

2

AFWAL-TR-88-4123

RESOURCE ALLOCATION MODELING FOR MILITARY SYSTEMS
AND TECHNOLOGY ACQUISITION



R. G. HONEYWELL

SPACE APPLICATIONS MAJOR THRUST ICE
MATERIALS LABORATORY

June 1988

Final Report for Period September 1986- March 1988

Approved for Public Release; Distribution Unlimited

DTIC
ELECTE
MAY 05 1989
S E D

MATERIALS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6533

88 010

AD-A208 131

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AUTHORITY N/A		3. DISTRIBUTION/AVAILABILITY OF REPORT Approval for public release; distribution unlimited.	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE N/A		4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFWAL-TR-88-4123	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) AFWAL-TR-88-4123		5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a. NAME OF PERFORMING ORGANIZATION SPACE APPLICATIONS MAJOR THRUST OFFICE	6b. OFFICE SYMBOL (if applicable) AFWAL/MLX	7a. NAME OF MONITORING ORGANIZATION	
6c. ADDRESS (City, State, and ZIP Code) WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6533		7b. ADDRESS (City, State, and ZIP Code)	
8a. NAME OF FUNDING / SPONSORING ORGANIZATION AF WRIGHT-AERONAUTICAL LABS	8b. OFFICE SYMBOL (if applicable) AFWAL/MLX	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code)		10. SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO. 63224C	PROJECT NO. L502
		TASK NO. 00	WORK UNIT ACCESSION NO. 01
11. TITLE (Include Security Classification) RESOURCE ALLOCATION MODELING FOR MILITARY SYSTEMS AND TECHNOLOGY ACQUISITION			
12. PERSONAL AUTHOR(S) R.G. HONEYWELL			
13a. TYPE OF REPORT FINAL	13b. TIME COVERED FROM SEPT 86 TO MAR 88	14. DATE OF REPORT (Year, Month, Day) 1988 JUNE	15. PAGE COUNT 99
16. SUPPLEMENTARY NOTATION The computer software contained herein are theoretical and/or references that in no way reflect Air Force - owned or - developed computer software.			
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	
OS	01		
12	02		
		RESOURCE ALLOCATION DECISION MODELING MULTIPLE CRITERION DECISION MODELING SYSTEM DYNAMICS MODELING	
19. ABSTRACT (Continue on reverse if necessary and identify by block number) RESOURCE ALLOCATION PLANNING FOR MILITARY SYSTEM AND TECHNOLOGY ACQUISITION REQUIRES THE ACQUISITION AND STRUCTURING OF TYPICALLY LARGE QUANTITIES OF DATA CONCERNING THE ALTERNATIVES FOR DECISION - MAKING. THE RESOURCE ALLOCATION MODEL DEVELOPED BY THIS EFFORT USES A MULTIPLE CRITERION DECISION MAKING APPROACH IN COMBINATION WITH DYNAMIC MODELING. A INTERACTIVE MODEL IS PROVIDED FOR DEMONSTRATION PURPOSES.			
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL R.G. HONEYWELL		22b. TELEPHONE (Include Area Code) 513-255-8205	22c. OFFICE SYMBOL AFWAL/MLX

SUMMARY

Resource allocation requires the institutionalization of processes to allow collection, structuring and maintenance of information for decision-making and the application of tools to evaluate that information. The Resource Allocation Model described in this paper is suggestive of the nature of the type of evaluation tools which must be made available to our public institutions. With a methodology based in multiple criteria decision modeling and dynamic programming, the Resource Allocation Model provides the structures and tools for requirement and capability forecasting, program length evaluation, cost/benefit evaluation, risk evaluation, and program accomplishment evaluation.

Application of this or similar programs and tools is gaining broader acceptance and use in our public institutions with various degrees of implementation and success. Development of increasingly capable information processing systems is expected to accelerate this advancement, given our need to manage increasingly complex systems and technology in an increasingly dynamic environment.

Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

TABLE OF CONTENTS

I.	INTRODUCTION	1
II.	HISTORICAL PERSPECTIVES	2
III.	SCORING METHODOLOGY AND DYNAMIC PROGRAMMING	3
IV.	PROBLEM STRUCTURES	5
V.	MODEL DESCRIPTION	7
	A. REQUIREMENTS FORECAST	7
	B. CAPABILITIES FORECAST	9
	C. FUNDS PLANNING	10
	D. RISK FORECAST	11
	E. PROGRAM ACCOMPLISHMENT EVALUATION	13
	F. DELTA FUNDS EVALUATION	18
	G. PROGRAM LENGTH EVALUATION	20
	H. COST/BENEFIT EVALUATION	22
	I. MENUS	23
	J. OTHER NOTABLE FUNCTIONS	23
VI.	RESULTS	25
	A. CASE #1 - CONSTRAINED FUNDING, DELTA FUNDS OFF	25
	B. CASE #2 - CONSTRAINED FUNDING, DELTA FUNDS ON	26
	C. CASE #3 - SINGLE LAYER PROBLEM STRUCTURE	26
	D. CASE #4 - FUNDING CONSTRAINT RELIEF	29
	E. CASE #5 - EFFICIENCY FACTOR EFFECTS	29
	F. CASE #6 - TABLE FUNCTION MODIFICATION EFFECTS	30
VII.	CONCLUSIONS	30
	REFERENCES	32
	BIBLIOGRAPHY	33
	APPENDIX A. PROGRAM LISTING	A-1
	APPENDIX B. PROGRAM DATA	B-1
	APPENDIX C. SAMPLE RUNS	C-1

LIST OF FIGURES

1	RESOURCE ALLOCATION MODEL PROBLEM STRUCTURE	6
2	RESOURCE ALLOCATION MODEL	8
3	REQUIREMENTS FORECAST PROGRAM MODULE	9
4	CAPABILITIES FORECAST	10
5	FUNDS PLANNING	11
6	RISK FORECAST	12
7	TABLE VALUES FOR PSS	13
8	TABLE VALUES FOR PSF	14
9	PROGRAM ACCOMPLISHMENT EVALUATION	15
10	TABLE VALUES FOR ACCOM	17
11	DELTA FUNDS EVALUATION	18
12	TABLE VALUES FOR DFUNDS	19
13	PROGRAM LENGTH EVALUATION	21
14	COST/BENEFIT EVALUATION	22
15	MENU ALTERNATIVES	24
16	TABULAR RESULTS FOR SOLAR	27
17	GRAPHICAL RESULTS FOR SOLAR	28

I. INTRODUCTION

Resource allocation planning requires the acquisition and structuring of typically large quantities of data concerning alternatives for decision-making. Key concerns to the decision-maker include identification of the type and levels of capability required, allocation of funding, commitment to program timing, allocation of manning and facility resources if needed.

Resource allocation models provide the capability necessary for data evaluation. Decision analyses involving few decision criteria and a single layer of alternatives competing for resources often yield self-evident conclusions to those familiar with the data. Analyses involving multiple, layered programs and an environment of fluctuating resource levels are at issue.

Resource allocation models are intended to provide predictive tools to the manager much as mathematical models are used by engineers to predict the capability of a device to function within a given environment. The model must provide reliable results while minimizing the burden associated with operation and maintenance. Realism of results was identified by W.E. Souder as a primary concern in resource allocation modeling efforts. Souder's survey of over one hundred experienced administrators and management scientists identified other key concerns including flexibility of the model, ease of use and format of model results.[1] The Resource Allocation Model provided by this effort addresses each of these concerns.

The Resource Allocation Model is an interactive computer model designed for use on MS-DOS based computer system using basic programming language. The model is inherently flexible, permitting evaluation of changing funding levels, program timing and efficiency factors such as contracting leadtimes and technical risk on expected capability. The model is menu-driven for ease

of use. The following sections provide a historical overview of modeling efforts, the structure of problems expected to be considered for evaluation, and a detailed discussion of the capabilities of the Resource Allocation Model.

II. HISTORICAL PERSPECTIVES

Resource allocation modeling has an extensive history with the roots of serious modeling interest established in the 1950s. Since this time hundreds of resource allocation models have been developed. These models can be classified into four major categories including scoring, economic analyses, risk analysis and mathematics programming models including linear and dynamic programming approaches.

