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An On-Line Information System for Army Force Planners

RAC

ECONOMICS AND COSTING DEPARTMENT
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An On-Line Information System for Army Force Planners

by
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CRDSTA

1. RAC-TP-364, "The On-Line Version of RECAP: A Quick Response Information System for Army Force Planners," was prepared by the Research Analysis Corporation. The purpose of the paper is to discuss the method of information retrieval using data available at the time of model development. At the present time, the Studies and Models Group, Force Planning Analysis Directorate, OAVCSA, is updating the RECAP data and modifying the list of measures. The combat modules and selected optional elements are battalion size and smaller and include those found in the Modular Force Planning System. The two models can thus complement each other. It is anticipated that the RECAP model, used with experienced judgment, will provide the Army force planner with a cost effectiveness tool for the selection of the preferred force structure from a set of alternatives. Although the on-line version of RECAP has a real advantage in speed of response and orientation, the iterative use of the Prototype RECAP model in "batch" mode is still practical for the Army force planner.

2. The findings of this report are not to be construed as an official Department of the Army position.

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:

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FOREWORD

This paper describes a man-machine interactive aid to Army force planners. The originators of the RECAP (Resources and Capabilities) Model—A. J. Pellegrini, T. Mahar, and R. B. Hamm—saw the need for a mode of operation that would provide the military force planner with a response in a matter of seconds instead of hours, or sometimes days, as in the usual printout system or "batch mode."* It was also thought that the model should be largely self-teaching, allowing the planner to attack his problem directly and eliminating the need for a programmer or computer specialist in formulating a problem.

In May 1968, RAC acquired a cathode ray tube (CRT) graphical display terminal and computer, and it was determined that this system possesses the capabilities required for an on-line version of RECAP, with estimated response times on the order of a few seconds.

In the following 3 months, Robert Hamm designed and implemented the version of RECAP described in this paper. Concurrently Anthony Pellegrini designed and Robert Hamm implemented a system of automated updating of the RECAP library, using existing Army files. (This updating is not discussed in this report.)

Arnold Preachen
Head, Economics and Costing Department

*A "batch" system is the mode of computing used most often at present. It typically has the following characteristics:

(1) The problem solver prepares his data on some type of coding sheet, which is punched onto IBM cards.

(2) Special control cards are added to the data cards, which together with the computer program are submitted to a computer dispatcher.

(3) At some later time the problem is run on the computer.

(4) When the problem solver receives his results, he may find that:

(a) the data were punched incorrectly, or

(b) the data were prepared incorrectly, or

(c) the answers he has received suggest new possibilities for the solution to his problem, in which case the entire process is repeated with variations.

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An On-Line Information System for Army Force Planners

ABBREVIATIONS

CDC	Control Data Corporation
CONUS	continental US
CRT	cathode-ray tube
IBM	International Business Machines Corporation
ICE	index of combat effectiveness
RECAP	resources and capabilities
SP	self-propelled
SRC	standard requirement code

ABSTRACT

This paper describes an information system called RECAP (REsources and CAPabilities) designed to assist military planners by providing immediate, easy-to-understand displays to aid in the comparison of Army force-structure alternatives. The version of the model described herein is a follow-on to the original batch system completed under the FOREWON II research program sponsored by the Force Planning Analysis Directorate of the Chief of Staff, US Army.

A cathode-ray tube (CRT) remote terminal facilitates man-computer interaction and improves the speed of system responses. The CRT accepts all procedural instructions for the use of the model, enabling the system to be used even by Army planners who know nothing about computer programming or programming languages.

As a force-planning tool, both versions of RECAP are designed to be used in conjunction with other existing planning models. The information provided by the model is only one of the kinds of information needed for Army force planning. Alternatives are compared with this system on the basis of their relative differences in physical capabilities and cost. Other more time-consuming techniques and models will ordinarily be employed to analyze in detail those alternatives that appear most promising on the basis of RECAP output.

Only the on-line version of RECAP is described in this paper. The reader is referred to "The Prototype RECAP Model: An Aid to Army Force Planning," RAC-R-61,[1] for a more detailed explanation of the concepts involved in the model. RAC-R-61 also describes the planning environment generating the need for the model and the operation of the model in a batch processing mode on an IBM 7044. Both versions of the model are intended to provide a demonstration of system potential. Data were collected for only a small number of Army force units.

Chapter 1

INTRODUCTION

RECAP is the acronym given to a model designed to assist in the preliminary stages of Army force-structure planning by providing information on both the resource requirements and the capabilities of alternative Army force structures. (See Ref 1 for the basic documentation of the model.) The model operates mainly as an information-retrieval system. It serves as a framework for organizing a wide variety of quantitative planning data on individual Army force units and performs the computations necessary to relate this information to entire theater-, corps-, division-, or brigade-sized force-structure alternatives.

The primary purpose of the model is to allow a rapid analysis of many alternatives in the early stages of the force-planning process. It does this by bringing together, in a preassembled library, information on Army force units that has heretofore been scattered throughout many Army agencies.

