A Computer-Assisted Planning System

by

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FOREWORD

This paper was presented to the 22d National Meeting of the Operations Research Society of America (ORSA) held on Nov 7, 8, 9, 1962 — the theme of the meeting being "Defense Planning." The paper describes the requirement for, and development of, a computer-assisted military planning system. The description is at a level of detail consonant with security requirements and brevity.

Both the rationale used in studying the basic planning problem and the system developed to solve it have considerable other military and industrial analogies. The problem stated in its widest sense is how to effectively determine future resource requirements for men and materiel in the face of a wide range of possible situations. The system developed has attempted to provide an effective solution by complementing human decision with the rapid computational capabilities of a digital computer.

In the case of the Army planning problem — as in the case of many industrial and other military planning situations — a manual method of planning already existed. The manual method, however, had major deficiencies principally related to its heavy computational burdens and resultant inconsistencies. It also had many assets — the principal one being the fact that it reflected considerable planning sophistication. The problem faced by the research team was to develop a new planning system that would preserve the current planning sophistication but eliminate the computational burdens and planning inconsistencies.

The paper places special emphasis on the research techniques utilized to ensure — as far as practical — that the best of the former planning methods would be translated into the new computer-assisted system. The system is being implemented now, and hence it is premature to discuss its complete proved capabilities. However, parts of the computer-assisted system have already been utilized both on an in-house evaluation basis and to assist in development of Army plans. In addition, some computer programs such as the network analysis program have created considerable other military and nonmilitary interest for planning and resource allocation purposes.

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ABSTRACT

A COMPUTER-ASSISTED PLANNING SYSTEM

This paper describes the development of a computer-assisted logistic planning system by the Research Analysis Corporation (RAC) for the Department of the Army. The system described is the first known large-scale application of computer assistance to Army planning problems.

The computer-assisted planning system is designed to determine future requirements for manpower and materiel and thus affects the Army's troop and materiel programs. Previous procedures utilized in determining these requirements have been time consuming, involved extensive amounts of hand computations diverting military planners from decisions, and lacked the capability to evaluate assumptions or consider alternative concepts of support. The new planning system is designed to eliminate these deficiencies and provide a more responsive planning tool to handle the wide range of contingencies which face the Army today.

The paper places primary emphasis on the techniques utilized in developing the system, which included a systems analysis, a pilot study, special analytical techniques — including PERT — and concurrent computer program development and evaluation. Research began in January 1959 on a pilot area — transportation planning. Upon successful completion of this phase, the study was extended " across the board " to design an integrated computer-assisted system for determination of the complete manpower and materiel technical support requirements for the plan.

In order to hasten the reduction of the new system design to operational use a computer programming contract was let. As areas for computerization were determined during the research, model designs were turned over to the contractor for programming. The design of the computer-assisted planning system is now essentially complete. Programming of the computer-assistance models will continue, however, into 1963. The operational system is being implemented on an IBM 7090 computer at the Army's Strategy and Tactics Analysis Group (STAG).

A COMPUTER-ASSISTED PLANNING SYSTEM

INTRODUCTION

The Research Analysis Corporation (RAC) is developing a computer-assisted logistic planning system for the Department of Army. This system represents the first known large-scale application of computers to Army planning. It involves an interplay of planner decisions and reviews with a series of computer routines — each performing specific computational or analytical functions.

This paper places primary emphasis on the techniques utilized in developing the planning system. In order to orient the discussion we may first look at the planning area in which the development lies.

ARMY PLANNING

The current Joint and Army Planning Programs recognize three time frames as depicted in Fig. 1. Short-range plans are directed toward how to employ what we have today; mid-range plans are directed toward what we can buy and do to increase our military readiness 5 years hence; long-range plans are directed to improving our military position through research and development in the more distant future.

Our study is directed toward the development of one of the mid-range plans — Department of the Army Strategic Logistic Studies (DA-SL's). DA-SL's are staff studies that provide guidance in determination of mid-range requirements for manpower and materiel. These studies develop a plan for logistic support for a campaign, measure the costs in manpower and materiel, and identify the situations and problems that are likely to arise in support of the campaign. Preparation of DA-SL's is a joint effort of the Deputy Chief of Staff for Military Operations (DCSOPS) and the Deputy Chief of Staff for Logistics (DCSLOG). DCSOPS prepares the Campaign Plans (CP's) on which DCSLOG bases its Logistic Support Plan (LSP). The CP describes the anticipated combat situation. The LSP provides general guidance for

PLANNING PROBLEMS	TIME FRAME	TYPE PLAN	JOINT PLANS
HOW TO WIN A WAR NOW	SHORT RANGE — 1 YEAR	CAPABILITY	JOINT STRATEGIC CAPABILITIES PLAN (JSCP)
WHAT TO BUY AND DO TO INCREASE MILITARY READINESS	MID RANGE — 5 YEARS	OBJECTIVE	JOINT STRATEGIC OBJECTIVES PLAN (JSOP)
WHAT TO DO TO IMPROVE MILITARY MACHINERY, ORGANIZATIONS, AND CONCEPTS	LONG RANGE — 8-12 YEARS	DEVELOPMENT	JOINT LONG RANGE STRATEGIC STUDY (JLRSS)

Fig. 1—Planning Areas

the preparation of logistic support requirements. (For example, troop consumption factors are provided, information on the intra- and intertheater air capabilities, etc). Technical Support Annexes—the area on which our study focuses — are then prepared. These Annexes provide detailed statements of the support concept, logistic implications, conclusions, recommendations, and complete listings of phased requirements by TOE unit and Class IV items of materiel to support the proposed campaign. (TOE's are documents listing the personnel and equipment contained in each Army troop unit. Class IV items of materiel are those items of materiel required by reason of the specialized nature of an operation but not prescribed — at least in the required quantities — by the TOE). The format of these Annexes is illustrated in Fig. 2. At the time of initiation of research on this problem one such Annex was prepared by each Technical Service and the seven Annexes were then incorporated into Vol II of the DA-SL (The complete Log Support Plan).*

*During the course of the research the Department of the Army was reorganized and the roles of the Technical Services have changed. However, the planning procedures presented in this discussion relate to planning for support of the Army in the field. Here the Technical Services continue to provide for such technical specialties as transportation, communications, hospitalization, construction, supply, and maintenance.

DEPARTMENT OF THE ARMY STRATEGIC LOGISTIC STUDY

DA-SL #________

TECHNICAL SERVICES ANNEX TO VOL. II - LOG. SUPPORT PLAN

1. General
   a. Technical Service Mission
   b. Assumptions (other than those in basic guidance)
2. Concept of Support
   a. Major Tasks
   b. Effect of Environmental Factors
   c. Impact of Atomic and CBR Warfare
   d. Planning Factors - (other than those contained in basic guidance)
3. Logistic Implications
4. Conclusions
   a. Feasibility
   b. Critical Items
   c. Pre-D-Day Stockpiling, Construction, and Troop Deployments
5. Recommendations

APPENDICES

- I Troop Unit Requirements
- II Summary of Personnel Requirements
- III Gross Class IV Materiel Requirements
- IV Net Class IV Materiel Requirements
- V Phased Facility Requirements
- VI Summation of Engr. Functional Components (or signal coded facilities) (In Engr. or Sig Annex Only)
- VII Summation of Construction Effort (In Engr. Annex Only)
- VIII Summation of Engr. Cl. IV Tonnage (In Engr. Annex Only)

Fig. 2—Format for Technical Support Annexes

DIFFICULTIES IN THE CURRENT PLANNING PROCEDURE

Development of the Technical Annex portion of a DA-SL study is scheduled for completion in 6 weeks but more typically has required 7 to 8 weeks and longer. As many as four different such studies may be required in a year, based on widely different campaigns and geographic situations.