Scoring models involve an approach of utilizing multiple evaluation criteria such as development cost, expected capability, acquisition cost, etc. to calculate a ranking score. High scoring programs are selected for implementation. Economic analysis models use a benefit/cost ratio comparison between alternatives. A maximum expenditure justified (MEJ), equivalent to the product of the discounted net worth of the project and probability of success is divided by the expected cost of the project. Risk analysis models require estimation of benefits relative to varying levels of resource allocation to the project. Sensitivity analyses are accomplished to maximize total project benefits. Linear programming models use optimizing functions to select programs while dynamic models provide feedback loops to allow evaluation of program performance. Sensitivity analyses are accomplished to maximize total project benefits.

Given the wide range of complexity represented by these models, Souder evaluated the relative effectiveness of over 40 models based on their realism, flexibility, capability, ease of use, and cost. "Probability index and

scoring types of models were found to have the easiest useability and the lowest cost and performance characteristics, while linear, nonlinear, and zero-one models had the highest realism, flexibility and capability."[2]

The resource allocation model developed in this effort combines the best characteristics of scoring and modified benefit/cost models with dynamic programming approaches. The model allows consideration of complex program structures where the interrelationship between several programs is critical to providing a desired outcome.

Understanding the scoring methodology and dynamic programming is key to understanding the basis for this modeling effort. Understanding the problem structure is key to understanding the model's structure. The following two sections will address these subject.

III. SCORING METHODOLOGY AND DYNAMIC PROGRAMMING

Since the scoring methodology and system dynamics programming approach are key to the development of the Resource Allocation Model, an understanding of these concepts is important to comprehending the model's operation and its capability.

The scoring methodology for this model uses a multiple criterion decision-making (MCDM) approach which shares a similar history to that of resource allocation modeling. Researchers during the post World War II period recognized the dilemma of "several conflicting maximum problems" in works by John Von Neumann and Oskar Morgenstern. While many researchers in the 1950s laid groundwork for MCDM, it was Peter Bod's efforts in the early 1960s which established the foundation for linear multiobjective programming. It was, however, another 15 years before serious modeling and theory was established. Several RAND reports on multiattribute utility theory by Raiffa and MacCrimmon are most notable. Johnsen's Studies in Multiobjective Decision Models in 1968

established the basis for serious study and modeling efforts.[3] The seventies was the growth period for MCDM, one of the fastest growing and innovative of the many operations research efforts in 1970s and 1980s.

The simplest concepts from MCDM have been applied in this modeling effort including parametric descriptions and utility assessments. Parametric descriptions resolve a technology or system capability into typically independent elements. A power system as an example can be parametrically described by power level, energy level, acquisition cost, weight, reliability, and any number of other factors. The key is to select important factors for the decision, such as power level, weight and reliability for space systems, and conduct evaluations on that basis. Utility assessments involve determining the priority or importance of the various parameters. A host of approaches exist for establishing utility assessments including statistically based surveys, delphi techniques, etc. Finally, the product of the paired parameter value and utility assessment is normalized by dividing that product by the maximum parameter value. This approach is used to describe capability requirements as well as system and technology capabilities.[4] These capability descriptions are applied as sources for feedback in the dynamic modeling approach.

Systems dynamics and the name of Jay Forrester are synonymous. His work during the early 1960s culminating in the book Industrial Dynamics is the basis for much of the systems dynamics modeling efforts since that time.[5] Dynamic problems have two features in common including 1) quantities which change over time, and 2) the concept of feedback. The concept of quantities or parametric values which change over time is straightforward, feedback, however, may not be a self-evident concept for resource allocation modeling. Feedback is the transmission and return of information. A heating system uses the thermostat as a feedback device. The resource allocation model uses a programmatic capability assessment as a feedback device to the "funds furnace"

which provides variable levels of funds based on the return of increased capability.

The key objective of the system dynamics approach is establishment of a formal, quantitative computer model which represents the system realistically.[6] The Resource Allocation Model then must represent the realities of project management including delays in funds and contracting, unexpected technical risks, nonoptimum schedules which introduce performance risks, nonoptimum funding, which in turn introduces different kinds of performance risks, etc.

With background now established for the modeling methodology, the following section will address the type of problem structures to which the Resource Allocation Model can be applied.

IV. PROBLEM STRUCTURES

Most complex organizations are responsible for a number of independent projects which are interdependent in terms of achieving a desired capability. Examples of this characteristic are found in most major development efforts. Independent developments of ceramic materials, innovative aeromechanical structures, and digital controls become interdependent when measured against a propulsion system development requirement. Failure to achieve a capability in one or another area can lead to a significantly reduced system level capability. The problem structure demonstrating this interrelationship is provided in Figure 1.

Achievement of the goals of the Gallium Arsenide Solar Panel Program as shown in Figure 1 is a critical step to achieve thin Gallium Arsenide technology or Gallium Arsenide based Multi-Band Gap technology capabilities. The contributions of the Gallium Arsenide solar panel program to processing techniques, material composition and manufacturing if lost due to a funding

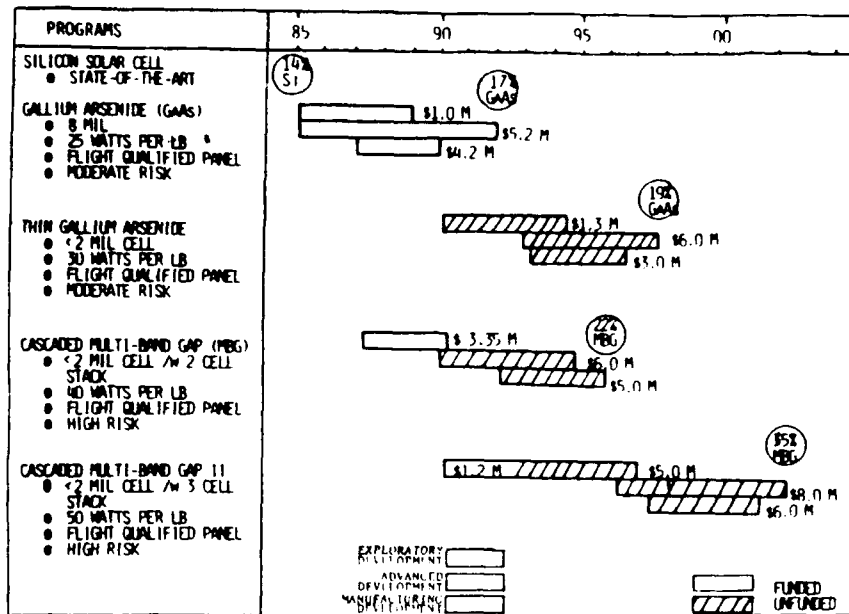


FIGURE 1
RESOURCE ALLOCATION MODEL PROBLEM STRUCTURE

discontinuity must be reflected in higher development risks to the latter programs. This will possibly result in delayed program initiation, increased funding requirements, and a probable loss in expected capability.

A second consideration in the structuring of a resource allocation problem is the need to conduct several programmatically independent programs, each with their inherent risks, to achieve a desired capability. Figure 1 demonstrates the need to conduct a research program, application development program and manufacturing capability development program before a Gallium Arsenide solar panel capability can be achieved. This layering effect must be considered in analyses as the loss of an element of a program development will most probably lead to the previously discussed effects on subsequent Gallium Arsenide based development programs.

The Resource Allocation Model is designed to accommodate the multiple layer interrelated problem structure. Capability evaluations serve to integrate the results of loss of funding, higher than expected technical risk, or low technical performance. The utility analysis feature of this model allows the analyst to feedback loss of expected capability to the capability forecasts for future programs. This model will accommodate simple single-layer problems as well, involving the selection of an alternative from competing, independent alternatives.

V. MODEL DESCRIPTION

The resource allocation model provided by this effort was developed on a Z-100 computer system using Z-Basic as the programming language. A program disk containing a working copy of the model is provided in Appendix A with a program listing provided in Appendix B.