Model operation has been designed for simplicity. To use RECAP the military analyst postulates any alternatives that he feels should be considered. Alternatives consist of different numbers and mixes of force units. The model provides as output, through a CRT, a visual display of values showing both the resource requirements and the physical characteristics of each force alternative specified; included are measures such as cost, firepower potential, total number of vehicles of various categories, and measures of mobility. When several alternatives have been selected, the output values are displayed in parallel for ease of comparison. Figure 1 shows the Control Data Corporation (CDC) 1700 CRT in use. Table 1 lists the force units that the analyst uses to form alternatives. They are generally of battalion or division-base size except for aircraft companies, which are separately identified.

The set of resource and performance measures that can be provided as output are listed in Table 2. These are measures such as total 5-year cost, number of C-5A's required for strategic lift, antipersonnel firepower potential, and maximum simultaneous troop-lift capacity. In any iteration of the model the user would select from this list those measures of significance to the problem at hand. Most of the data in the model library is separately maintained by Army agencies for other purposes and is available on magnetic tape, thus easing the process of periodic update.

The profiles of the selected measures for each postulated force alternative are used by the planner to determine which alternative, in his judgment, best satisfies the requirements of the problem scenario.

Fig. 1—CDC 1700 CRT in Use

The model itself does not in any sense optimize or automatically select the best alternative. It simply provides information. Because of this, it should be used iteratively, the results of one iteration being analyzed and used as the basis for making succeeding iterations, which are in turn analyzed. In the initial stages of planning, Army force-structure problems are likely to be defined only very loosely, so that the first iteration may provide information that stimulates suggestions for changing the size or mix of alternatives to make them more suitable. Using the RECAP model, the military planner himself makes the judgments required to choose the best of the alternatives in view of the problem scenario and on the basis of the relative differences in the

TABLE 1

Army Force Units in Data Library of Prototype RECAP Model

SRC[a] number	Common unit name
	Combat Base Units
07000E320	Infantry division base
07100E310	Separate infantry brigade base
17000E310	Armored division base
37000E310	Infantry mechanized division base
57000F500	Airborne division base
57100F500	Separate airborne brigade base
67000T500	Airmobile division base
77100T500	Light infantry brigade base
	Maneuver Elements and Divisional Subunits
01055F50.	Aviation battalion, airborne division
01075E300	Aviation battalion, infantry division
01077E300	Airmobile company, light
01100T500	Aviation group, airmobile
01127D100	Aviation company corps
01128T500	Aerial surveillance company
01137D100	Aviation company army
01258F500	Aviation medium helicopter company
05025F500	Engineer battalion, airborne division
05155E320	Engineer battalion, infantry division
05215T500	Engineer battalion, airmobile division
06155E300	Howitzer battalion, 105-mm, towed, infantry division
06165E300	Howitzer battalion, 155-mm, 8-in., towed, infantry division
06215F500	Howitzer battalion, 105-mm, towed, airborne division
06405D100	Field artillery battalion, howitzer, 105-mm, towed
06425D010	Field artillery battalion, howitzer, 155-mm, self-propelled (SP)
06425D020	Field artillery battalion, howitzer, 155-mm, towed
06435D300	Field artillery battalion, 175-mm, SP
06445E300	Field artillery battalion, 8-in., SP
06705T500	Howitzer battalion, 105-mm, towed, airmobile division
06725T500	Aerial rocket battalion, airmobile division
07015E300	Infantry battalion
07035F500	Airborne infantry battalion
07045E300	Mechanized battalion
07055T500	Airmobile/airborne infantry battalion, airmobile division
07175T500	Light infantry battalion
17035E300	Tank battalion
17051E500	Armored cavalry regiment
17055E500	Armored cavalry squadron, separate
17105E300	Armored cavalry squadron, division
17095T500	Cavalry squadron, airmobile division

[a]Standard requirement code.

TABLE 2

Measures in Data Library of Prototype RECAP Model

Description of measures	Measure code[a]
Total 5-year cost, millions, CONUS[b]	M9000
Initial investment cost, CONUS	M1
Annual recurring cost, CONUS	M16
C-5A's required for outsized equipment	M100
C-5A's required for balance equipment	M101
C-141's required for balance equipment	M102
Total officers	M120
Total enlisted men	M125
Total strength	M130
Procurement of equipment and missiles, Army, equipment combat consumption, thousands of pounds/month	M110
Activation lead time, weeks	M140
Firepower potential, antipersonnel, indirect fire weapons	M201
Firepower antipersonnel, line-of-sight weapons less tanks and aircraft	M200
Firepower potential, antipersonnel, tanks	M202
Firepower potential, antipersonnel, aircraft armament	M203
Total, antipersonnel firepower potential	M204
Firepower potential, antipersonnel, SP[c] weapons	M2041
Firepower, antiarmor, aircraft armament	M206
Firepower, antiarmor, SP weapons	M207
Firepower, antiarmor, other weapons	M208
Firepower, total antiarmor	M209
Firepower, total ICE,[d] antipersonnel plus antiarmor	M210
Fixed-wing aircraft	M301
Observation (O) helicopters	M3011
Utility (U) helicopters	M3041
Cargo (C) helicopters	M3061
Helicopters, UH-1B	M304
Helicopters, UH-1D	M307
Medium transport helicopters, CH-47	M306
Aircraft of all types	M300
Crew-served weapons, less than .60-cal	M310
Artillery tubes, 155-mm and greater	M312
Artillery tubes, less than 155-mm	M313
Mortars, (60-, 81-, 107-mm, 4.2-in.)	M314
Antiarmor weapons, not including tanks or aircraft	M315
Tanks	M316
Armored personnel carriers, M113, M114, M577	M317
Trucks, ¼-, ¾-ton	M323
Trucks, 2½-ton	M324
Trucks, 5-ton and greater	M325
Trucks, all types	M321
Trailers, all types	M322
Payload capacity on highway, wheeled cargo vehicles	M650
Payload capacity on poor roads, wheeled cargo vehicles, tons	M651
Weight of wheeled cargo vehicles, lb	M670
Weight of tracked cargo vehicles, lb	M671
Weight of all weapons, lb	M673
Maximum simultaneous troop lift	M690
Maximum simultaneous cargo capacity by air, tons	M691
Armored-carrier capacity, personnel	M700

[a]For purposes of automation each measure has been assigned a code designation. This code consists of the letter "M" followed by a unique number of four digits or less.

