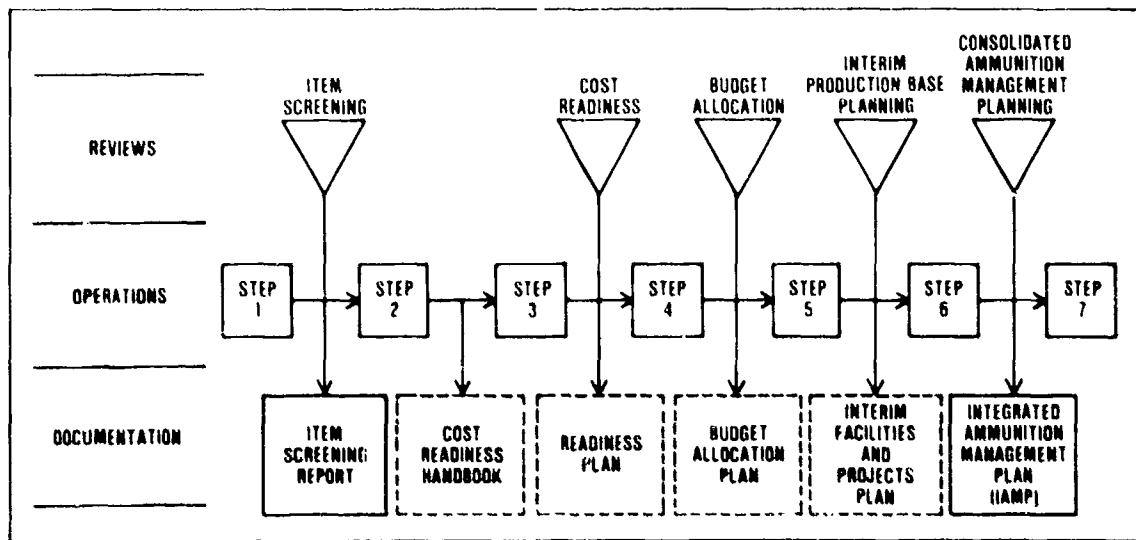
The approved form of these outputs constitutes the logical base line for planning operations and supporting documentation for the management of the conventional ammunition production base. How it all fits together is discussed next.



Rationale For Supporting Documentation

SYSTEM INTEGRATION

The general concept for integration of the model system steps, of the major internal management reviews, and of the supporting documentation is indicated in the composite diagram below. The five major internal reviews implement direct management control of the model system and guide the system as it sequentially operates through the seven step process. The basic questions at these reviews are the ones that express the ammunition manager's planning needs. The in-process management reviews are the major points at which the decision options output by the system at that point are evaluated by management and a decision is made. These decisions progressively direct the system in its ensuing steps and cause updates of the planning base line for management and staff reference during the cycle.



Integration of Reviews, Operations and Documentation

The specific, rational, and progressive procedures enhance upper level management control over the annual planning, programming, and budgeting processes. The last review, the Consolidated Ammunition Management Planning Review, is aimed at the final system integration and adjustment of all summary and support plans. This integration, backed up by model system operations, documentation and supportive analyses, enables not only the preparation and approval of the IAMP but also provides the rationale and data required to develop the APAAR reclama.

The model system as described to this point has emphasized its *planning* application in Industrial Preparedness Planning and in the Production Base Support Program. However, many decisions made during the IAMP preparation are closely related to and integrated with current procurement, production, and on-going associated programs/activities, such as research and development, inventory management, logistics support, facility construction, etc. This interaction between planning and control means that, in some cases, the model system or some of the DMD models or subsystems may be applied to resolve current operational problems in Industrial Preparedness Operations.

Before examining the system steps in detail, it should be noted that even though the model system is based upon proven models, no system mode operations have, as yet, tested these procedures in totality. Hence, the proposed integrated model system and procedures are subject to further refinement and adjustment under operational experience *and* total integration with management missions, structures and reporting systems which may occur in transition to SM.