This model consists of several modules as shown in Figure 2. The key feedback loop provided in this model is the difference between requirements and capability achievement which is used to drive varying levels of program funding. Feedback from evaluation modules, such as cost/benefit, and program length, must be accommodated through sensitivity analyses accomplished by the analyst.

The following discussion will provide a detailed overview of each of these functional modules and the interrelationship between modules.

A. REQUIREMENTS FORECAST

The requirements forecast function represented in Figure 3 establishes the system or technology objectives used by the Resource Allocation Model. Requirement forecasts taken in conjunction with accomplishments realized during program execution establish a potential which drives varying funding levels.

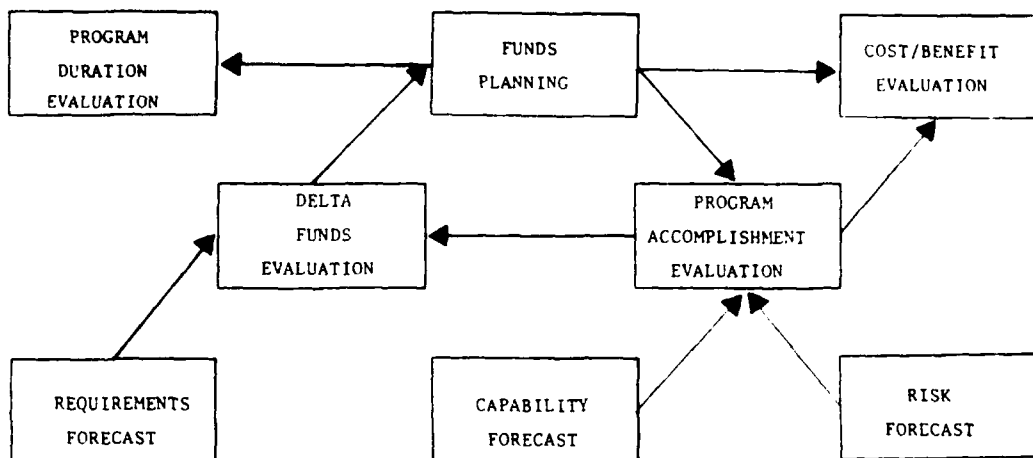


FIGURE 2
RESOURCE ALLOCATION MODEL

Parametric evaluations of system or technology requirements considered in conjunction with utility assessments of those parameters establish the basis for the requirements evaluation. The variables used in this model are $P(T\%)$, representing a parameter value in a given time, $T\%$, $U(T\%)$, representing a utility value in a given time, $T\%$, and P_{MAX} which represents the highest parameter value provided as input to the model. P_{MAX} is used to normalize the parametric values such that $P(T\%) = 1$. The variable $REQ(T\%)$ then represents the product of a normalized value and utility value. Multiple parameters may be considered to describe a requirement. $REQ(T\%)$ is used to provide a summation of these additional parameter and utility products. This function is represented by:

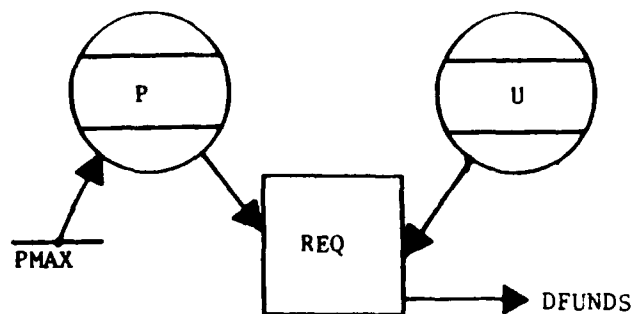


FIGURE 3
REQUIREMENTS FORECAST PROGRAM MODULE

$$REQ(T\%) = \sum_{n=1}^{n=X} (P_n(T\%) / P_{nMAX}) * U_n(T\%)$$

The requirements forecast function supplies information to the delta funds evaluation function, affecting the variable DFUNDS. When this is considered in combination with the program accomplishment evaluation function, a driving potential for funding above and below planned levels is created.

B. CAPABILITIES FORECAST

The capabilities forecast function, represented by Figure 4, establishes the unconstrained capability of a technology or system based on technology forecasting by experts.

Parametric forecasts are provided to the program from the file PDATA.DOC, utilizing identical parameters as established for the requirements forecasting function. The use of equivalent parameters permits "apples to apples" comparisons between requirements and capabilities. The utility values are also required to be identical to the utility values used in the requirements forecasts.

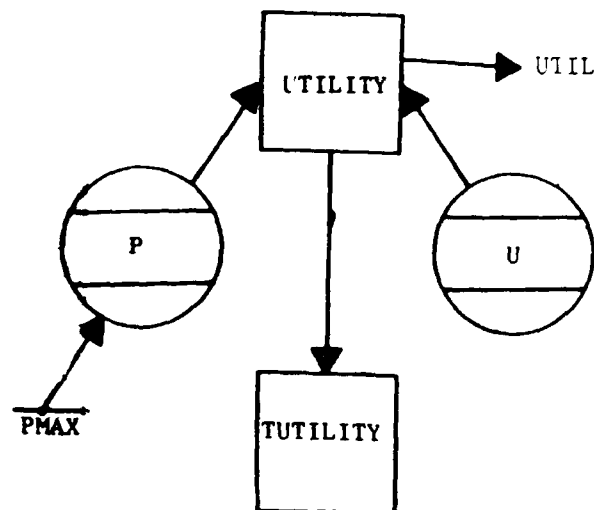


FIGURE 4
CAPABILITIES FORECAST

The variables $P(T\%)$, $PMAX$, and $U(T\%)$ are identical in relationship to those discussed in the previous section. The variable, $UTILITY$, is used to collect the sum of multiple parameter and utility products. The variable $TUTILITY$, is used to provide an average value for the potential utility represented by all programs evaluated. This variable is expected to be particularly useful for evaluating the total potential represented by a series of independent programs.

C. FUNDS PLANNING

The funds planning function provides the budgetary information necessary to permit program execution. This function is represented by Figure 5. The funds planned for program execution are established by data input from the file OBLIG.DOC. The variable $OBP(T\%)$ represents the baseline plan for funds obligation. The variable $OB(T\%)$, although initially set equivalent to the baseline funds plan, is effected by the delta funding function and by limitations on available funding during program execution. Available funds are determined by data provided by inputs from the file TOA.DOC. The variable $TOAP(T\%)$ represents a baseline for available funds for all programs

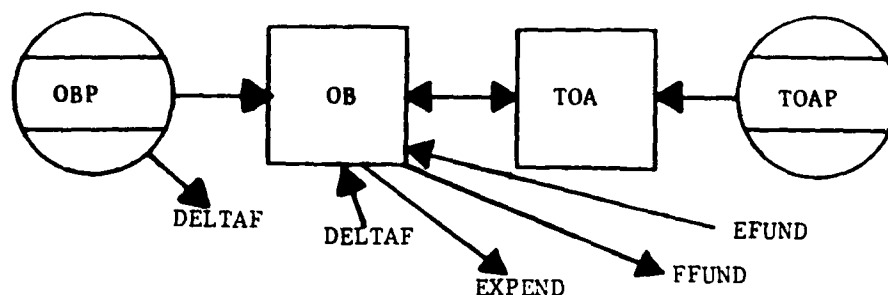


FIGURE 5
FUNDS PLANNING

considered. The variable TOA(T%) as with obligations is set equivalent to TOAP initially, but is potentially effected by changing obligation levels.

The funds planning function as with requirements and capability forecasting is extremely flexible due to the ease in modifying the appended data base. Thus funding cuts are easily evaluated, and the sensibility of program plans can be assessed through sensitivity analyses.