[b]Continental US.

[c]Self-propelled.

[d]Index of combat effectiveness.

quantitative cost and performance indicators. Those alternatives that seem most promising on the basis of a comparison of the indicators provided from the RECAP library can then be subjected to a more detailed and time-consuming analysis, perhaps involving war gaming or simulations. Figure 2 shows an example of the model output.

ALT NO.	ELEMENT NAME	QNTY	M9000 TOTAL 5 YEAR COST	M130 TOTAL STRENGTH	M120 TOTAL NUMBER OF OFFICERS	M125 TOTAL NUMBER OF ENLISTED	M210 FIREPOWER TOTAL ICE AP + AA
A1	INF DIV BASE	1.00	449.80	7912.00	723.00	7189.00	13.2
A1	INF BN	9.00	291.60	7461.00	351.00	7110.00	10.0
	FORCE TOTALS		741.40	15373.00	1074.00	14299.00	23.2
A2	INF BDE BASE	3.00	324.90	5814.00	534.00	5280.00	11.8
A2	INF BN	9.00	291.60	7461.00	351.00	7110.00	10.0
	FORCE TOTALS		616.50	13275.00	885.00	12390.00	21.8
A3	INF BDE BASE	2.00	216.60	3876.00	356.00	3520.00	7.9
A3	INF BN	6.00	194.40	4974.00	234.00	4740.00	6.7
A3	ABN BDE BASE	1.00	78.50	1587.00	144.00	1443.00	2.5
A3	ABN BN	3.00	102.90	2376.00	114.00	2262.00	3.2
	FORCE TOTALS		592.40	12813.00	848.00	11965.00	20.3
A4	LT BDE BASE	3.00	199.80	4527.00	417.00	4110.00	6.5
A4	LT INF BN	9.00	250.20	6921.00	342.00	6579.00	5.2
	FORCE TOTALS		450.00	11448.00	759.00	10689.00	11.7
A5	INF DIV BASE	1.00	449.80	7912.00	723.00	7189.00	13.2
A5	INF BDE BASE	-1.00	-108.30	-1938.00	-178.00	-1760.00	-3.9
A5	INF BN	6.00	194.40	4974.00	234.00	4740.00	6.7
A5	LT BDE BASE	1.00	66.60	1509.00	139.00	1370.00	2.2
A5	LT INF BN	3.00	83.40	2307.00	114.00	2193.00	1.7
	FORCE TOTALS		685.90	14764.00	1032.00	13732.00	19.9

Fig. 2—Sample Output of RECAP Model

Five division-sized alternatives.

A feature called the force-adjustment option facilitates the choice among the force alternatives. This feature assists the user in formulating the alternative force structures in terms of either an equal-cost or an equal-capability framework. If alternatives are formed on the basis of equal cost, for example, the selection would be made on the basis of the differences in capability profiles. This option is explained in detail later in the paper.

Chapter 2

RATIONALE FOR THE ON-LINE VERSION

TIME REQUIRED FOR ANALYSIS

The model was first developed for the batch operating mode, and it is this mode that is documented in RAC-R-61.[1] The time involved in setting up the input data for any one run of the model in the batch mode is usually less than 1 hour. It was found, however, that actual use of this version of the model often required a week or more to make several iterations. This time was taken largely by waiting for access to the computer. Often, because of a minor input error, an entire day would elapse before results could be obtained. This affliction of course affects most models that use a computer in the batch mode. A model that is designed to be used iteratively suffers multiplication of the waiting. The observed effect of this slow response when using the RECAP model is that analysts tend to formulate fewer alternatives and make fewer iterations than they might if the response time were quicker. Moreover, the alternatives most likely to be dropped from analysis are the ones that involve the most radical departures from existing structures; among these may be the very alternative offering the potential for greatest improvement.

This observed effect is compounded by the fact that RECAP is an information model and does not automatically compute and display an optimum force-structure alternative. It requires instead that the analyst make judgments and decisions (often difficult ones), guided by the multifaceted information displayed. As has been observed:

> Rarely does one recognize or discover a complex problem, formulate it, and lay out a procedure that will solve it—all in one great flash of insight. Usually it is necessary to go through several or many steps of planning, formulating, calculating, evaluating, and replanning—sometimes progressing, sometimes retreating to mount a new attack, sometimes bogging down in what may seem to be endless interaction or recursion or search before hitting upon the path that leads to satisfaction.[2]

Because the model is most effectively used in an iterative fashion, and because human judgment and interaction are required at the end of each step, the model was reprogrammed for use on a remote terminal with visual display to make it easier to use, to speed its response, and thus to encourage use of the model in this iterative fashion.