SYSTEM STEPS

Step 1 - Item Screening

The purpose of this step is to prioritize all ammunition end-items on the Industrial Preparedness Planning List (IPPL) to determine the specific items that warrant intensive analyses in the ensuing system steps. Prioritization is done on the basis of expected cost to meet item inventory objectives (IO's) as defined by logistics guidance. This type of prioritization is a practical application of what is known as Pareto's Law. As a rule of thumb, it can be expected that about 10 percent of the items will contribute in the neighborhood of 90 percent of the total peacetime cost of ammunition. It is important to identify these items as early as possible in the cycle in order to concentrate the various resources involved on the areas of highest potential economic payback. The screening process provides a simple identification code for use by all functional managers, data managers, and analysts. Designation as a potential high payback item is doubly significant. It denotes that the item requires concentrated effort to obtain and update data, and it denotes an inherent priority with respect to the level of detail with which the item is to be considered in all phases of the analysis.

The output of Step 1 is a draft Item Screening Report which lists each item by highest net IO value. This draft is reviewed by ammunition managers during the Item Screening Review. Following this review, revisions of the item priority list are made as necessary to reflect the priorities of management. These revisions are incorporated into the data base and, if deemed necessary by management, an Item Screening Report is published.

Step 2 - Cost-Readiness Analyses

The purpose of this step is to determine the cost-readiness relationship of each ammunition end-item in order to answer the question of how readiness should be planned to get the most readiness for the dollar. The basic output of a cost-readiness analysis is a "curve" of cost versus readiness for an end-item. For the high priority items, (i.e., those items identified by the Step 1 screening as having a high economic payback potential) these curves show the least amount of dollars required to achieve readiness planning levels up to 1.0 after trade-offs of all options available for that item. For the other items, end-item buy projections based on average unit production cost are used to determine the cost-readiness relationships.

The Item Acquisition/Production Trade-Off Model (IA/PT) is used to perform the trade-off analyses of the high priority items. Except for certain site-specific alternatives, all cost inputs for the IA/PT are average costs. The model performs trade-offs of end-item and component peacetime inventory acquisition and Industrial Preparedness Measures (IPM's) related to post-D-day production response for each item independently. Since these trade-offs are performed for specific levels of readiness, several iterations are required to obtain good estimates of cost-readiness up to the level of 1.0.

Item cost-readiness "curves" may be printed in the form of a Cost-Readiness Handbook to provide a source of cost-readiness information on each end-item.

Step 3 - Readiness Maximization

The purpose of this step is to develop a plan for allocating the total ammunition budget to end-items in such a way that the overall ammunition readiness is maximized in accordance with management priorities.

The Materiel Acquisition Planning (MAP) Model is used in this step. It dynamically allocates the budget to items of lowest readiness, using the end-item cost-readiness relationships developed in Step 2, until the budget is depleted. Thus, the output of the MAP Model identifies the best overall readiness achievable within budget constraints, including the projected readiness posture of every end-item on the IPPL. This output further specifically identifies the time-phased budget breakouts by year for each item. These budget breakouts may, however, require adjustment since they do not reflect any specific item readiness or item funding priorities. Therefore, this initial output is submitted to the ammunition manager for his review. After examination, the manager may decide to prespecify certain item readiness or item funding priorities. The MAP Model is then recycled to respond with the best budget breakouts as constrained by the manager's priorities.

Upon completion of Step 3 and the Cost-Readiness Review, the data base and the Cost-Readiness Handbook can be updated by a Readiness Plan listing quantitative requirements and budgets by item, time period, and funding category.

Step 4 - Ammunition Budget Breakout

The purpose of this step is to complete the budget allocation plan by sub-allocating the end-item budgets to end-item buys, component buys, and Industrial Preparedness Measures. This is accomplished by using detailed trade-offs of end-item buys, component buys, and IPM's on the items having the greatest economic payback. Other items are planned on the basis of their end-item buys. The end result of Step 4 is a total budget allocation plan to be acted upon during the Budget Allocation Review.