D. RISK FORECAST

The risk forecast function provides an evaluation of the technical, scheduler, and funding risks associated with nonoptimum program planning. This function is represented in Figure 6. The probability of success due to scheduler effects is represented by the variable PSS(T%). This is a table function which uses the values derived from the quotient of the variables PL, the planned program length and OPTPL, the optimum program length. The values for PL and OPTPL are established by data inputs from the file PROG.DOC. The

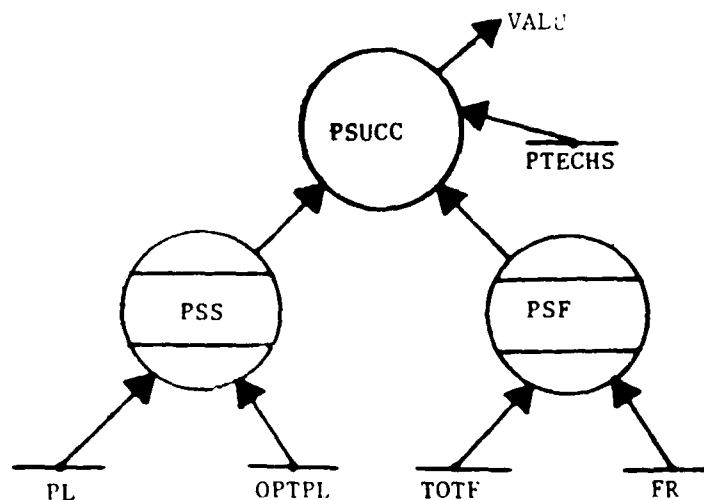


FIGURE 6
RISK FORECAST

value of the table function is derived from the file TABMAK.DOC. Figure 7 represents a typical risk profile, which was used in this effort. Programs which are shorter than the timing considered reasonable will incur higher risk and result in a probable reduction in ultimate capability. Currently the Resource Allocation Model uses a fixed value for the variable PL, rather than using feedback from the program length evaluation function to vary risk with changing program lengths.

The probability of success due to funding effects is represented by the variable PSF(T%). This is also a table function, the value of which is dependent on the quotient of the variables TOTF, representing the total funding planned for the effort and FR, representing the estimate of funding required for the effort to be fully successful. The values for TOTF and FR are determined by data inputs from the file PROG.DOC. The value of the table function is derived from the file TABMAK.DOC. Figure 8 represents a typical risk profile due to funding considerations. Programs funded at levels below that considered reasonable will incur higher risk and likely achieve less

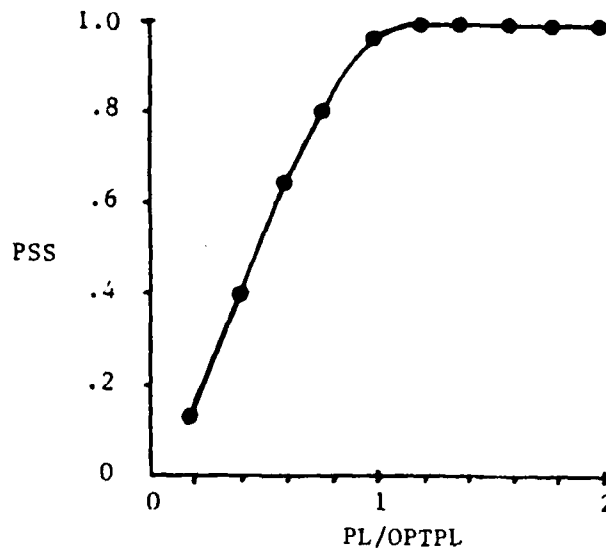


FIGURE 7

TABLE VALUES FOR PSS

capability.

The probability of technical success is represented in the model by the variable PTECHS. This value is provided to the program by data inputs from the file PROG.DOC. The value of PTECHS is expected to result from evaluations by technical experts of the feasibility of meeting technical objectives considering reasonable funding and schedule constraints. Programs requiring technology breakthroughs are likely to have low values for PTECHS. Evolutionary programs requiring modest advances are likely to demonstrate high values for PTECHS.

The probability of program success is represented by the variable PSUCC. Its value is determined by the product of PSS, PSF, and PTECHS. The value of PSUCC affects the variable, ACCOM in the program accomplishment evaluation function discussed in the following section.

E. PROGRAM ACCOMPLISHMENT EVALUATION

The evaluation of program accomplishment occurs in two functional

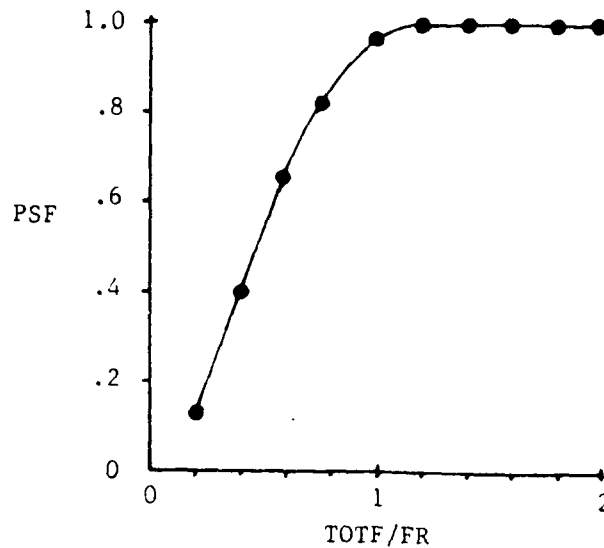


FIGURE 8
TABLE VALUES FOR PSF

steps. Initially, based on funds planning, expenditures are determined leading to an evaluation of accomplishment. Second, accomplishment is used to determine the utility or capability achieved by the work. Figure 9 represents the program accomplishment evaluation function of the Resource Allocation Model.

Expenditures, represented by the variable EXPEND (T%), are the product of several factors including the funds obligated for the program, OB(T%), funds available for expenditures which were unused in the prior year's program execution due to program inefficiencies, FFUND (T%) and several "real world" delay functions. These inefficiencies include delays in receiving funding, FDELAY, delays in contracting, CDELAY, and delays in start up of the program, SUDELAY. These inefficiencies are characteristic of larger programs

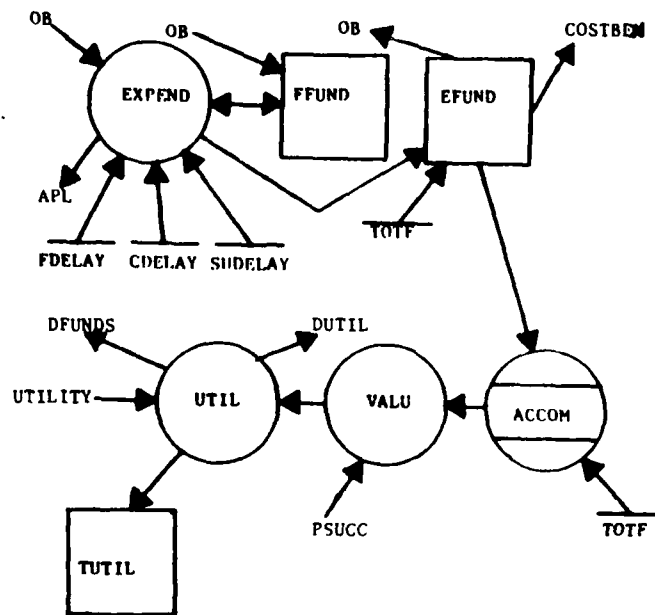


FIGURE 9
PROGRAM ACCOMPLISHMENT EVALUATION

which require time to build a team and achieve a level of team efficiency. Expenditures are determined by the expression:

$$\text{EXPEND}(T\%) = (\text{OB}(T\%) * \text{FDELAY} * \text{CDELAY} * \text{SUDELAY}) + \text{FFUND}(T\%-1)$$

Forward financed funds represented by the variable FFUND (T%), are the difference between available funds and expenditures. The value of FFUND(T%) is determined by the expression:

$$\text{FFUND}(T\%) = \text{OB}(T\%) + \text{FFUND}(T\%-1) - \text{EXPEND}(T\%)$$

The effect of inefficiencies in expending available funds creates the need to "forward finance" funds into the following year.