LEARNING TO USE THE RECAP MODEL

The on-line version was designed to significantly reduce the time required to learn to use the model. To use the batch version:

(a) A force planner must first derive sufficient knowledge from manuals about RECAP to determine how it is used for force-planning problems.

(b) Data cards must be prepared that specify his problem in the detailed format acceptable to the batch mode RECAP.

(c) Computer system control cards must also be prepared and added to the data cards.

(d) A form must then be filled out telling the computer operator which magnetic tapes are to be used and other information about running the job.

A force planner using the batch mode must therefore either know about computers or work with a computer analyst or programmer in using the model. Even working with a computer analyst, the force planner would probably require several days of experimentation to fully understand the RECAP model.

The on-line version attempts to achieve more of a man-computer symbiosis, allowing the force planner to state his problem more directly. All instructions for use of the model are displayed on the screen in a step-by-step fashion so that military planners need know nothing about computers or programming in order to make use of it, thus obviating the need for a computer specialist. It requires no handling of card decks or keypunching. Learning is quick; it was found in testing the system that personnel with no background in data processing could master the use of the system within half an hour. It is virtually impossible to make an error fatal to the program, so that a planner need not feel constrained in learning to use the model.

COMPARATIVE COST

The on-line version of RECAP has proved to be cost competitive with the International Business Machines Corporation (IBM) 7044 and S/360 batch combination for solving problems. A problem with three alternatives and five Army forces per alternative was run with the times and charges shown in the accompanying tabulation.

Problem mode	Computer	Relative computer size	Monthly rental, dollars	Hourly charge,[a] dollars	Problem execution time, min	Total problem, charge, dollars
Batch[b]	IBM S/360, model 30	Small scale	9,200	90	2	3.00
	IBM 7044	Medium scale	39,500	264	2–3	+ 9.00–13.00
						12.00–16.00
On-line[c]	CDC 1700, digigraphic system	Small scale	7,000	65	5–10[d]	5.50–11.00

[a]Including overhead.

[b]The batch-mode combination requires an IBM S/360 for card input and printer output and an IBM 7044 for computation.

[c]The on-line mode version makes extensive use of a random access device (disk) whereas the batch-mode version uses only magnetic tape drives.

[d]This figure varies with the experience of the user and the time spent analyzing results.

One should not generalize from these results that on-line operation is less expensive than batch-mode operation. On the contrary, on-line operation is often more costly (considering only computer charges), especially for large problems.[3-6] What these results do show is that models such as RECAP can be run economically in an on-line mode.

CONCLUSIONS

On-line operation has definite advantages for the Army force planner over the batch mode of operation. With on-line operation he may pose his questions to the computer directly and receive his answers in seconds. An on-line model can be self-teaching, requiring no previous knowledge of the model and relieving the Army force planner of reading manuals. The immediacy of response allows the planner or problem solver to consider many more alternatives within his time constraints than could be considered with the batch mode of operation. The version of RECAP described in his paper is an attempt to demonstrate the advantages of on-line operation for an initial phase of force planning.

Chapter 3

PROCEDURES FOR USE OF THE ON-LINE VERSION OF THE RECAP MODEL

The model program deck and data base are stored on disks. (The same data base is used for the on-line and batch versions of RECAP, although data-accessing techniques are significantly different.) At the command *RECAP, given by the user through the teletypewriter, a message appears on the screen, explaining the use of the CRT and light pen (Fig. 3). All further data and instructions to be given by the user of the model to the program are given with the light pen. In other words, if the reader were now sitting in front of the CRT with the light pen in his hand, he would be led, depending on the choices he himself made, through the various steps discussed (less quickly and graphically) in the several pages of the remainder of this chapter.

When the user points the pen at the word PROCEED, the message on the screen changes (Fig. 4) and he is asked whether he desires to see a brief explanation of the purpose of the model. A YES produces the text appearing in Fig. 4.

The next display, Fig. 5, allows the user of the model to begin structuring alternatives. Five steps to be followed are given at the top of the screen. The user selects those force units to be incorporated in his alternatives from the list of units in the column on the right.

The user first points the light pen at one of the elements (A1, A2, ..., A9) found at the bottom left of the screen. These serve to indicate that a particular force unit (the one to be selected next) is part of alternative A1, alternative A2, or one of the other alternatives. Up to nine alternatives can be investigated in any one iteration.

Next, the user points the pen at one of the force units, e.g., 0700E320 INF DIV BASE. The number in front of the name is the SRC identifying the force unit. The list of units pictured in Fig. 5 is only one page of the total list of units available. Other pages can be brought to view by pointing at either page FORWARD or page BACK. After selecting the unit, the user specifies how many of these units are to be in the alternative. He does this by pointing the pen at one of the numbers listed under the word QUANTITY. To specify a quantity with more than one digit, he would point the pen at the first digit of the number, then the second, and so forth, until the entire number was formed.

I WILL ASK YOU A SERIES OF QUESTIONS.

CHOOSE AN ANSWER WITH THE LIGHT PEN.

TRY TO AIM THE LIGHT PEN SO THAT IT IS PERPENDICULAR TO THE SCREEN, THEN PUSH THE BUTTON ON THE PEN AND HOLD IT UNTIL THE SCREEN FLICKERS. IF NOTHING HAPPENS MOVE THE PEN BACK AND FORTH.