The typical planning procedure has followed this pattern. On receipt of the LSP and Campaign Plan by the planning agency of each Technical Service, the cognizant planning staff began review of the plans. Depending on the organizational structure of the Technical Service, the planning activities might then be divided and the parts assigned to specialists within a planning branch or outside to operating agencies. The former procedure within the Transportation Corps (TC) is illustrated in Fig. 3. Here the various aspects of the plan were assigned to operating agencies, and the results were then consolidated by the planning branch into a Technical Service Annex. During the period of Annex preparation considerable planner time and effort were expended both in hand computations and exchanges of information with other Technical Services. Difficulties existed both because of the magnitude of hand computations and the subsequent delays in timely exchanges of information. Computations of dry cargo tonnages, by user, theater location, and time phasing in the campaign might occupy a week's effort before development of a transportation plan and determination of the detailed routing of tonnages by transportation mode over the Lines of Communication (LOC). The transportation movement plan might be fairly complete by the third or fourth week of the planning cycle. However, the Corps of Engineers (CE) required this information urgently and early to determine construction and maintenance requirements on the LOC. The Ordnance Corps (OrdC) required detailed and early TOE statements from all Technical Services to determine maintenance requirements for the equipment associated with the units. However, final TOE's were not

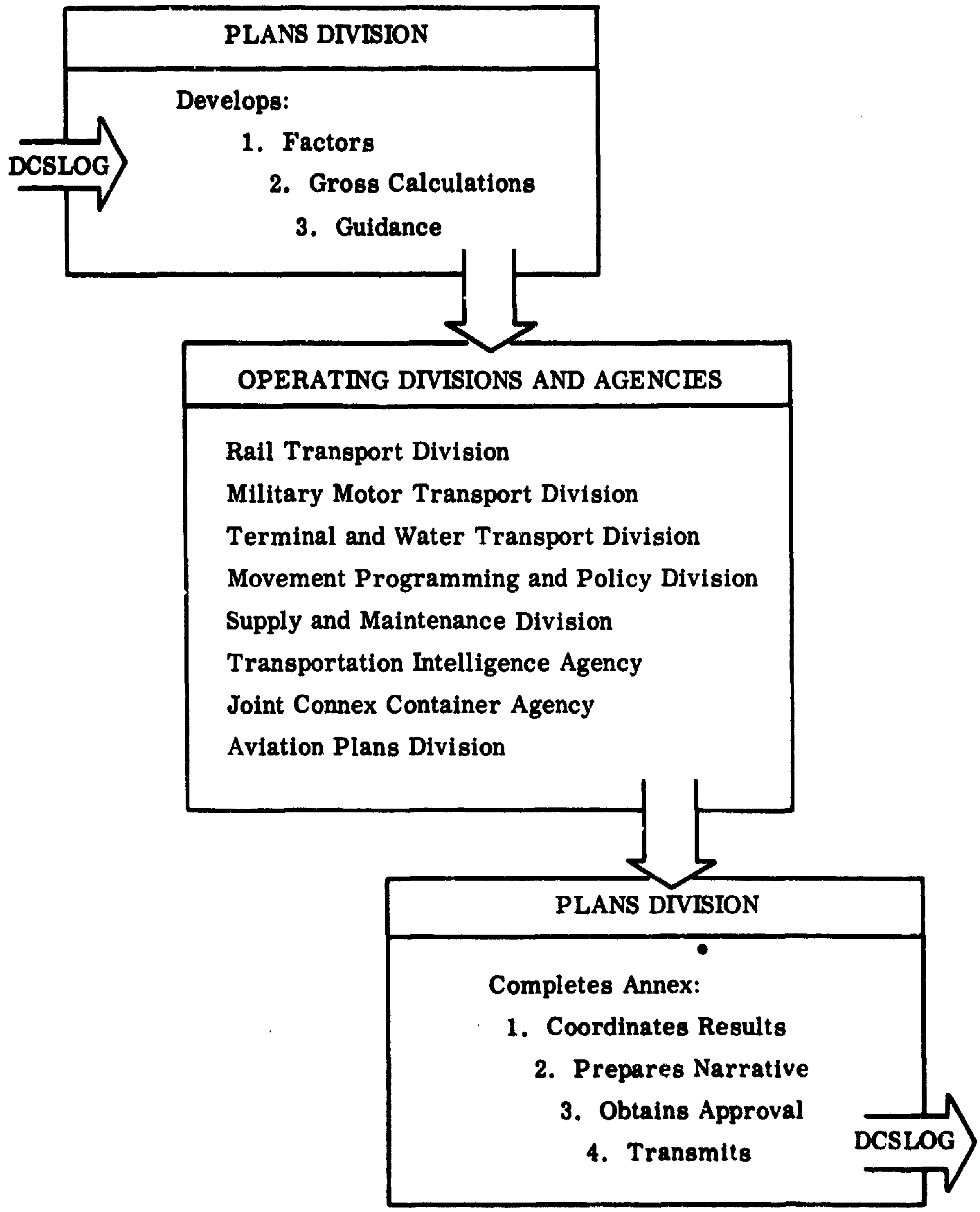

Fig. 3—Former Transportation Corps Annex Preparation Procedure

available until near the end of the allocated planning time.

Methods were developed to somewhat alleviate the critical delays imposed by heavy computational requirements and subsequent late exchanges of information. For example, an early estimate of the transportation movement plan was transmitted from TC to CE and updated as the planning continued. Similarly tentative TOE statements were submitted by all Technical Services to the OrdC to facilitate determination of maintenance requirements. However, gross inconsistencies and delays persisted. It was apparent to both the Technical Services and DCSLOG that the manual methods utilized in preparation of these studies were too time consuming — diverting military planning effort from decisions to computations — and in general lacked the capability to evaluate planning assumptions or consider alternative concepts of support. In view of the additional wide variety of new combat situations and requisite flexibility of response demanded of the Army, a more effective method of planning was called for.

DEVELOPMENT OF THE NEW PLANNING SYSTEM

The large computational loads imposed on the military planners, the subsequent difficulties and inaccuracies introduced by delayed exchanges of information and the requirement for a more responsive planning system suggested the possible benefit of providing computer assistance in the planning process. However, at the initiation of the research by the Research Analysis Corporation (RAC) * in January 1959 no previous work was known that would provide clues as to the possible feasibility or desirability of a large-scale computer-assisted planning system. Clearly if preparation of input forms for a computer computation imposed a greater burden on the planner than his hand computations, the system would be deficient. In addition the requirement by the

*At that time, the Operations Research Office (ORO).

computer for rigidly expressed rules and procedures might impede rather than assist the planner. Accordingly, a research plan was evolved by which RAC would undertake a study to develop a computer-assisted planning system for one Technical Service and evaluate its capabilities. The Transportation Corps was selected as the test case both because of the amount of computational load involved in its planning and the criticality of its interactions with other Services.