In essence, Step 4 is a continuation of the analysis started in Step 2 with the important difference that the budget breakout for each item has been specified. Thus, the problem addressed in this step is the determination of the *specific mix* of end-item stockpiling, component stockpiling, and application of IPM's which maximizes *item* readiness under the constraints of the item budget breakout made in Step 3. Trade-offs of this type considered in Step 2 were made without budget constraints.

Upon completion of Step 4 and the Budget Allocation Review, the data base is updated to incorporate the results. Additionally, the Cost-Readiness Handbook can be updated with a Budget Allocation Plan which records the fiscal decisions made during the Budget Allocation Review.

Step 5 - Base Modernization, Expansion, and Workloading Analyses

The purpose of this step is to determine the most economical plan for production base modernization and utilization to produce the high priority end-items and components. In this way, it is assured that high priority items are given their appropriate preference with regard to facilities. Having satisfied the requirement for these items, all remaining items are dealt with in Step 6.

The Production Facilities Life Cycle Cost Subsystem is used in this step to conduct the economic trade-offs necessary to determine what modernization and expansion projects are needed; whether new plants should be built; when and where each end-item and each component should be produced; and, which plants and lines should be laid away.

The magnitude of effort in this step is large and the trade-offs included have great significance since, up to this point, facilities have been involved only in the context of some site-specific IPM's introduced in Steps 2 and 4. At this point, *all facilities and all modernization and expansion projects are brought into the analysis*. These plants, lines, and projects represent all possible alternatives for execution of the component buys, end-item buys, and IPM's identified earlier. As in previous steps, this step requires close coordination with ammunition managers to assure that their priorities are appropriately accounted for. For example, the manager may dictate that certain items be produced on certain lines, that certain facilities be workloaded to a given level, or that certain facilities investments be delayed. In these cases, the model system will determine the most economical approach within the constraints of these overrides, and it will provide a comparison of the least cost approach with the least cost approach as constrained by the overrides.

Step 5 is complete when the information in these analyses is approved by the ammunition manager as the Interim Facilities and Projects Plan at the Interim Production Base Planning Review. This information is then incorporated into the data base, to serve as the framework for total system integration in Step 6.

Step 6 - System Integration

The purpose of this step is to develop, for top management review, a draft Integrated Ammunition Management Plan. This requires expanding the approved Interim Base Modernization, Expansion and Work-loading Plan to fulfill requirements for all items in the most practical and economic manner. The output of this step is a plan that specifies the configuration, operation, maintenance, and workloading of the total ammunition production base over the planning period based on rationale for achieving the maximum ammunition readiness within the budget constraints. The plan will identify all needed modernization and expansion projects; where and when these projects should be implemented; if new facilities are required, if so - where, at what capacity, and when they should be built. It will also identify what plants should be operating during peacetime and their associated schedule and workloads, which plants should be laid away, and how they should be laid away and maintained, production locations and schedules for each end-item and component during peacetime, mobilization schedules for each facility, and the expected readiness posture over the planning period.

The role of the model system during this step is primarily to complete and integrate plans for resources for all items and facilities to support information needs of management. Step 6 is complete when the information in the draft Integrated Ammunition Management Plan is approved by ammunition functional managers and the data has been incorporated in the integrated data base. An increased need for management support occurs during this step since, as decision alternatives are identified, more management questions arise. Therefore, to respond to these needs and to purify the integrated plan, intensive demands will be made of the interactive features of the integrated data base.

Step 7 - Finalization

The purpose of this step is to complete and verify all analyses resulting from the Consolidated Ammunition Management Planning Review so as to adjust and finalize the Integrated Ammunition Management Plan in accordance with top management decisions.

The purpose of the model system in this step is to provide responsive support for sensitivity or change analyses concerning all aspects of production and mobilization planning. Any or all of the models may be called upon to conduct management investigations or provide supporting rationale for planning variations.

The step is considered complete when the Integrated Ammunition Management Plan is approved and the integrated data base is updated accordingly.

SYSTEM REVIEWS

The Ammunition Manager and his staff direct and guide model system operations by means of the *internal review process*. The objectives of the reviews, summarized in the diagram opposite, parallel the basic planning needs described earlier. Management decisions, from among the alternatives presented by the model system outputs and analyses, ensure that management priorities and expertise guide the system operations and shape the final plans.