AIM THE PEN AT THE WORD --PROCEED-- WHEN YOU ARE READY

PROCEED

Fig. 3—Initial Message

NOT REPRODUCIBLE

WOULD YOU LIKE AN EXPLANATION OF RECAP

YES NO

a.

RECAP HAS BEEN DESIGNED TO AID ARMY FORCE PLANNERS BY PROVIDING INFORMATION ON BOTH THE CAPABILITIES AND THE RESOURCE IMPLICATIONS OF CANDIDATE FORCE ALTERNATIVES. THE ALTERNATIVES WILL CONSIST OF DIFFERENT MIXES OF FORCE UNITS SELECTED FROM THE LIST THAT WILL BE PROVIDED.

AFTER OBTAINING INITIAL RESULTS, THE PLANNER MAY THEN MODIFY HIS ALTERNATIVES AND REPEAT THE PROCESS UNTIL HE HAS FOUND AN ACCEPTABLE SOLUTION TO HIS PROBLEM.

PROCEED

b.

Fig. 4—Explanation of Model's Purpose

STEPS TO BE FOLLOWED

1. SELECT AN ALTERNATIVE(A1,A2,...)
2. SELECT AN SRC FROM THE TABLE
3. SELECT A QUANTITY
4. ACCEPT OR REJECT THE FORCE UNIT
5. REPEAT THE ABOVE STEPS AS NECESSARY

ALT NO.	DESCRIPTION	QUANTITY

SRC TABLE

07000E320	INF DIV BASE
07100E310	INF BDE BASE
17000E310	ARMD DIV BASE
27000E310	MECH DIV BDE
57000F500	ABN DIV BASE
57100F500	SEP ABN BDES
67000T500	AMB DIV BASE
771007500	LT INF BDE BA
01056F500	AVN BN, ABN D
01075E300	AVN BN, INF D
01077E300	AMB CO, LT
011007500	AVN GP, AMB
011270100	AVN CO CORPS
011207500	AER SURV CO
011270100	AVN CO ARMY
012007500	MED HCPTR CO
06020F500	ENGR BN ABN D
06150E320	ENGR BN INF D
06215T500	ENGR BN AMB D
06150E300	NGN BN 10GMV

PAGE = BACK FORWARD

ALTERNATIVE

A1 A2 A3 A4 A5 A6 A7 A8 A9

QUANTITY

0 1 2 3 4 5 6 7 8 9 . BACK

ACCEPT NEW FORCE UNIT

REJECT NEW FORCE UNIT

DELETE SPECIFIED FORCE UNIT

ALTERNATIVES COMPLETE

Fig. 5—Structuring Alternatives

NOT REPRODUCIBLE

By pointing the light pen at ACCEPT NEW FORCE UNIT, he indicates that no mistakes have been made and that he is satisfied with the unit. By pointing the pen at REJECT NEW FORCE UNIT, he can start over again and change the quantity, the unit, or the alternative designator.

The user repeats these steps for each force unit that he wishes to include in the alternative. There is no limit to the number of force units per alternative. He then specifies the units and the quantities in succeeding alternatives. Figure 6 illustrates a completed set of alternatives.

After completely specifying the alternatives, the user points the light pen at ALTERNATIVES COMPLETE. This produces the list of resource and capability measures for which data can be provided through the model. He chooses those of significance to the scenario at hand. Figure 7 shows the original list on the right and a selected list on the left. The original list of measures is also contained on several pages. The user can see other pages of available measures by pointing at either FORWARD or BACK on the page control under the list of measures.

After selecting measures, the user is asked (Fig. 8) whether he would like to employ the force-adjustment option (or pivot option). This option allows the user to modify the size or mix of the alternatives until each alternative is equal in a designated "pivot" measure. When he points the pen at EXPLAIN, a description of the force-adjustment option will flash on the screen.

If the force-adjustment option is taken, the list of indicators selected previously is shown again on the screen (Fig. 8). The pivot measure is chosen by pointing the light pen at the designated measure. Only one measure at a time may be a pivot measure.

Following this, the alternatives are brought back to the screen to allow the user to specify how each alternative can be modified to bring the alternatives to parity in the pivot measure. In the remote-terminal version of the model an arbitrary rule is employed that adjusts the alternatives until their pivot value equals the largest pivot value of any alternative. This adjustment takes place by changing the quantities of certain force units within an alternative. The user himself selects the force units to be varied by pointing the light pen at them. An X appears to the left of the quantity when this is done. At least one force unit per alternative must be selected. The quantities of all Xed force units within an alternative will be multiplied automatically by the constant that will make the pivot value of the alternative equal to the largest pivot value of any alternative. When several units within the same alternative are selected, as in A1, A2, and A3 in Fig. 9, the ratios of the quantities of units in the original specifications are preserved after adjustment. In A1, for example, the infantry battalions and tank battalions will be maintained in the ratio of 8 to 2.

Pointing the pen at the word COMPUTE produces the output display (see Fig. 10).