The Pilot Study

The RAC team studied the TC planning procedure in detail and worked closely with the Technical Service planners in manual development of specific SL studies. As a result of this effort a computer-assisted planning procedure shown in Fig. 4 was developed for TC. The shaded areas to the right represent five specific computer programs. The boxes in the center represent planner decisions and actions. The arrows to the left represent major Technical Service interactions. The normal sequence of planning is illustrated in the figure. However, each program is independent — the planner may proceed directly through the process or utilize separate parts of the procedure to evaluate or change basic planning assumptions. The final output is a detailed listing of TOE and Class IV requirements as shown in Fig. 5. Various means were utilized to test the practicality of the procedure during the research. As areas were designated for computer assistance, prototype computer programs were prepared by the study team on RAC's 1103A computer. (These programs had full computational capabilities but lacked sophisticated input and output routines.) Operational parts of the system were then utilized during the study development to prepare the corresponding results for SL studies in process. In addition a series of operational tests were made utilizing the complete sequence of prototype computer programs. These served as an in-house test of the utility of the system in practical operational terms, i.e., with respect to time

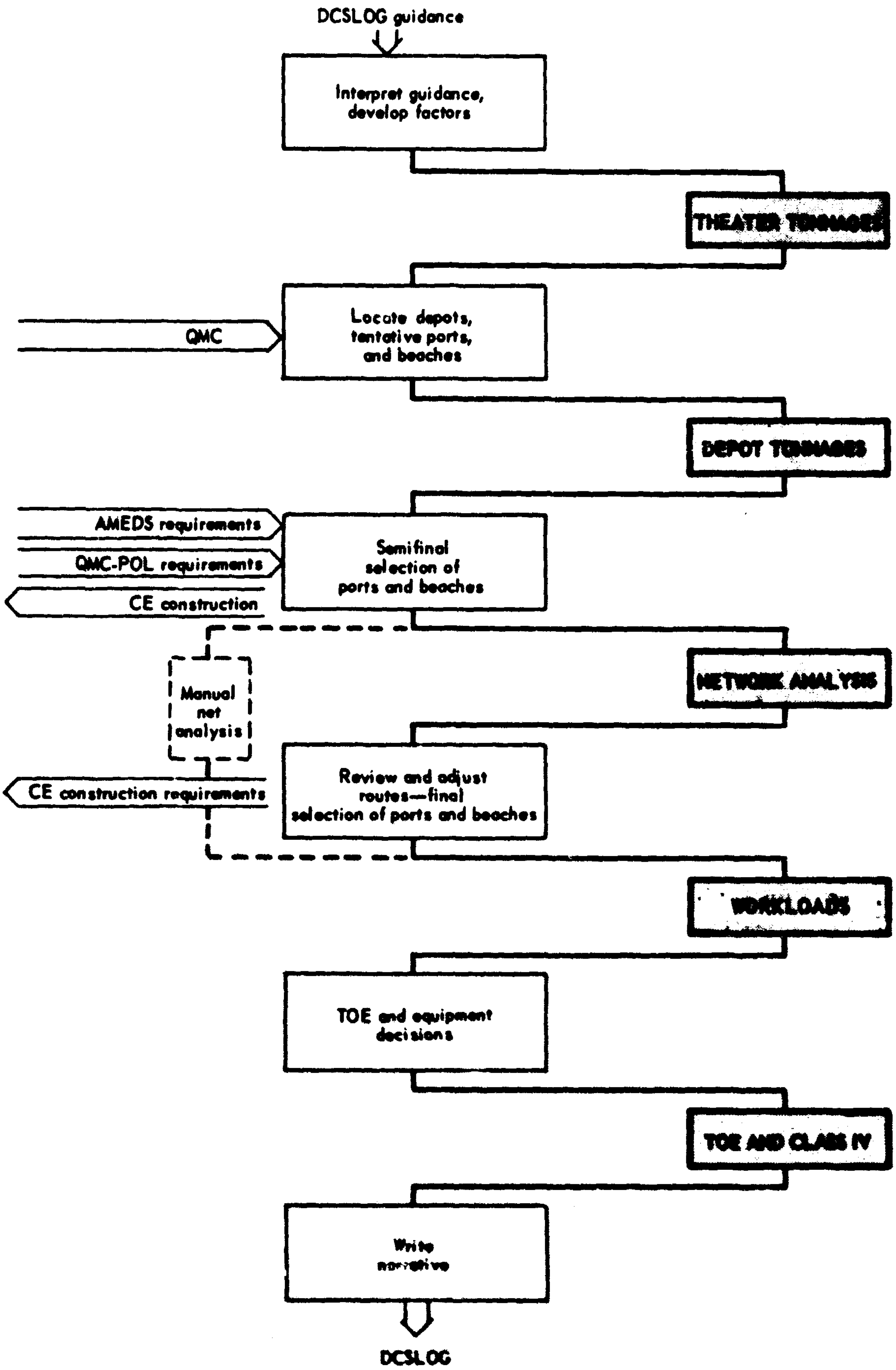

Fig. 4—Computer-Assisted Transportation Planning

TOE UNITS

NO	TYPE	DESIGNATION	DATE	UNIT TOE	UNIT STRENGTH	QUARTER 1	2	3	4	5	6
001	[illegible]	TRANS ACFT [illegible]	10 31 58	55-[illegible]	72		1	1	1	1	1
002	CD	LT HCPTR	3 12 56	55-[illegible]	147	1	2	2	2	2	2
003	CD	TRANS ACFT [illegible]	6 8 56	55-[illegible]	30		1	1	1	1	1
004	CD	MED HCPTR	11 58	55-[illegible]	170		2	2	2	2	2
005	DET	C HCPTR [illegible]	6 22 56	55-[illegible]	56	1	2	2	2	2	2
006	DET	A ACFT REP	7 26 58	55-[illegible]	82		2	2	2	2	2
007	COMD	TERMINAL A [illegible]	11 16 58	55-[illegible]	151	1	1	1	1	1	1
008	[illegible]	TRUCK [illegible]	11 16 58	55-[illegible]	67	2	2	3	3	2	2
009	[illegible]	TERM [illegible]	2 1 58	55-[illegible]	56	2	2	2	2	2	2
010	CD	LT TRK ST TYPE A	6 22 57	55-17D	176	9	11	16	12	10	10
011	CD	LT TRK ST TYPE B	9 22 57	55-17D	73	1	1	1	1	1	1
012	CD	TRANS M [illegible]	--	55-[illegible]	100		2	2	2	2	2
013	CD	STAGING TYPE B	8 12 56	55-[illegible]	20	1	1	1	1	1	1
014	CD	TERM SVC TYPE A	6 8 56	55-117B	201	3	3	3	3	3	3
015	CD	TERM SVC TYPE B	6 8 56	55-117B	152	2	2	2	2	2	2
016	CD	RWY ENGR TYPE B	1 11 56	55-227B	80		2	2	2	2	2
017	TN	[illegible]	6 22 56	55-[illegible]	4	2	2	2	2	2	2
018	TN	[illegible] BOAT CREW	6 22 56	55-[illegible]	3	3	3	3	3	3	3
019	TN	[illegible] TUG CREW	6 22 5[illegible]	55-[illegible]	16	2	2	2	2	2	2
020	TN	[illegible] CRAFT [illegible]	6 22 56	55-[illegible]	30	1	1	1	1	1	1
021	TN	[illegible] CONT	6 22 56	55-[illegible]	6	2	2	2	2	2	2
022	TN	[illegible] CONT	6 22 56	55-[illegible]	4	2	2	2	2	2	2
023	TN	[illegible] CONT	6 22 56	55-[illegible]	6	4	4	4	4	4	4
024	DET	HA TRANS [illegible]	10 15 57	55-[illegible]	12	1	1	1	1	1	1
025	DET	HB TRANS [illegible]	10 15 57	55-[illegible]	14	1	1	1	1	1	1
026	CD	TRANS (TAC CARGO)	6 16 58	55-[illegible]	104	2	2	2	2	2	2