The entire process emphasizes presentation at each step of the best set of decision alternatives available at the step of the process with pertinent sensitivity analyses so as to support and facilitate the decision process with a minimum of recycling.

- **ITEM SCREENING REVIEW**
To Direct Scope and Depth of
Subsequent Model System Operations
- **COST-READINESS REVIEW**
To Develop the Readiness Plan and
Its Budget Projection Annex
- **BUDGET ALLOCATION REVIEW**
To Approve Ammunition End-Item
Budget Allocation Plan
- **INTERIM PRODUCTION BASE PLANNING REVIEW**
To Approve Interim Facilities and
Project Plans
- **CONSOLIDATED AMMUNITION MANAGEMENT
PLANNING REVIEW**
To Develop the Final IAMP and APAAR by
System Adjustment and Integration of all
Summary and Support Plans

Objectives of Major Internal Management Reviews

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Upon completion of Step 3 and the Cost-Readiness Review, the data base and the Cost-Readiness Handbook can be updated by a Readiness Plan listing quantitative requirements and budgets by item, time period, and funding category.

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Step 5 is complete when the information in these analyses is approved by the ammunition manager as the Interim Facilities and Projects Plan at the Interim Production Base Planning Review. This information is then incorporated into the data base, to serve as the framework for total system integration in Step 6.

SYSTEM DOCUMENTATION

The output reports, plans and analyses support the Ammunition Manager in his internal review process leading to the IAMP and APAAR. The approved plans and reports constitute the logical base line of planning operations and support documentation for the management of the conventional ammunition program.

An important feature of the model system is, as indicated by the figure to the right, the *planned system updating* of the cost-readiness information contained in the Cost-Readiness Handbook and its counterpart data in the Integrated Data Base, as more precise planning decisions are made during the cycle. The system of planned updating ensures that all management levels, as well as the model system, operate uniformly with the more complete planning information approved at key steps in the cycle. Updated versions of the Cost-Readiness Handbook are submitted in "draft" form as part of the review package prepared for each major review. An added benefit is the documentation provided for review and audit.

After each review, updated versions of the handbook incorporate the results of management planning decisions by means of supplementary sections or updated sheets. Identical updating to the integrated data base ensures configuration control over the planning baseline used in model operations.