This display shows the three alternatives listed vertically on the left and the measures listed horizontally. Only four measures are displayed at any one time because of limitations in the size of the screen. Output values of the other

STEPS TO BE FOLLOWED

1. SELECT AN ALTERNATIVE(A1,A2,...)
2. SELECT AN SRC FROM THE TABLE
3. SELECT A QUANTITY
4. ACCEPT OR REJECT THE FORCE UNIT
5. REPEAT THE ABOVE STEPS AS NECESSARY

ALT NO.	DESCRIPTION	QUANTITY
A1	INF DIV BASE	1.00
A1	INF BN	8.00
A1	TANK BN	2.00
A2	INF BDE BASE	3.00
A2	INF BN	9.00
A3	ARMD DIV BASE	1.00
A3	TANK BN	8.00
A3	INF BN	2.00

SRC	TABLE
061056200	HOW BN 155MM
062156500	HOW BN 105MM
064050100	FA BN HOW 105
064250010	FA BN HOW 155
064250020	FA BN HOW 155
064350300	FA BN 175MMSP
064456300	FA BN BIN SP
067057500	HOW BN ARMD D
067257500	AIR ROCKT BN
070156300	INF BN
070356500	ABN INF BN
070456300	MECH BN
070557500	ARMD/ABN INFBN
071757500	LT INF BN
170356300	TANK BN
170516500	ARM CAV REGT
170556300	ARM CAV SQD,S
171056300	ARM CAV SQD,D
170057500	CAV SQD ARMD D
000000025	TYPE SPT ABN

PAGE: BACK FORWARD

ALTERNATIVE

A1 A2 A3 A4 A5 A6 A7 A8 A9

QUANTITY

0 1 2 3 4 5 6 7 8 9 . BACK

ACCEPT NEW FORCE UNIT

REJECT NEW FORCE UNIT

DELETE SPECIFIED FORCE UNIT

ALTERNATIVES COMPLETE

Fig. 6—Completed Set of Alternatives

CHOOSE MEASURES OF INTEREST WITH THE LIGHT PEN

M0000 TOTAL SYR COST (MIL) (CONUS)

M100 NO. OF CSAS FOR OUTSZD EQP

M101 NO. OF CSAS FOR BALNCE EQP

M120 TOTAL STRENGTH

M000 MAXIMUM SIMULT TROOP LIFT

M001 MAX SIMULTCGO CAPAC. BY AIR (T)

M3041 NO. OF UTILITY (U) HCPTRS

M3061 NO OF CARGO (C) HCPTRS

M316 NO. OF TANKS

M700 ARMORED CARR CAPAC(PERS)

MEASURE TABLE

M0000 TOTAL SYR COST (MIL) (CONUS)

M1 INITIAL INVESTMENT (CONUS)

M16 ANNUAL RECURRING (CONUS)

M100 NO. OF CSAS FOR OUTSZD EQP

M101 NO. OF CSAS FOR BALNCE EQP

M102 NO. OF C141 FOR BALNCE EQP

M120 TOTAL NUMBER OF OFFICERS

M125 TOTAL NUMBER OF ENLISTED

M120 TOTAL STRENGTH

M110 COMBAT CONSUMPTN THOU-LB/MO

M140 ACTIVATIONLEAD TIME (WEEKS)

M210 FIREPOWER TOTAL ICE AP +AA

M204 FIREPOWER TOTAL ANTI PERSN

M201 FP AP, INDIRECT FIRE WPN

M200 FP AP, SETUPWS, NO TES OR A/C

M202 FIREPOWER AP, TANKS

M203 FIREPOWER AP OF A/C ARMAMENT

M2041 FIREPOWER POTENTIAL SELF PROP.

M200 FIREPOWER TOTAL ANTI ARMOR

M206 FIREPOWER AA OF A/C ARMAMENT

PAGE: BACK FORWARD

DELETE MEASURE

MEASURES COMPLETE

Fig. 7—Original and Selected List of Alternatives

WOULD YOU LIKE TO PIVOT

YES NO EXPLAIN

a.

SELECT THE PIVOT MEASURE

MEASURES SELECTED

x M0000 TOTAL SYR COST (MIL) (CONUS)

M100 NO. OF CSAS FOR OUTSZD EQP

M101 NO. OF CSAS FOR BALNCE EQP

M130 TOTAL STRENGTH

M000 MAXIMUM SIMULT TROOP LIFT

M001 MAX SIMULTCOD CAPAC. BY AIR (T)

M3641 NO. OF UTILITY (U) HCPTRS

M3001 NO OF CARGO (C) HCPTRS

M316 NO. OF TANKS

M700 ARMORED CARR CAPAC(PERS)

ACCEPT

CLEAR

b.

Fig. 8—Force-Adjustment Option

RAC

SELECT FORCE UNITS WHICH CAN BE ADJUSTED

A1	INF DIV BASE	1.00
A1	INF BN	x 0.00
A1	TANK BN	x 2.00
A2	INF BDE BASE	3.00
A2	INF BN	x 0.00
A3	ARMD DIV BASE	1.00
A3	TANK BN	x 0.00
A3	INF BN	x 2.00