SUMMARY OF PERSONNEL REQUIREMENTS

QTR	COMBAT	COMBAT SUPPORT	TOTAL
1	515	3444	3959
2	1090	4421	5513
3	1090	5350	644[illegible]
4	1090	4646	5736
5	1090	4247	5337
6	1090	4247	5337

NOTE -- REQUIREMENTS ARE SHOWN CUMULATIVELY FOR TROOPS IN PLACE AND OPERATIONAL AS OF END OF PERIOD FOR WHICH SHOWN

CLASS IV REQUIREMENTS

NO.	ITEM NOMENCLATURE	QUARTER 1	2	3	4	5	6	PEAK [illegible]T
	TRANSPORTATION CORPS							
1	LOCO, DE, 56 1/2IN GA, 60 TON, 0-4-4-0 WH, DS	2	0	0	0	0	0	2
2	LOCO, DE, 56 1/2IN GA, 120 TON, 0-4-4-0 WH, DS	6	3	1	0	0	0	10
3	RWY CAR, BOX 56 1/2IN GA, 50 TON, 8 WH, DS	52	3	3	0	0	0	58
4	RWY CAR, GON, 1.5 56 1/2IN GA, 40 TON, DS	64	4	3	0	0	0	71
5	RWY CAR, FLAT, 56 1/2IN GA, 40 TON, 8 WH, DS	57	4	2	0	0	0	63
6	RWY CAR, TANK, PET, 56 1/2IN GA, 10,000 GAL, 8 WH, DS	113	167	61	0	0	0	341
7	TRANSPORTER, LIQUID ROLLING WH, 1,000 GAL, T3	227	252	394	0	0	0	873
	QUARTERMASTER							
8	TRUCK, FORK, GAS, 6000 LBS, PNT, 144IN LIFT, NO.[illegible]	4	0	0	0	0	0	4
9	TRUCK, FORK, GAS, 6000 LBS, PNT, 144IN LIFT, NO.[illegible]	3	0	0	0	0	0	3
10	TRUCK, FORK, GAS, 15,000 LBS PNT 210IN LIFT, NO.[illegible]	3	0	0	0	0	0	3
11	TRACTOR, WHSE, 4000 LBS, DBP 4 WHEEL, PNT NO.[illegible]	3	0	0	0	0	0	3
12	TRAILER, WHSE, 6000 LBS, 40IN x 100IN WHEEL PNT	18	0	0	0	0	0	18
13	TRUCK, STRADDLE, GAS, 30,000 LBS CAPACITY, NO [illegible]	3	0	0	0	0	0	3
14	CONVEYOR, PORTABLE, ELECTRIC, 20FT DRIVING SECTION	1	0	0	0	0	0	1
15	CONVEYOR, PORTABLE, ELECTRIC, 20FT DRIVEN SECTION	1	0	0	0	0	0	1
16	TRUCK, PALLET, HYDRAULIC, 4000 LBS CAPACITY	24	0	0	0	0	0	24

Fig. 5—Computer Print-Out of Requirements

requirements and planner effort.

For purposes of this test an unclassified version of a DA-SL was developed. A requirements study was then prepared and designated the "standard" study. The study included the operation decisions, inputs, and computations characteristic of the production of a typical TC Annex. The planning procedure illustrated in Fig. 4 was followed down to and including the calculation of TOE and Class IV requirements.* (The transportation network for the theater of operations was so simple, however, that the manual option indicated in the third step of Fig. 4 was utilized.) Results of external guidance, conferences with other technical services, and TC decisions were simulated by the research team. Then 243 alternative studies were prepared. They differed from the standard study in varying degrees ranging from minor changes in a planning factor to basic changes in the concept of support.

The 243 studies were completed within 6 weeks — the time period normally allotted to the preparation of a single TC Annex. No significance is attached to the exact number of studies conducted in this time period as this depends on many factors such as complexity of the study, types of variations introduced, etc. ** All factors considered, however, indicated that with the computer-assisted planning procedure it was practical to consider a substantial number of variations in factors or concepts and examine their effects on requirements.

As a result of such tests and the experience gained in developing the TC phase of the computer-assisted planning system it was decided to extend the development "across-the-board."

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*The rules programmed for computation of these requirements were oversimplified at this stage of the system development, however.

**In addition, the in-house studies did not include the narrative preparation of the Annex — its publication and review.

The Integrated Computer-Assisted Planning System

In January 1961 RAC undertook a study under DCSLOG sponsorship to develop a computer-assisted planning procedure for preparation of all Technical Annexes to the LSP. In order to reduce the research rapidly to practice a contract was let by the sponsoring agency, DCSLOG, to a computer organization. The role of the contractor was to provide continuous support to the RAC research team — programming the computer-assistance models as they are developed. Arrangements were also made to implement the new computer-assisted system on STAG's (Strategy and Tactics Analysis Group's) IBM 7090 computer in Bethesda, Md.

As in the pilot study for the Transportation Corps, the first step in the research was an analysis of the complete manual planning procedure. The seven Technical Services were now involved, not one, and a multitude of planning techniques and interactions had to be investigated by the six-man research team. To facilitate the study and development of the new planning system an Experiment & Development Center (E&D Center) was set up at RAC. This consists of a large room approximately 20 by 40 feet, the walls and windows of which are completely covered with mounting board. The room also includes an extensive library of planner's reference manuals and can be secured for classified studies. The primary purpose of the E&D Center was to serve as a analysis and design facility and later to be used for evaluating the new planning system. As mentioned in the following discussion it has been utilized to prepare mock-ups of the manual planning procedure, conduct planning studies, and design the new computer-assisted planning system.

In order to obtain an initial grasp of the complete planning system "Major Planning Element" (MPE) lists were prepared for each Technical Service. These lists simply define the major planning tasks necessary to determine the requirements of that service for men and materiel in support of a particular campaign. Each MPE is characterized by a definite output; this may be a final result, such as the list of required support troop units, or an intermediate result such as the tabulation of tonnages to be delivered to each depot location in each time period. A typical MPE list — that for the Army Medical Service Planning operation is shown in Fig. 6. "Supplemental Notes" were also prepared defining in more detail the planning process included in each MPE and statements of the nature and phasing of Technical Service planning interactions.

To provide an evaluation of our knowledge of the planning system based on the MPE's and Supplemental Notes a plan was developed to utilize this information to compute the Technical Service Annexes for an already completed SL study, compare results, and critically examine the procedures. This evaluation was designated Study 1 and was conducted in the E&D Center previously described. RAC analysts were assigned Technical Service roles, a study controller was selected, and an analyst to represent agencies external to the Technical Services. Fig. 7 shows the study in operation with the MPE lists and interactions for each Technical Service posted on the room walls.

Results obtained from the study showed good agreement — in many cases — with Technical Service results. The study, however, was not definitive enough to provide adequate guidance for designing the computer-assisted system. In particular it was apparent that a means had to be found to more adequately evaluate the time and effort devoted to specific operations in the planning process. Accordingly — following discussions with the Special Projects Office of the Navy — it was decided to attempt a PERT-type analysis of the complete planning process. This, if successful, would provide a quantitative method of determining the critical path for planning within a given Technical Service and for the total planning process.