The inefficiencies previously discussed FDELAY, CDELAY, and SUDELAY

are typical effects realized in the initial year of a program. The Resource Allocation Model takes a simplistic approach and assumes first year values obtained from the file PROG.DOC. In subsequent years the values for CDELAY and SUDELAY are equated to the value 1.0. FDELAY is equated to the value 0.98 due to continuing congressional inefficiency in the public sector in appropriating funds. Often with ongoing programs, continuing resolutions are passed providing funding at least at the prior year's level. The contractor often is willing to use his own funds to maintain program continuity.[7]

The summation of expenditures over the program life is accomplished by the variable EFUND, representing total earned funds. This variable affects several other variables in the program including the cost/benefit evaluation function, accomplishment evaluation function, and obligations planning. The effects on accomplishment and cost benefit evaluations will be discussed in later text. The effect of EFUNDS (T%) on obligations is realized when earned funding meets or exceeds the total planned funding for the program, TOTF. Should this condition exists when funding still remains, then funds planned for obligation, OB(T%), will be eliminated by equating OB (T%) to zero for the time T% and future years.

The value of earned funding, EFUND (T%), is used to determine accomplishment, which is represented by the variable ACCOM (T%). The value of accomplishment is determined by the quotient of earned funding, EFUND(T%), and total funding planned, TOTF. The table value for accomplishment is determined by data input from the file TABMAK.DOC. The table values used for examples run on the Resource Allocation Model are shown in Figure 10. Certain cases were run with a typical 's-curve' as well as the linear relationship used as the baseline case for the resource allocation model. Effectively, the assumptions in the model relative to inefficiencies provided the typical 's-curve' results.

Once accomplishments are determined, the effect of the risk

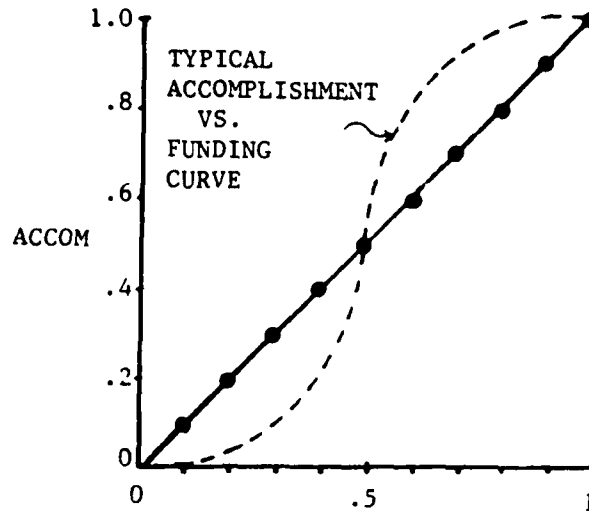


FIGURE 10
TABLE VALUES FOR ACCOM

evaluation is applied to establish the expected value of work accomplished. The expected value of work, represented by the variable, $VALU(T\%)$, is simply the product of the variables $PSUCC(T\%)$ and $ACCOM(T\%)$, variables whose genesis has been previously discussed.

Finally, the utility of work accomplished is determined by the product of the work's value, $VALU(T\%)$ and the potential utility of the work represented by $UTILITY(T\%)$. The result is the expected utility of work, which considers funding, schedular, and technical risk factors. Ideally, its value, when decomposed into its elemental parameters, should reflect the actual values measurable from the work accomplished. The utility of the work accomplished is established in identical terms as the requirement for the work allowing direct comparisons to requirements. Comparison between the requirement for a technology and the current utility of the work can then serve to drive evaluative tools such as the cost/benefit funding evaluation.

Multiple layer programs require the collection of utility values from each program to establish a collective utility. The variable $TUTIL(T\%)$ is

used to represent the average utility for multiple programs.

F. DELTA FUNDS EVALUATION

The delta funds evaluation function provides a capability within the program to modify funding levels based on the potential created by program utility, $UTIL(T\%)$, exceeding or falling short of program requirements, $REQ(T\%)$. The delta funds function is represented in Figure 11. This function is based on the value of two key variables, $DFUNDS(T\%)$ and $DELTA F(T\%)$.

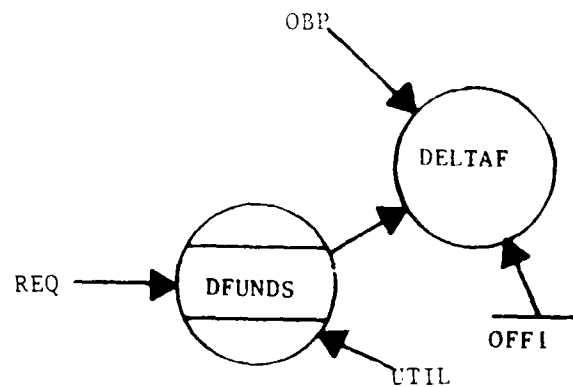


FIGURE 11

DELTA FUNDS EVALUATION

An exceedance or shortfall in satisfying requirements establishes a potential represented by the variable $DFUNDS(T\%)$. Its value is determined from a table function based on data derived from the file TABMAK.DOC. Figure 12 demonstrates the baseline table values established for the Resource Allocation Model. The actual table value is determined by the percentage difference between requirements $REQ(T\%)$ and program utility, $UTIL(T\%)$. This relationship is positive when requirements exceed utility and negative when program utility exceeds requirements. The implication to the delta funds function is clear in that exceeding requirements will result in a reduced funding demand and positive correlations will in an accelerated funding

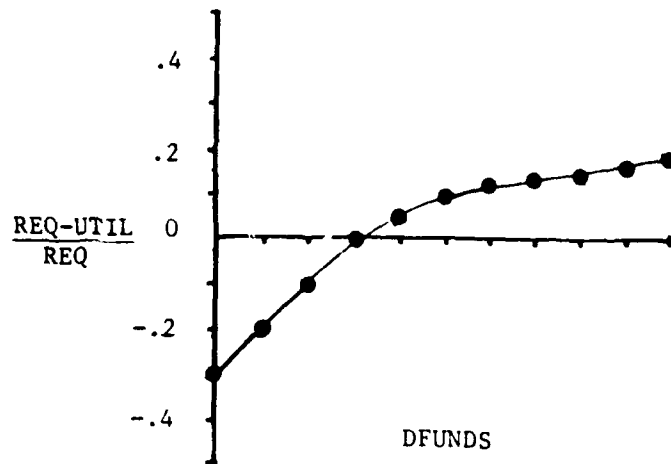


FIGURE 12

TABLE VALUES FOR DFUNDS

demand.

The demand rate, established by the values extracted from the table is intended to reflect the realities of the world in that funding can only be increased at a limited rate before additional funding has little marginal value. The question of appropriate values for marginal rates on increasing funding to various programs deserves a separate case study. The ability to reduce funding on programs is relatively easy to accomplish, and is represented by a rather steep curve.

The delta funds multiplier is applied to establish a dollar value for the delta funds function. The variable DELTAF(T%) represents this fiscal value and is determined by the product of the DFUNDS multiplier and the obligations plan represented by the variable OBP(T%). DELTAF(T%) is additionally constrained so that:

$$OB(T\%) + DELTAF(T\%) = TOA(T\%)$$

This condition insures program funding levels will never exceed available funding, perhaps a program condition which should perhaps be reevaluated given the national deficit.

The variable OFF1 is a second multiplier in the equation used to determine a value for delta funds. It is a switch with the value of zero when the delta funds function is to be disabled, and a value of one when it is to function. Its value is provided as an input from the file SPEC.DOC.

G. PROGRAM LENGTH EVALUATION

The program length evaluation function provides a measure of the expected variance in program length of programs relative to plan. The program length evaluation function is represented by Figure 13.

The variable PLC represents a counter function which is initiated when the program start time is reached during model execution. The variable TSTART initiates and TFIN stops the model's execution. PSTART, representing the program start time, is provided to the model by data input from the file OBLIG.DOC.