DELETE x

COMPUTE

Fig. 9—Adjustable Unit Selection

ALT NO.	ELEMENT DESCRIPTION		ORIG QNTY	ADJ QNTY	TOTAL SYR COST (MIL) (CONUS)	NO. OF CSAS FOR OUTSZD EOP	NO. OF CSAS FOR BALNCE EOP	TOTAL STRENGTH
A1	INF DIV BASE		1.[illegible]	1.00	440.00	26.00	117.00	7912.00
A1	INF BN	x	0.00	0.00	250.20	0.00	32.00	6032.00
A1	TANK BN	x	2.00	2.00	00.00	14.00	54.00	1142.00
					700.00	40.00	203.00	15086.00
A2	INF BDE BASE	x	3.00	3.00	324.00	57.00	63.00	5014.00
A2	INF BN	x	0.00	0.00	201.00	0.00	36.00	7401.00
					616.50	66.00	90.00	13275.00
A3	ARMD DIV BASE		1.00	1.00	400.10	37.00	116.00	8117.00
A3	TANK BN	x	0.00	0.00	300.00	56.00	216.00	4500.00
A3	INF BN	x	2.00	2.00	64.00	2.00	8.00	1826.00
					812.00	95.00	340.00	14343.00

FORWARD BACK

PAGE • 1 2 3 1 2 3

Fig. 10—Output Display

selected indicators can be obtained by pointing at either the FORWARD or BACK page designator. Figure 11 shows some of the other output measures.

ALT NO.	ELEMENT DESCRIPTION		ORIG QNTY	ADJ QNTY	NO. OF CS/S FOR BALNCE EQP	TOTAL STRENGTH	MAXIMUM SIMULT TROOP LIFT	MAX SIMULT CGO CAPAC. BY AIR (T)
A1	INF DIV BASE		1.00	1.00	117.00	7012.00	240.33	82.30
A1	INF BN	x	8.00	10.61	42.44	8795.10	.00	.00
A1	TANK BN	x	2.00	2.66	71.61	1514.49	.00	.00
					231.05	18221.60	240.33	82.30
A2	INF BDE BASE		3.00	3.00	63.00	5014.00	295.00	60.42
A2	INF BN	x	8.00	10.15	72.50	15044.82	.00	.00
					135.50	20058.81	295.00	60.42
A3	ARMD DIV BASE		1.00	1.00	116.00	8117.00	240.33	82.30
A3	TANK BN	x	8.00	8.00	216.00	4560.00	.00	.00
A3	INF BN	x	2.00	2.00	8.00	1650.00	.00	.00
					340.00	14342.00	240.33	82.30

FORWARD BACK
PAGE: 1 2 3 1 2 3

Fig. 11—Additional Output Measures

Note that the alternatives displayed in this instance are equal-cost alternatives (Fig. 10). Each has a purchase cost plus a 5-year operating cost of approximately $913 million. Since the alternatives all cost the same, the analyst can focus on an analysis of the relative differences in the capability indicators.

If the information thus provided to the analyst suggests modifications to alternatives that would better suit the military purpose, he can easily make the appropriate changes. If, for example, he would like to see the effect on alternative A1 of replacing one of the tank battalions by an armored cavalry squadron, he would point at CHANGE ALTERNATIVES and would be returned to the stage in the model allowing him to structure alternatives (Fig. 6). He could then change the alternatives in any way he saw fit. This process of iteration can be continued until the planner arrives at a satisfactory alternative, or a satisfactory set of alternatives, which he can then subject to a more detailed analysis than is possible with the RECAP model.

Chapter 4

DISPLAY SYSTEM

GENERAL DESCRIPTION

The computer system used for the model is the Control Data 1700 digigraphic entry and display system shown schematically in Fig. 12. The digigraphic system enables a user to establish two-way on-line (i.e., immediate) communication with a digital computer in either graphic or alphanumeric

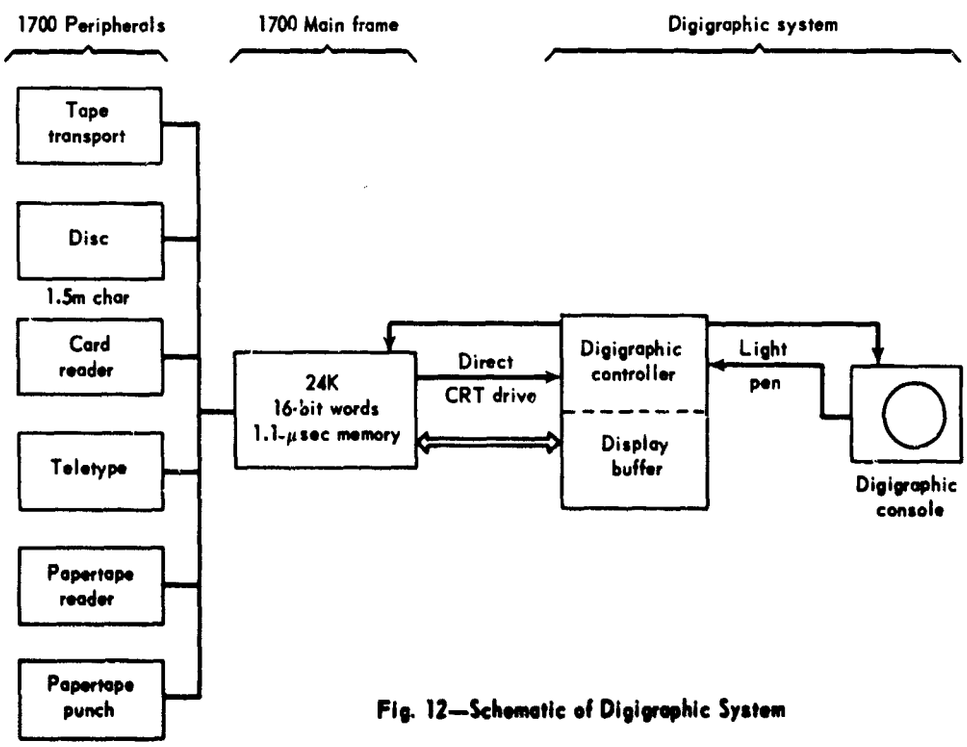

Fig. 12—Schematic of Digigraphic System

terms and has been used in such applications as circuit design, management information systems, ship and aerospace design, command and control, mathematical analysis, and simulation. Elements of the digigraphic system include·

(a) A CDC 1700 Computer with 24,000 16-bit words of which 8500 are used by the operating system.