Prepare Concept :
- Preventive Medicine
- Dental
- Veterinary

Compute :
- Casualties
- Whole Blood Requirements
- Fixed Bed Requirements
- Airlift Requirements

Determine Facility Requirements :
- Hospitals
- Storage Space
- Optical Shop Space

Compute Troop List and Personnel Requirements

Compute Class IV Requirements

Write Narrative Statement Including :

1. Summary of mission, applicable directives and policies, assumptions and factors used;
2. Discussion of concept of support;
3. Conclusions as to feasibility, critical elements, pre-D-day requirements and deployments;
4. Recommendations.

Fig. 6—Major Planning Element List — Army Medical Service

Fig. 7—Planning Study in Process

Through a series of Technical Service interviews and the background information obtained on the planning system to date, PERT-type diagrams were developed for each Technical Service planning procedure and the complete planning process. The diagram developed for the CE planning — with the resulting critical path, i.e., that series of activities determining the maximum planning time — is shown in Fig. 8. The left-hand box (event) indicates initiation of the Technical Service planning — the right-hand box (event) represents completion of the Technical Service Annex. Gray boxes represent events occurring within the Technical Service while black boxes represent interactions with other Technical Services. Fig. 9 shows the diagram for the complete planning system with the corresponding critical path. (The original layouts of these diagrams were developed in the E&D Center). The resulting analysis of the PERT type diagrams together with the previous studies provided the basis for selection of the key areas for computerization in the planning process. A list of the program areas so designated is shown in Fig. 10 Detailed model specifications for each area to be computerized were then developed and turned over to the contractor for programming. (The specifications for the TC programs were developed in the pilot study and were programmed for STAG's IBM 7090 computer earlier in the research).

The majority of the programs perform rather simple sorting and arithmetical operations, as illustrated by the functional diagram for computation of theater dry cargo tonnage requirements in Fig. 11. However, specialized programs such as the " Network Analysis " program also perform analytical functions for the planner. This program determines specific rail and highway routings of required tonnages from origins to destinations, consistent with given network restrictions and statements of port capacities and depot requirements. The program provides considerable flexibility for the planner: it permits him to specify both upper and lower bounds on links in the network, thus ensuring that militarily desirable links are utilized if desired; it also permits the