The variable APL(T%) represents the estimate of actual program length required to complete a given activity. Two equations are required to establish a value for APL(T%). First, if remaining obligations for the next year, OB(T% + 1), and forward financed funds FFUNDS(T%) exceed some nominal value, SK, then the equation used to predict a value for APL (T%) is given by:

$$APL(T\%) = PLC + ((FFUND(T\%) + OB (T\% + 1)/EXPEND (T\%))$$

The rationale for this estimate is based on equating the remaining program time to a percentage of remaining funds relative to the prior year's expenditure rates. A second equation is required to estimate a value for APL(T%) when the earned funds, EFUND(T%), met or exceed planned funding, TOTF,

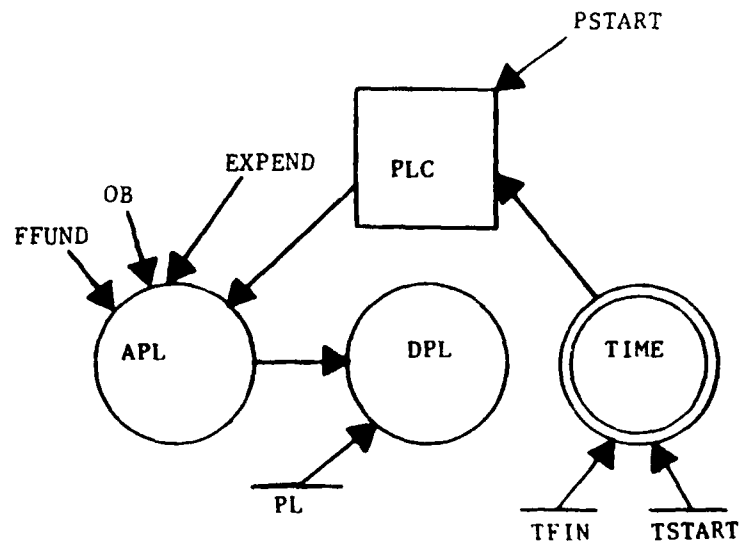


FIGURE 13
PROGRAM LENGTH EVALUATION

and the forward financed funds or next year's obligations are less than some nominal value, SK. The value used for SK in the Resource Allocation Model is established at one thousand dollars when working with million dollar order of magnitude programs. The second equation is represented by:

$$APL(T\%) = PLC + (EXPEND(T\%)/EXPEND(T\% - 1))$$

This estimate's rationale is based on equating remaining program time to the percentage of remaining funds planned for expenditure relative to the prior year's expenditure rates. The methodologies are roughly equivalent, but a variance in the terms of the equations is required due to a difference in time perspective for conclusion of the program activity.

The variable DPL(T%) represents the difference in program duration value is simply the difference between the variable PL and APL(T%). This function provides an evaluative tool to the analyst to perform sensitivity analyses on varying planned program lengths and its effect on overall program utility and risks. It may be appropriate for future versions of this model to

provide feedback directly to the risk forecast functions.

H. COST/BENEFIT EVALUATION

The cost/benefit evaluation function is an additional evaluation tool for the analyst. Figure 14 represents the cost/benefit evaluation function.

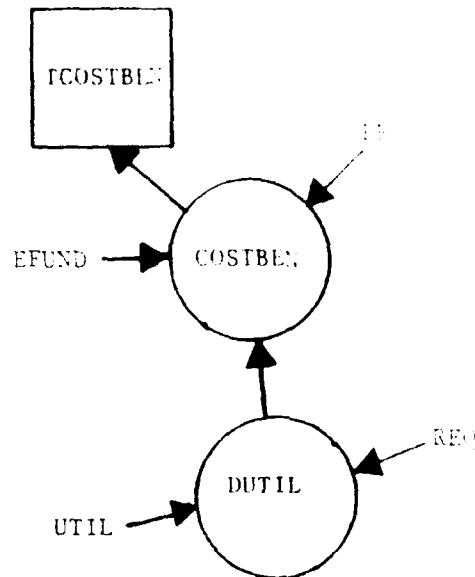


FIGURE 14

COST/BENEFIT EVALUATION

The key driver for the benefit portion of this evaluation is established by the quotient of program utility $UTIL(T\%)$, and requirements, $REQ(T\%)$. The variable $DUTIL(T\%)$ represents the value of this quotient. The cost/benefit ratio, for a given cost value, will approach infinity as $UTIL(T\%)$ approaches zero. Alternatively, this ratio will approach zero as program utility exceed requirements.

The variable $COSTBEN(T\%)$ represents value of the cost/benefit ratio. $COSTBEN(T\%)$ is determined by the expression:

$$COSTBEN(T\%) = EFUND(T\%) / (FR * DUTIL(T\%))$$

The cost/benefit ratio, for a given value of $DUTIL(T\%)$, will approach zero as earned funding, $EFUND(T\%)$, approaches zero. This ratio will approach infinity as earned funding exceeds the projected funding required, FR . Intuitively, this relationship provides a reasonable correlation. Cost/benefit ratios near 1.0 or below are desirable.

The benefit evaluation approach used in this modeling effort is appropriate for use in the public sector, but would likely need to be revised for private sector use. Consideration of the projected discounted net worth for a project is more appropriate. The public sector concerns typically focus on overcoming a threat or need in a given time. Further work should be considered, however, to develop a methodology which evaluates utility to requirement comparisons over the life of a alternative.[8]

The variable $TCOSTB(T\%)$ is provided to accumulate an average cost/benefit ratio for a multilayered program.

I. MENUS

The Resource Allocation Model uses eight functional menus to assist the analyst in accomplishing evaluations. The major functions represented are summarized in Figure 15.

Future versions of this model are likely to include additional menus to allow total data base revisions without leaving the Resource Allocation Model.

J. OTHER NOTABLE FUNCTIONS

The Resource Allocation Model contains a project priority subroutine which, when multiple programs are required to be evaluated, will establish project priority on the basis of the following factors:

- Factor #1 $PSTART < PSTART \text{ Alternatives}$
- Factor #2 $PTECHS > (PTECHS - 0.1) \text{ Alternatives}$
- Factor #3 $UTILITY > UTILITY \text{ Alternatives}$

Thus, alternatives are first ranked in order of utility potential. However

- Menu 1 - Nonfunctional header
- Menu 2 - Course selection
 - 1. Review table functions (Menu 8)
 - 2. Enter model (Menu 3)
 - 3. End program
- Menu 3 - Course selection
 - 1. Review model specifications (Menu 7)
 - 2. Select model output format (Menu 4)
 - 3. Select programs for review (Menu 6)
 - 4. Run model
 - 5. Return to Menu 2
- Menu 4 - Format selector
 - 1. Graph only
 - 2. Table only
 - 3. Both
- Menu 5 - Output device selector
 - 1. Screen only
 - 2. Printer only
 - 3. Both
- Menu 6 - Project selector
 - 1. Project 1
 - 2. Project 2
 - 3. Project 3
 - 4. All
- Menu 7 - Model specifications
 - 1. Review specifications
 - 2. Revise specifications
 - 3. Return to Menu 3
- Menu 8 - Table functions
 - 1. Accomplishment
 - 2. Probability of schedule success
 - 3. Probability of funding success
 - 4. Delta funds
 - 5. Return to Menu 3

FIGURE 15
MENU ALTERNATIVES

should the probability of technical success be marginally lower (a higher risk program by a margin of 0.1), then priorities will be reversed. Finally, should the start date of a higher priority program be later than other programs, the priority will be reversed. The analyst can avoid this subroutine, if desired, by directly changing the project order in the file PROG.DOC.

VI. RESULTS

The Resource Allocation Model was developed and tested using data provided by the Air Force Wright Aeronautical Laboratories.[9] The modeling activity considers three independent development activities including a Gallium Arsenide Solar Array, a High Energy Density Battery and a Laser Hardened Concentrator Solar Array. Each of these developments affects the potential capability of a fourth effort, a High Voltage Power System, which can integrate the products of the three independent component development efforts.

Thus through this data the opportunity exists to evaluate a single layer problem, examining each component effort individually, or a multiple layer problem, examining the combined effectiveness of all efforts, measured against the requirements established for the High Voltage Power System.

The data used in this effort is provided in Appendix B, with a key to the parameter values and units discussed for each data file. The breakout of data files roughly approximates the functional diversity required to provide source data. Thus the financial data is provided by divisions responsible for funds estimating and budget status, requirements data is provided by planning groups, while component capability data is provided by program engineering groups.

The data results were provided in tabular and graphical formats. Figure 16 is an example of the tabular format and Figure 17 an example of the graphical format. Simple modifications to the program can allow presentation of other data of interest to the analyst.