(b) A graphic software system, under operating system control, providing an interface between the user and the computer.

(c) A 22-in. diameter CRT display scope.

(d) A light pen, which can be used for drawing and activating controls on the scope.

(e) Various peripherals including a card reader, teletypewriter, magnetic-tape drive, and high-speed disk drive.

The computer has a 1.1-μsec cycle time and uses the same advanced silicon-transistor technology employed in Control Data's larger "6000 Series" computers.

Currently no hard-copy output capability is available on the RAC system except through photographs. Hard-copy output could have been provided through the teletypewriter, but it was decided that this was too slow and the paper size too restrictive for this output to be of special value on this version of the model, which is intended primarily as a demonstration of system potential. If computer facilities were to be employed by the Army in operating the RECAP model, a high-speed printer could be provided on-line for hard-copy purposes.

DISPLAY HARDWARE

The display hardware consists of a CDC 1744 digigraphic controller, a CDC 274 CRT, and a light pen. The controller contains an independent 4000-word "refresh" buffer memory. The computer sends display information to this buffer memory, causing the information to be displayed on the CRT. By altering the data in the buffer memory the image on the screen may be altered. The image on the CRT is refreshed every 25 msec, or 40 times per sec. Any part of the image on the screen can be made to blink. Three levels of image intensity can be specified.

When an image, either graphic or alphanumeric, is to be placed on the screen, the desired position is specified in terms of a standard X, Y coordinate system. The center of the screen is defined as (0,0) and X and Y may assume values ranging from -2047 to +2047.

The user communicates with the computer by means of the light pen. Contrary to appearances, the light pen is not a light transmitter but a receiver that picks up light from one of the images on the CRT. The light pen is a fiber optic cable that has a photomultiplier at one end. The position on the CRT where it senses the light is relayed to the computer, which translates it into terms meaningful to the computer program.

DISPLAY SOFTWARE

With the exception of a few display subroutines the RECAP model was programmed entirely in FORTRAN. Display subroutines generate special

data words that are interpreted by the 1744 controller to display information on the CRT. Typical subroutine "calls" are:

CALL INIT

to clear the display area, and

CALL ALFDPY

to display alphanumeric text. Although RECAP does not now use the system's graphics capability, graphics can be programmed rather easily by using subroutines such as LINE, ARC, and CIRCLE, giving the appropriate X and Y coordinates.

A programmer may optionally attach a number between 1 and 32,000 for identification purposes to any part of alphanumeric text or graphic display. An arbitrary graphic "type" may also be assigned by the programmer. Graphic types must assume a value between 0 and 15. Identification numbers and types are assigned by subroutine IDGEN. If the programmer wishes to delete some portion of text or some graphic from the CRT, he uses the DELETE subroutine:

CALL DELETE (ID)

where ID is the identification number assigned to the graphic.

To interrogate, in a program, the position of a light-pen strike, subroutine IDINT is used. This subroutine returns the identification number and type of the text or graphic struck by the light pen. A "threshold type" can be specified in this subroutine as a screening device. If the graphic or text struck by the light pen contains a type that has a value below the threshold value, it is considered an invalid light-pen strike and ignored. A man sitting at the CRT console, using the light pen to answer questions posed to him on the CRT, can thus be saved from making this type of error.

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13. ABSTRACT This paper describes an information system called RECAP (REsources and GAPabilities) designed to assist military planners by providing immediate, easy-to-understand displays to aid in the comparison of Army force-structure alternatives. The version of the model described herein is a follow-on to the original batch system completed under the FOREWON II research program sponsored by the Force Planning Analysis Directorate of the Chief of Staff, US Army.

A cathode-ray tube (CRT) remote terminal facilitates man-computer interaction and improves the speed of system responses. The CRT accepts all procedural instructions for the use of the model, enabling the system to be used even by Army planners who know nothing about computer programming or programming languages.

As a force-planning tool, both versions of RECAP are designed to be used in conjunction with other existing planning models. The information provided by the model is only one of the kinds of information needed for Army force planning. Alternatives are compared with this system on the basis of their relative differences in physical capabilities and cost. Other more time-consuming techniques and models will ordinarily be employed to analyze in detail those alternatives that appear most promising on the basis of RECAP output.

Only the on-line version of RECAP is described in this paper. The reader is referred to "The Prototype RECAP Model: An Aid To Army Force Planning," RAC-R-61, for a more detailed explanation of the concepts involved in the model. RAC-R-61 also describes the planning environment generating the need for the model and the operation of the model in a batch processing mode on an IBM 7044. Both versions of the model are intended to provide a demonstration of system potential. Data were collected for only a small number of Army force units.

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