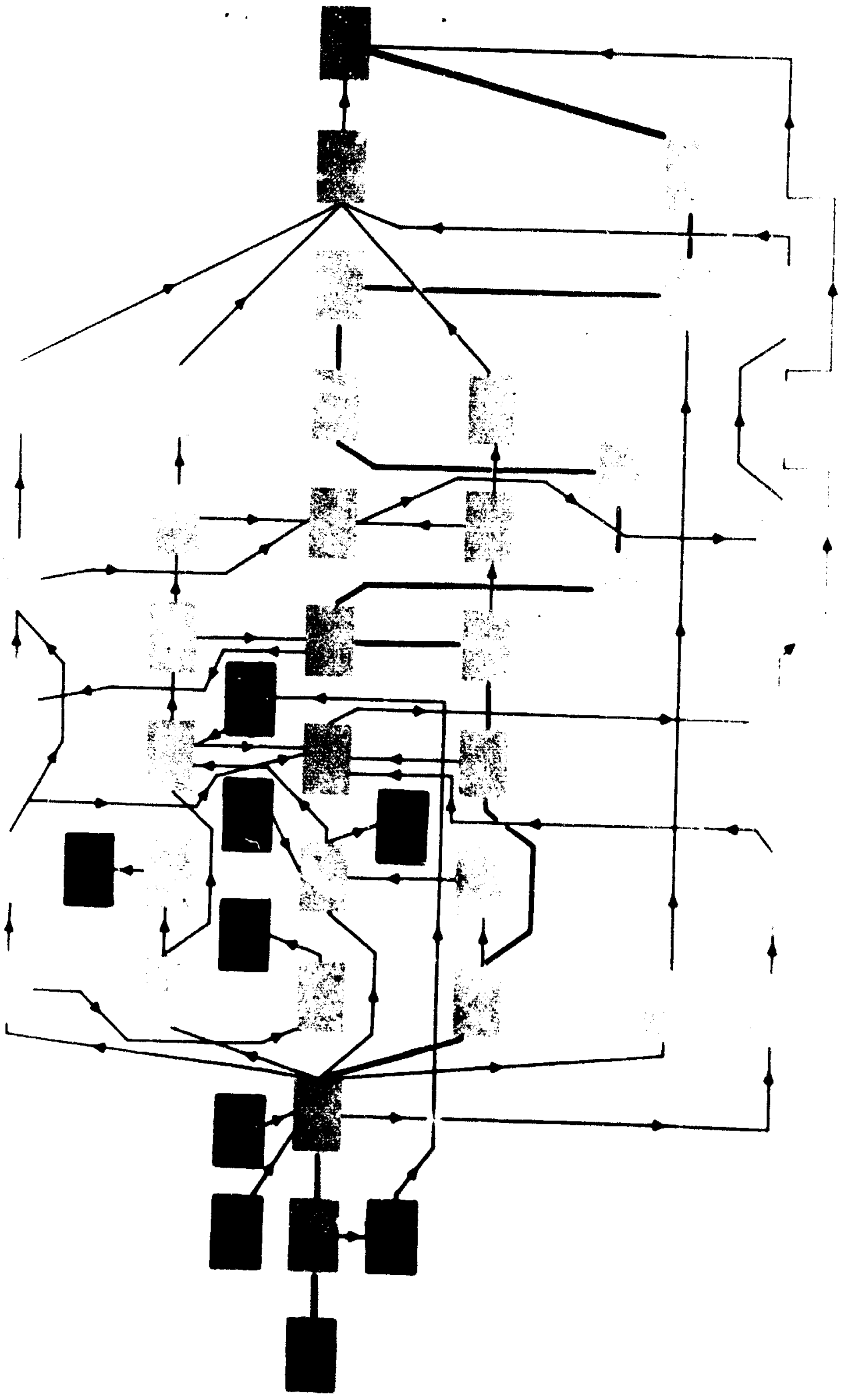

Fig. 3—PERT Diagram of CE Planning Procedure

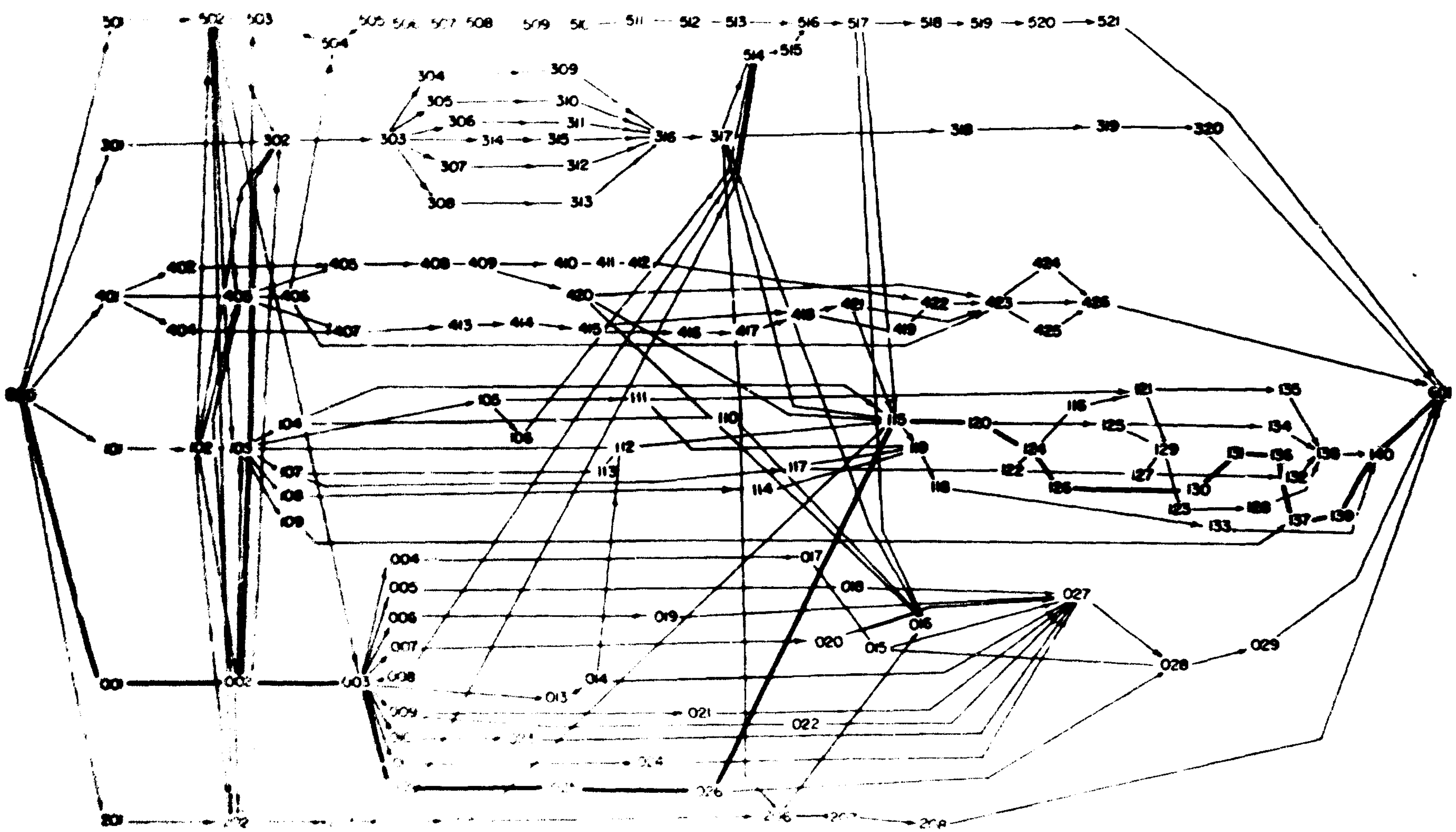

Fig. 9—Integrated PERT Diagram for Complete Planning Procedure

1. TOE
2. CASUALTY AND HOSPITALIZATION
3. AIRFIELD CONSTRUCTION
4. POL COMPUTATION AND APPORTIONMENT
5. CONSTRUCTION TASKS
6. COMBAT TASKS
7. DRY CARGO COMPUTATION
8. DRY CARGO APPORTIONMENT
9. NETWORK ANALYSIS
10. FUNCTIONAL COMPONENT

Fig. 10 —System Programs

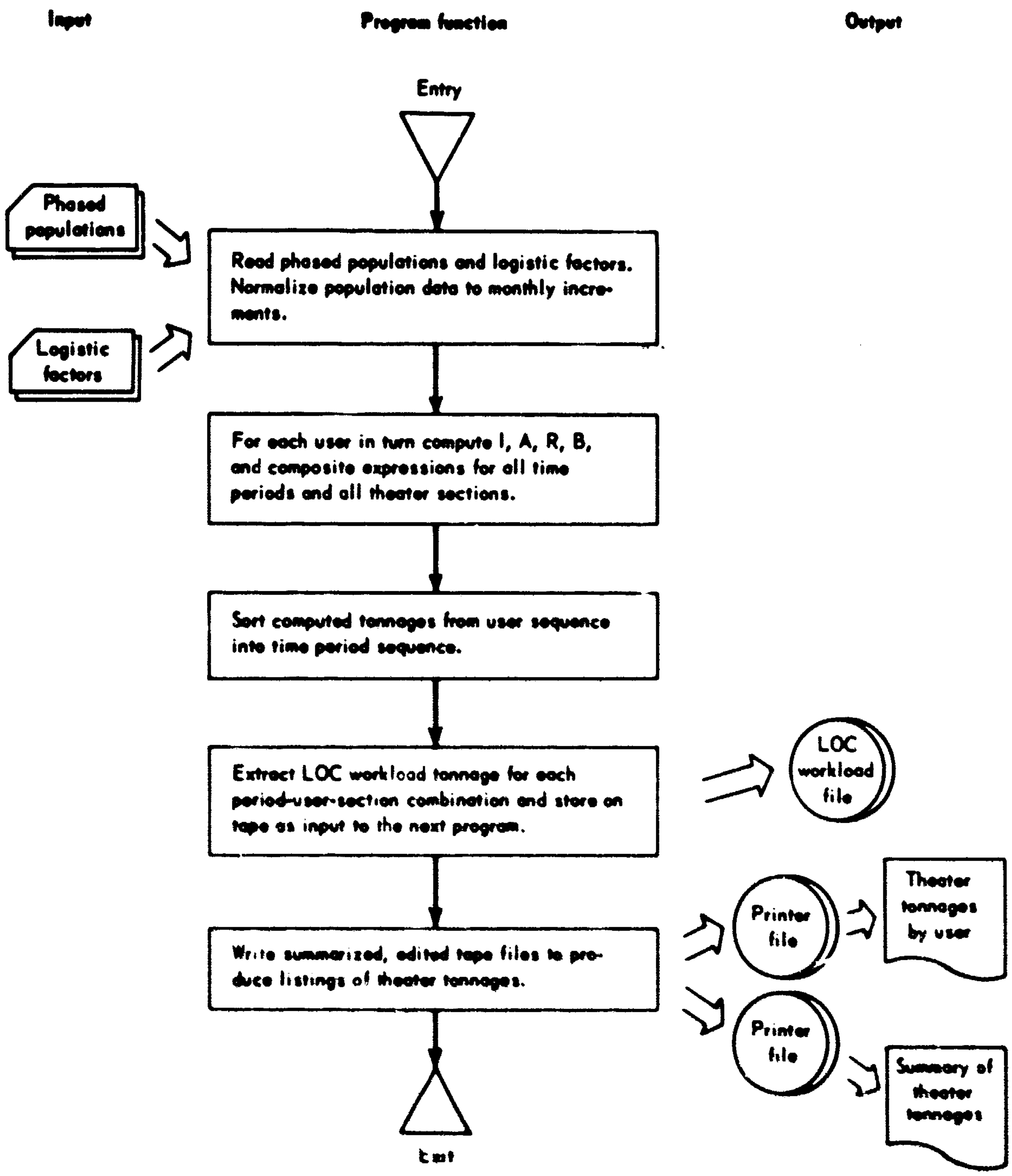

Fig. 11—General Flow Chart for Dry Cargo Computation Program

planner to specify the priority he wishes to place on meeting specific depot demands. Subject to the previous constraints, the program determines routings on a minimum ton-mileage basis.