Results of demonstration runs are provided in Appendix C for six cases. The intent of providing these sample cases is to demonstrate the flexibility of the program, as well as gain insight to the model's sensitivity to various factors.

A. CASE #1 - CONSTRAINED FUNDING, DELTA FUNDS OFF

Case #1 evaluates the effect of constraining available funding, TOAP(T%), for an interdependent problem structure with the delta funds function off. This constraint creates a situation where the battery development is under funded by some \$700K and a significant capability shortfall results. The concentrator program is unable to practically begin, until 1989, due to funding constraints and little capability is achieved for the concentrator by 1990. Reprogramming of the concentrator effort is necessary for this constraint.

B. CASE #2 - CONSTRAINED FUNDING, DELTA FUNDS ON

Case #2 evaluates the same constrained funding condition as the Case #1, however, the delta funds function is used. The solar program is accelerated by roughly 0.9 of a year with equal capability achieved. The battery development begins at an accelerated pace, but is completed at a higher cost, roughly \$70K, and achieves the equivalent capability and timing.

The concentrator program results in an equivalent capability in equivalent time. The average utility of the work varies between Case #1 and Case #2 over time, but is identical between cases by 1990. The average cost/benefit ratio is less favorable for the delta fund driven case due to the early expenditure of funds with subsequent delay in concentrator program execution.

Modification of the program timing for the concentrator program under funding constraints should be evaluated.

C. CASE #3 - SINGLE LAYER PROBLEM STRUCTURE

Case #3 evaluates each program independently as a single layer program. The solar program results are identical since no constraints were realized in the previous case. The battery program achieves full funding and yields a significant increase in capability over the previous case. The cost/benefit ratio is slightly more favorable by 6-7%. The concentrator

***** RESOURCE ALLOCATION MODEL RESULTS SOLAR *****				
02-23-1987			17:34:31	

TX	REQ TOAP DELTAF PSUCC ACCOM OPTPL	UTILITY TOA EXPEND PTECHS VALU PL	UTIL OBP FFUND PSS COSTBEN APL	TUTIL OB EFUND PSF TCOSTBEN DPL

85	0.96 1000.00 20.00 0.76 0.10 4.00	1.10 880.00 105.84 0.95 0.08 5.00	0.08 100.00 14.16 1.00 120.74 0.00	0.08 120.00 105.84 0.80 120.74 0.00

86	0.99 1000.00 54.00 0.76 0.30 4.00	1.13 666.00 341.48 0.95 0.23 5.00	0.26 300.00 6.68 1.00 610.48 0.00	0.26 334.00 447.32 0.80 610.48 0.00

87	0.99 1000.00 84.00 0.76 0.70 4.00	1.21 370.00 624.08 0.95 0.53 5.00	0.65 600.00 12.60 1.00 3137.35 0.00	0.65 630.00 1071.40 0.80 3137.35 0.00

88	1.55 1000.00 60.00 0.76 1.00 4.00	1.35 524.00 479.08 0.95 0.76 5.00	1.03 500.00 9.52 1.00 2970.91 0.00	1.03 476.00 1550.48 0.80 2970.91 0.00

89	1.60 1000.00 5.00 0.76 1.00 4.00	1.39 955.00 53.62 0.95 0.76 5.00	1.06 100.00 0.90 1.00 2962.39 4.11	1.06 45.00 1604.10 0.80 2962.39 -0.89

FIGURE 16

TABULAR RESULTS FOR SOLAR

```

*****
RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
SOLAR REQUIREMENTS
02-23-1987 17:35:27
*****
RAU 0.0 0.7 1.3 2.0
* . . . . *
*****
* . . . . *
85 C R U . . *
* . C R U . . *
86 C R U . . *
* . C R U . . *
87 C R U . . *
* . C U R . . *
88 C U R . . *
* . C U R . . *
89 C U R . . *
* . C U R . . *
90 C U R . . *
* . . . . *
R = REQUIREMENTS - REQ(T%)
C = CAPABILITY ACHEIVED - UTIL(T%)
U = UTILITY FORECAST - UTILITY(T%)
*****

```

```

*****
RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
SOLAR FUNDS
02-23-1987 17:35:42
*****
EOD 0.0 1000.0 2000.0 3000.0
* . . . . *
*****
* . . . . *
85 D EO . . . *
* . O E . . . *
86 D O E . . . *
* . D O E . . . *
87 D O E . . . *
* . D O E . . . *
88 D O E . . . *
* . DO E . . . *
89 DO E . . . *
* . OD E . . . *
90 OD E . . . *
* . . . . *
E = EARNED FUNDS - EFUND(T%)
O = FUNDS OBLIGATED - OBLIG(T%)
D = DELTA FUNDS - DFUNDS(T%)
*****

```

FIGURE 17
GRAPHICAL RESULTS FOR SOLAR

program nearly achieves full funding and yields a doubling in capability.

From a priority perspective, the model has correctly prioritized the programs based on capability. The solar program provides the greatest capability, and is top rated. The battery and concentrator programs follow suite.

Interestingly, the cost/benefit ratio for the concentrator is Case #3 is less favorable than the prior case at program completion. This effect is due to changing utility assessments and a more aggressive funding profile for this case.

D. CASE #4 - FUNDING CONSTRAINT RELIEF

Case #4 evaluates an interdependent problem structure with a less severe funding constraint. Comparing results to Case #2, the solar program is identical in outcome due to no funding constraints being encountered in either case. The battery program achieves full funding and capability equivalent to the independent case. The concentrator program achieves a modestly higher capability with a less favorable cost/benefit ratio. Generally, the average utility and cost/benefit ratio are more favorable for this case. However expenditures are over 900K or 17% higher in total. The average capability is over 17% higher for this case.

E. CASE #5 - EFFICIENCY FACTOR EFFECTS

Case #5 evaluates a modification to the risk assessment for the battery program. The change in the technical risk assessment from 0.75 to 0.99 results in over a 32% increase in program capability compared to Case #3 results. The resulting cost/benefit ratio is extremely favorable being less than one.

The model is sensitive to efficiency parameters. However, accuracy in factors such as probability of technical success is difficult to achieve. The potential to bias results by minimizing the risk assessment is great, suggesting wide review and consensus on model factors is critical to

successful analysis efforts.

F. CASE #6 - TABLE FUNCTION MODIFICATION EFFECTS

Case #6 evaluates the modification of table function slopes, using DFUNDS as the example case. The scope of DFUNDS is doubled and the impact on the concentrator evaluated. Comparing results to those of Case #3, the funds are accelerated as expected with modest a increase in capability, 6%, with less than 1% increase in program expenditures. A more favorable cost/benefit ratio results for this case.

The model is not extremely sensitive to the table function for DFUNDS, although the results of this case are favorable. Additional cases should be examined which evaluate a steeper slope to reduce funds. Correlation to determine the "real world" capability to increase funding rates is needed.

VII. CONCLUSIONS

The model results suggest the Resource Allocation Model is functional and can provide a valuable predictive tool with the availability of data from the integrated resource planning process.

Although applied only to technology alternatives in the example, it is easy to conceive that the Resource Allocation Model will be equally productive in system level evaluations. The range of problems to which it can be applied is unlimited.

Efforts are required to validate the relative accuracy of model results. Time for current program to evolve or a historical data base is needed. If a decision can be modeled within the methodology used by the Resource Allocation Model, and its actual results measured for several cases, then model accuracy can be validated. The programs selected for this effort are ongoing in the Air Force, and only very preliminary results are available for measurement. Early conclusions by industry, concerning the solar program used as an example

for this program, suggest that the Gallium Arsenide solar panel will result in a lower than predicted performance due to the difficulty in manufacturing and applying thin cells to panels. Also, its demonstrated radiation resistance is expected to result in a lower assessment for its survivability potential. Thus the model's prediction of lower than expected capability should be considered a reality for this program.

Additional feedback mechanisms need to be developed to more accurately model programs. The program length evaluation should affect the probability of schedule success factor and in turn the accomplishment evaluation factor. Feedback from the cost/benefit evaluation function to funding rates should be considered in future versions of this model.