INTEGRATED DATA BASE

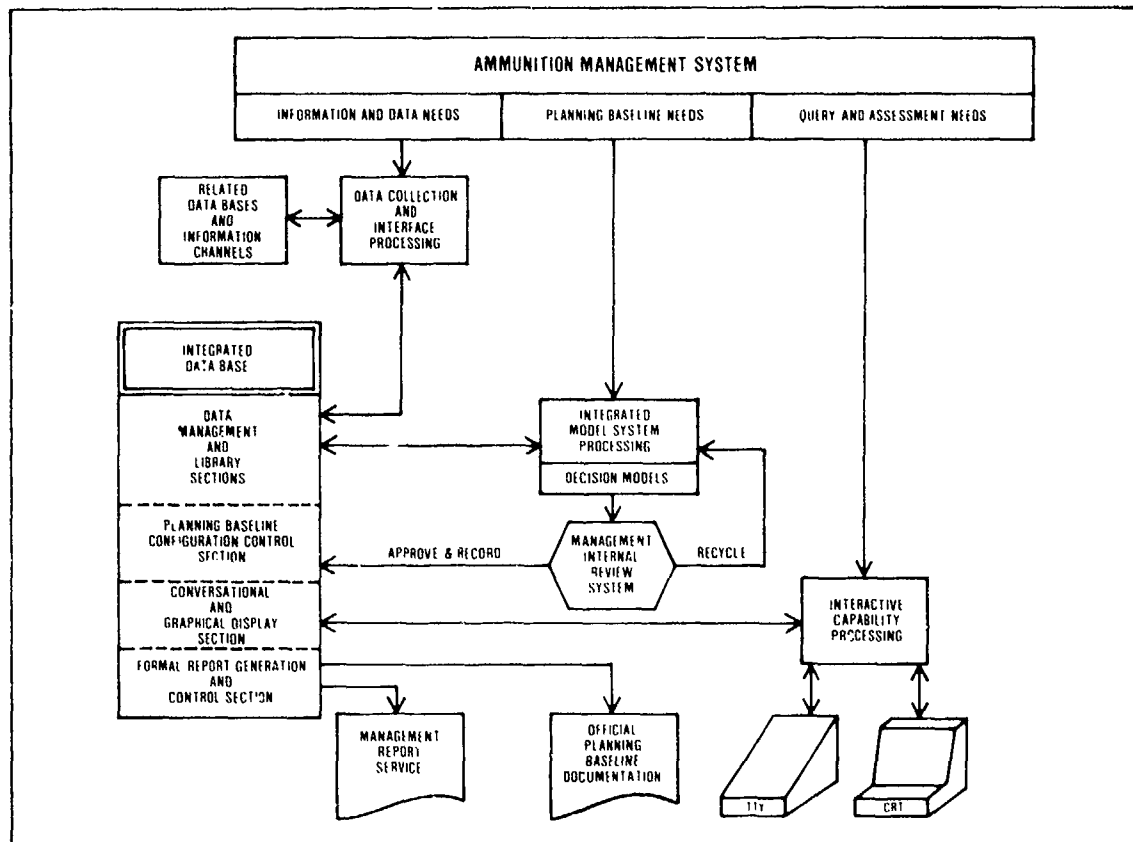
The integrated data base shown in the diagram on the next page is a major subsystem of a centralized data base management system. It supports the three principal types of information needs of the ammunition management system. On-going development efforts by DMD and its sister JCAP element MISD for the integrated data base, and for the centralized data base management system, parallel and support the development efforts for the model system. As seen in the diagram, each type of information need drives a processing block which interacts with the integrated data base. One major role of the integrated data base is to assure *commonality and consistency* of data within and across the various types of output shown at the bottom of the diagram. Without the integrated data base, any or all of the outputs would eventually lose credibility with management because of conflicting information.

The integrated data base and the centralized data management system achieve this output commonality and consistency criteria by incorporating certain fundamental data base principles. The first of these occurs by maintaining data integrity during the input block labeled "Data Collection and Interface Processing." Normally, data base management systems which are installed totally new have a subsystem devoted exclusively to managing the data input to the data base, without any provision within itself for output processing. Its function is to enter data into the structured set of "base" data elements. The base data is then available for subsequent "logical relationship" processing by a data management subsystem. The structure of a data base may be considered as composed of various vertical levels or strata, each easily expandable horizontally to provide for system expansion. The structure is a tree-like hierarchy in which all the data resides. Any external request for information, that is, for an assemblage of data in accordance with some specified logical relationships, is serviced by data accessing procedures under the control of the data management subsystem. The integrity of the base data is maintained during these steps and the information gathered is internally stored ready for output. This system manages the data base itself. It has built-in capabilities for controlling backup, recovery, availability and so forth. The third major component in an idealized data base management system is the generalized output control subsystem. It receives its information demands from management. These demands are processed by the data management subsystem and new output is obtained which has been combined to have informational value. This type of output, formatted and edited, is in the form of the traditional management report service indicated at the lower left in the diagram.

- **INITIAL PLANNING VERSION**
Based on Advanced Planning and Guidance
- **PLANNING ISSUE (UPDATE 1)**
Contains All Item Analyses Used in Total Budget Allocation
- **BASE LINE ISSUE (UPDATE 2)**
Identifies Approved Planning Decisions, by End-Item, Resulting from the Cost-Readiness Review
- **BUDGET ALLOCATION ISSUE (UPDATE 3)**
Identifies Approved Detail Planning Decisions Resulting from the Budget Allocation Review
- **PRODUCTION BASE PLANNING ISSUE (UPDATE 4)**
Identifies Approved Facilities and Projects Decisions Resulting from the Interim Production Base Planning Review
- **IAMP ISSUE (FINAL VERSION)**
Final Issue which Records Decisions Resulting From the Consolidated Ammunition Management Planning Review

Note: All the above revisions occur also to the Integrated Data Base.