Each of the programs listed in Fig. 10 is a basic system component requiring input prepared by the planner from basic guidance, planner decisions, or planner-reviewed output from a previous program. The output of each pı ɔgram may be both a printout of results of computations and a tape record for use in a succeeding program. Although the flexibility of separate programs permits a ·ariety of system configurations, Fig. 12 schematizes one manner in which basic system components fit into the complete computer-assisted planning system.* Here the development of a plan follows through a progression of levels — the exact number of levels depending on the complexity of the particular support situation. For simplicity two levels are shown in the figure. In the first level illustrated a TOE list is obtained utilizing programs and analysis requiring a minimum of sophisticated input. The resulting list is compared with the initial assumption of support slice, i.e. the assumed Technical Service population. The original input population is then adjusted and the iterative process continued until the population figures are in reasonable agreement. At this stage the second-level programs are utilized, generally these programs are more complex and require a fairly complete understanding of the total support problem. For example, construction requirements are now computed, the specific LOC pipeline construction requirements having been obtained in the first level. Final TOE's are then generated, Class IV requirements being concurrently generated by the various 'k analysis programs.

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* This figure also illustrates the manner in which human decision and review is combined with the supporting computer programs. The boxes denote specific planning tasks — the shaded ones indicating those tasks performed by computer programs and the light boxes signifying others performed by the planner. The circles represent outputs from a computer program or planner analysis. The dotted line separates the system from its external data sources and final outputs.

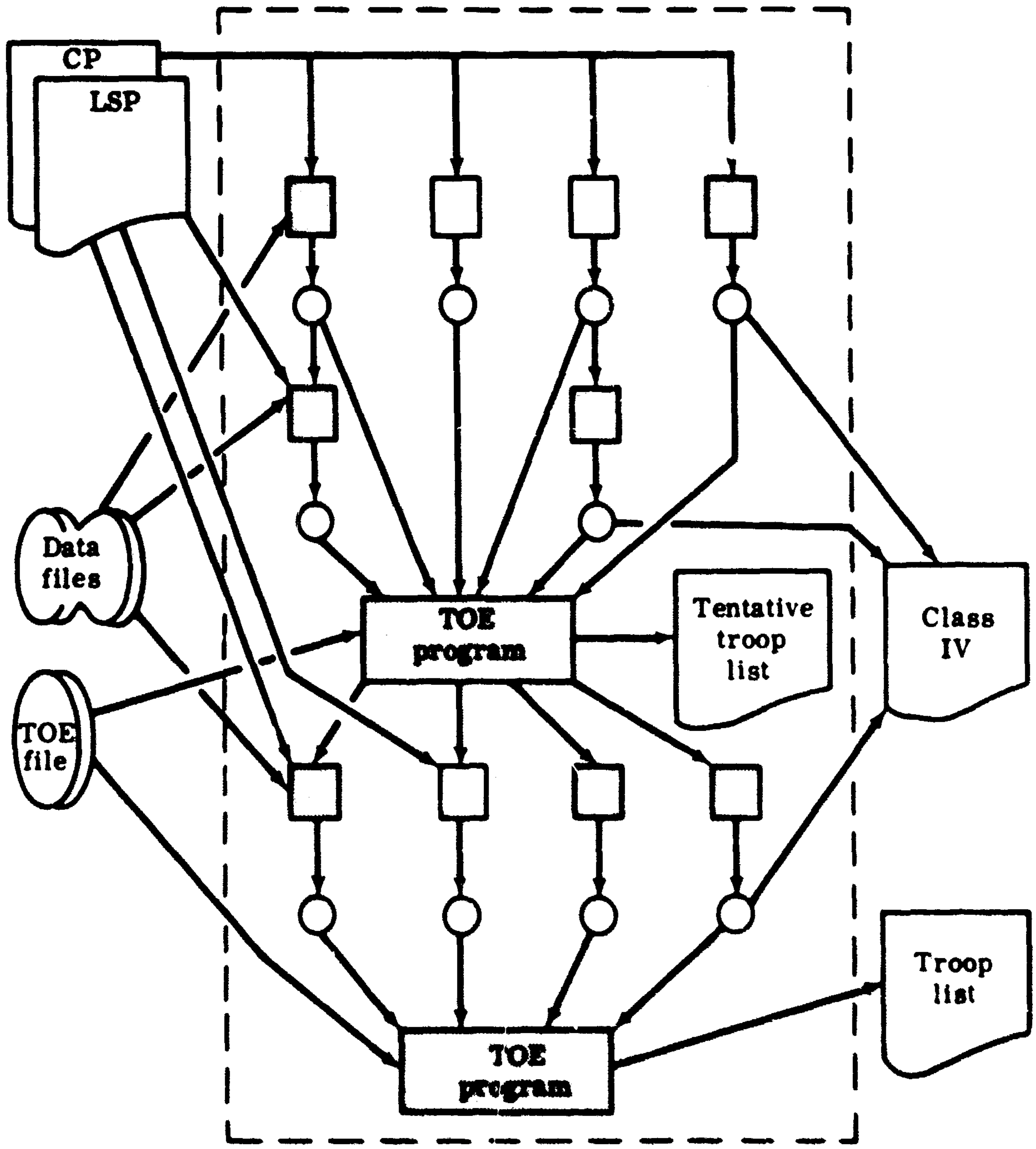

Fig. 12—Computer-Assisted System

The foregoing discussion of the complete system has been of necessity abbreviated and simplified. All programs provide for individual evaluation of tasks or workloads. Imbalances in the number of type of support troops can thus be investigated at any state. In addition the system provides a basis for rapid feasibility analysis as illustrated in Fig. 13. Here the transportation capabilities for a given support operation are first investigated. Should an infeasibility exist, additional routes or ports might be studied or a decision to develop additional pipeline facilities may be made. If the infeasibility is resolvable the planning operation then proceeds as in the previous discussion.

The physical facilities of the new planning system are depicted in Fig. 14. This is a schematization of a war planning room at STAG. "Shake-down" exercises will be conducted here by representatives of RAC, DCSLOG, and the cognizant military planning staffs when programming is completed for all models in 1963. In the meantime, tests are being conducted on programs already operational. Sufficient experience now exists to indicate that the new planning system will meet its objectives; planning time should be substantially reduced from 6 to 8 weeks to 2 to 3 weeks, a new capability will exist to consider alternative concepts of support and assumptions in development of requirements, and the military soundness of plans should be improved.

ADDITIONAL AREAS OF APPLICATION

Although the system described has been developed primarily for strategic planning its capabilities are planned for additional uses. The planning procedure described, for example, has many similarities with Army contingency planning. In this case, however, current manpower and materiel capabilities have a more central role and are introduced to evaluate feasibility of planned operations. The applicability of the

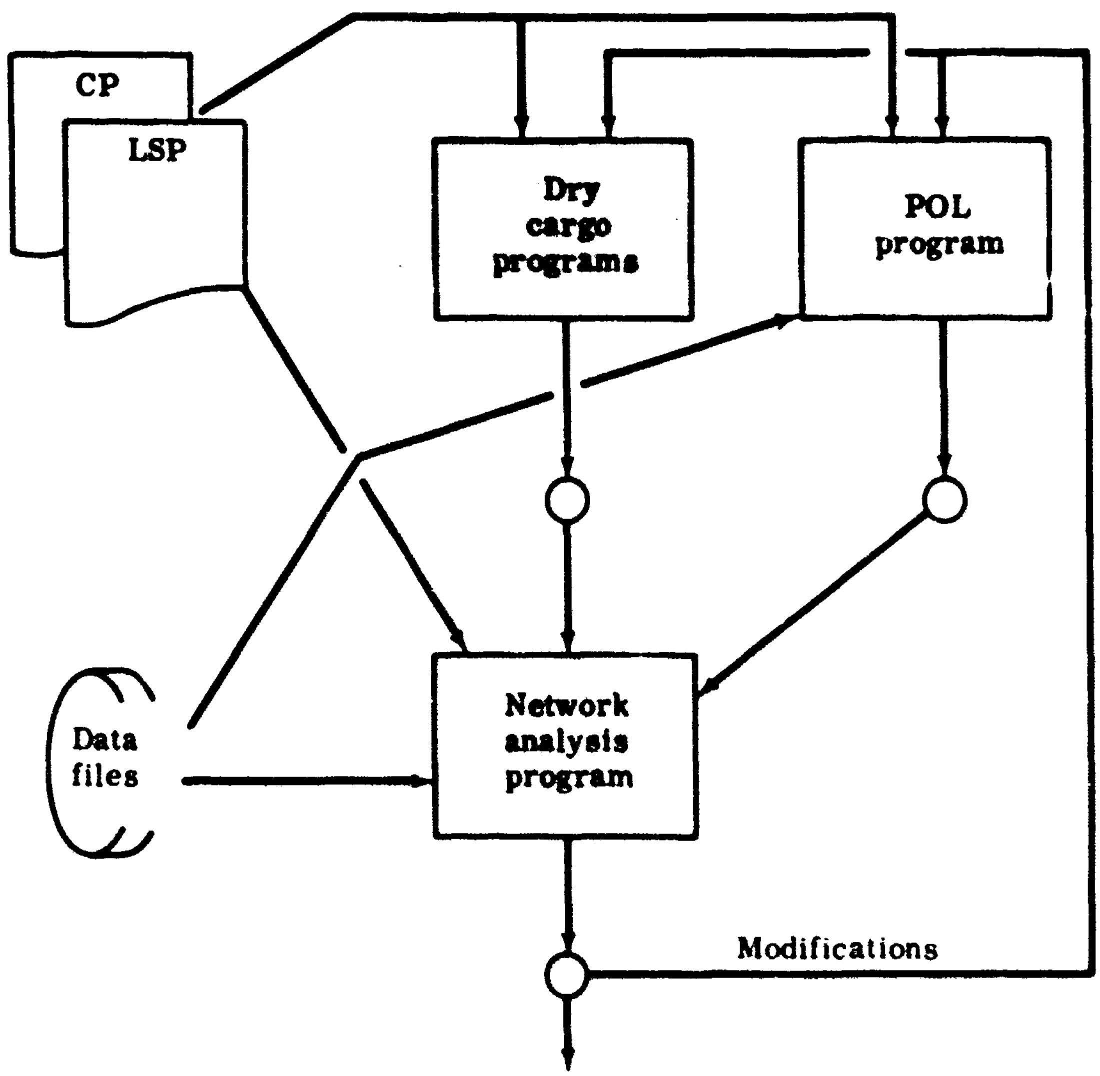

Fig. 13—Feasibility Analysis

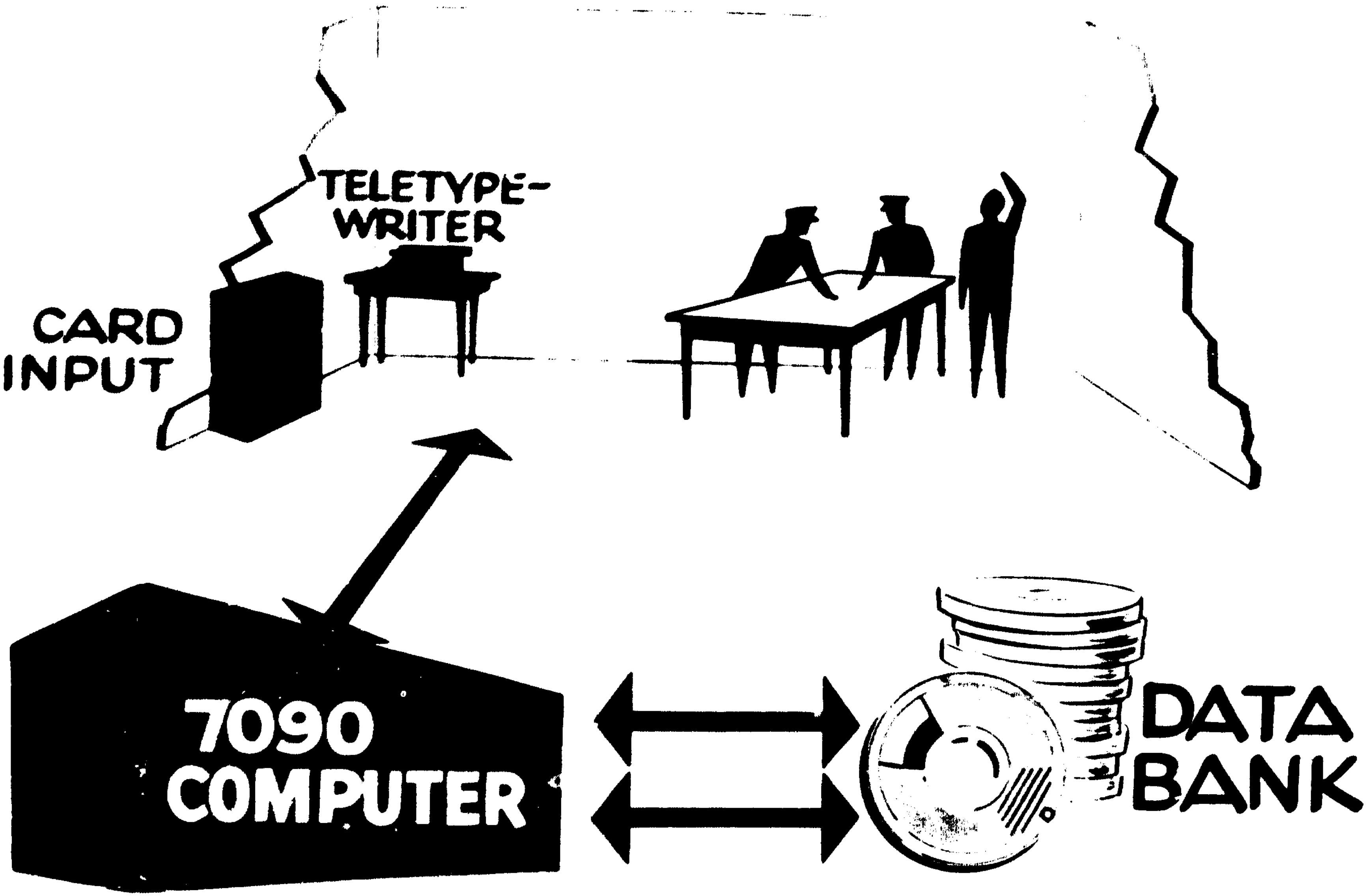

Fig. 14—Planning Room

system to such planning has had some preliminary evaluation. Results of RAC's development of the computer-assisted planning system were made available to a contractor developing such a planning system for another Service. This contractor has indicated a possible year's saving in development time through the use of RAC's results.