System Updating of Cost-Readiness Information



Integrated Data Base Relationships

The two-way arrows on the diagram indicate one of the major differences between the idealized new installation described above and the centralized data base management system under current development. For example, the centralized data base management system has input/output linkages, through interface processing, with related data bases. Some of these are the data bases for Demil and Disposal, PEPMIS, IPM, etc. In addition, current access techniques are applied for data existing in file management systems, such as ALPHA, WARS, the Storage Base, the Requirements File, CAMMT, the IPPL File and so on. The long range plans call for some of these to be converted to subsystems of the centralized data base management system at a later date. All such conversions require orderly transitions from existing data collection, file processing and output report techniques, with planned phases for development, testing and so on through acceptance. The data base management subsystem referred to here consists of the software package "System 2000" supplemented by additional commercial or installation developed software/procedures to meet back-up, security and other data management control specifications. The "System 2000" is *currently installed* at HQ, ARRCOM and operationally supports the JCAP data base requirements. The benefits by conversion to data base operations are:

- Management support is greatly expanded as the data becomes available for generalized information requests rather than special purpose prespecified application.
- Computing efficiency is generally improved for the same input/output previously done under file management.
 - File maintenance and related programming support efforts are reduced.
 - Interactive processing response time is improved by direct data accessibility through reduction of on-line file linkages.
 - Output information consistency is inherently attained since all output is based on the same collection of data elements - the data base.

The rest of the major differences are indicated in the diagram by the internal sections for the integrated data base. The most important features, insofar as the "Integrated Model System Processing" block is concerned, are the Data Management and Library Sections, the Planning Base Line Configuration Control Section and the Formal Report Generation and Control Section. These enable the model system to perform in the stepwise fashion previously described with all the benefits of data base management, with progressive planning development governed by the management internal review system, and with the documentation of official planning base line as output.

The third information need of management and its support function is for query and assessment. This need drives the "Interactive Capability Processing" block. It is supported within the integrated data base by the Conversational and Graphical Display Section. An important role of this aspect of the integrated data base is the response capability provided for by direct keyboard revisions incorporating any recycle actions during model system operations. Some recycling is deliberately planned within the model system operations, such as for the tandem operation between the IA/PT and MAP models in Steps 2 and 3.

One key concept not previously mentioned in that all the DMD models have standardized their input and output data elements to conform to data base operations. These elements are cataloged in the JCAP MISD publication - the JCAP Data Element Dictionary (DED) - which continually is coordinated and standardized through the DoD Logistics Data Element Standardization and Management Office.

This description of the role of the integrated data base concludes the coverage of the integrated model system concepts.

SUMMARY

This report has described the origin, capability, and achievements of the Decision Models Directorate. The models and the model system which have been developed and applied by the Directorate have been focused to serve as tools of the ammunition managers. They assist in the management of the broad spectrum of problems encountered in ammunition management. The models and Directorate personnel have captured years of experience and knowledge of modern decision analysis techniques as applied to effective ammunition management.

The role of the Directorate has become even more critical with the advent of the Single Manager for Conventional Ammunition. The key objective of the Decision Models Directorate is the support of the Single Manager mission. The services of the Directorate are readily available to assist the Single Manager and his functional directors in managing the conventional ammunition production base. The Directorate works on a continuing basis with the primary functional areas and ammunition community. Upon receipt of the data from the functional areas, a thorough and complete analysis with alternatives and recommendations is provided by the Directorate. The Directorate has demonstrated:

- Responsiveness
- Productivity
- Proven Capabilities

While this report provides an in-depth view of the Directorate and its capabilities, the reader may desire additional information. The Directorate welcomes all inquiries concerning this report. For further information, please call Mr. Bernard C. Witherspoon, AUTOVON 793-5262/6538 or Commercial (309) 794-5262/6538, or write him at Joint Conventional Ammunition Program Coordinating Group, ATTN: JCAP-DM, Mr. B. Witherspoon, Rock Island Arsenal, IL 61201.

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