REFERENCES

- [1] P.J. Sweeney, A Dynamic Resource Allocation Model, (University of Dayton, Ohio, September 1984), p. 2.
- [2] Ibid., pp. 3-4.
- [3] M. Zeleny, Multiple Criteria Decision Making (Mc Graw-Hill Book Co., New York, 1982), pp. 58-61.
- [4] P.J. Sweeney, USAF Market Penetration Study Of Advanced Energy Technologies, Vol 1, (AF Aero Propulsion Laboratory, WPAFB, Ohio, August 1979), pp. 48-78.
- [5] G. P. Richardson and A. L. Pugh, Introduction To Systems Dynamics Modeling With Dynamo, (MIT Press, Massachusetts), pp. ix-xi.
- [6] Ibid. pp. 2-4.
- [7] Dan Quayle, "The Federal Budget Cycle Should Be Replaced By a Two-Year Budget Process," Base Resource Management (Air Command and Staff College, ACSC 36A, Volume 11, Air University Alabama, 1986) pp. 6-12.
- [8] H. M. Dathe, "Optimum Allocation Of Resources to R&D Projects," Cost Benefit Analysis, ed. by M. G. Kendall, (American Elsevier Publishing Co., New York, 1971), pp. 144-163.
- [9] L. D. Massie, "Spacecraft Power Studies For DSCS III, GPS II, MILSTAR - Improvements Offered By Advanced Components" (Aero Propulsion Laboratory, WPAFB, Ohio, July 1984), pp. 1-34.

BIBLIOGRAPHY

Dathe, H. M. "Optimum Allocation Of Resources to R&D Projects." Cost-Benefit Analysis. Ed. by M. G. Kendall. American Elsevier Publishing Co. New York. 1971.

Massie, Lowell D. Spacecraft Power Studies For DSCS III, DMSP, GPS II, MILSTAR - Improvements Offered By Advanced Components. Aero Propulsion Laboratory. WPAFB, Ohio. July 1984.

Quayle, Dan. "The Federal Budget Cycle Should Be Replaced By A Two-Year Budget Process." Base Resource Management. ASCS 36A Volume 11. Air Command and Staff College. Air University. Maxwell, Alabama. 1986. pp. 6-12.

Richardson G. P. and Pugh A. L. Introduction To Systems Dynamics Modeling With Dynamo. MIT Press. Massachusetts. 1981.

Sweeney Patrick J. et. al. Advanced Technology Multiple Criteria Decision Model. University of Dayton. Dayton, Ohio. November 1981.

Sweeney Patrick J. A Dynamic Resource Allocation Model. University of Dayton. Dayton, Ohio. September 1984.

Sweeney Patrick J. USAF Market Penetration Study of Advanced Energy Technologies. Volume 1. Air Force Aero Propulsion Laboratory. WPAFB, Ohio. July 1986.

Zeleny, Milan. Multiple Criteria Decision Making. McGraw-Hill Book Co. New York. 1982.

APPENDIX A

PROGRAM LISTING

```

1000 REM *****RAM.BAS**
1010 REM *****      RESOURCE ALLOCATION MODEL      *****
1020 REM *****
1030 REM *****  DIMENSION PARAMETER MATRIX  *****
1040 REM *****
1050 DIM OB(100)      : DIM DELTAF(100): DIM T(20)      : DIM EFUND(100)
1060 DIM VALU(100)    : DIM ACCOM(100) : DIM UTIL(100)  : DIM PSUCC(100)
1070 DIM COSTBEN(100) : DIM PSP(100)   : DIM DFUNDS(100) : DIM UTILITY(100)
1080 DIM P(100)       : DIM U(100)     : DIM TOA(100)   : DIM REQ(100)
1090 DIM A(100)       : DIM B(100)     : DIM C(100)     : DIM Z(100)
1100 DIM SPA(100)     : DIM SPB(100)   : DIM SPD(100)   : DIM SPE(100)
1110 DIM TOAP(100)    : DIM OBP(100)   : DIM EXPEND(100) : DIM PFUND(100)
1120 DIM APL(100)     : DIM DPL(100)   : DIM PTECHS(100) : DIM PROJS(100)
1130 DIM TUTILITY(100): DIM TCOSTB(100): DIM TUTIL(100) : DIM PSS(100)
1140 REM *****
1150 REM *****
1160 REM *****  MENU FUNCTIONS  *****
1170 REM *****
1180 REM *****  MENU #1  *****
1190 REM *****
1200 CLS : LOCATE 12,29 : PRINT "RESOURCE ALLOCATION MODEL"
1210 LOCATE 17,38 : PRINT "1987"
1220 LOCATE 23,32 : PRINT "by RG HONEYWELL"
1230 J=1 : FOR J=1 TO 5000 : NEXT J : CLS
1240 REM *****
1250 REM *****  MENU #2  *****
1260 REM *****
1270 CLS : DEFINT J : IF J.REENTRY THEN GOTO 1320
1280 GZ%=2 : Z%=0 : SZ%=1 : CB%=0
1290 FOR TX=TSTART TO TFIN : TUTILITY(TX)=0 : TCOSTB(TX)=0 : TUTIL(TX)=0
1300 NEXT TX
1310 CLS : LOCATE 3,25 : PRINT "RESOURCE ALLOCATION MODEL"
1320 LOCATE 8,15 : PRINT "OPTIONS AVAILABLE:"
1330 LOCATE 12,25 : PRINT "1.....review table functions"
1340 LOCATE 14,25 : PRINT "2.....enter resource allocation model"
1350 LOCATE 16,25 : PRINT "3.....end program"
1360 LOCATE 22,20 : INPUT "select option 1, 2 or 3 ";J.OPTION
1370 OPEN "b:option.doc" FOR OUTPUT AS #1
1380 PRINT #1,J.OPTION : CLOSE #1
1390 IF J.OPTION<1 GOTO 1440
1400 IF J.OPTION>3 GOTO 1440
1410 IF J.OPTION=1 GOTO 6750
1420 IF J.OPTION=2 GOTO 1460
1430 IF J.OPTION=3 GOTO 7820
1440 LOCATE 24,20 : PRINT "option must be between 1 and 3" : GOTO 1360
1450 REM *****
1460 REM *****  MENU #3  *****
1470 REM *****
1480 CLS : LOCATE 3,25 : PRINT "RESOURCE ALLOCATION MODEL"
1490 LOCATE 8,15 : PRINT "OPTIONS AVAILABLE:"
1500 LOCATE 11,25 : PRINT "1.....review model specifications"
1510 LOCATE 13,25 : PRINT "2.....select model output format"
1520 LOCATE 15,25 : PRINT "3.....select programs for review"
1530 LOCATE 17,25 : PRINT "4.....run model"
1540 LOCATE 19,25 : PRINT "5.....return to start"
1550 LOCATE 22,15 : INPUT "select option 1, 2, 3, 4 or 5";J.OPTION
1560 OPEN "B:OPTION.DOC" FOR OUTPUT AS #1
1570 PRINT #1,J.OPTION : CLOSE #1 : CLS
1580 IF J.OPTION<1 GOTO 1650
1590 IF J.OPTION>5 GOTO 1650
1600 IF J.OPTION=1 GOTO 6440
1610 IF J.OPTION=2 GOTO 1690
1620 IF J.OPTION=3 GOTO 5970
1630 IF J.OPTION=4 GOTO 2010
1640 IF J.OPTION=5 GOTO 1250
1650 LOCATE 24,20 : PRINT "option must be between 1 and 4 : GOTO 1510

```

```

1660 REM *****
1670 REM ***** MENU #4 *****
1680 REM *****
1690 CLS : LOCATE 3,25 : PRINT "RESOURCE ALLOCATION MODEL"
1700 LOCATE 12,25 : PRINT "OPTIONS AVAILABLE:"
1710 LOCATE 14,25 : PRINT "1.....graph only"
1720 LOCATE 16,25 : PRINT "2.....table only"
1730 LOCATE 18,25 : PRINT "3.....graph and table"
1740 LOCATE 22,20
1750 INPUT "select option 1, 2, or 3";J.OPTION
1760 OPEN "B:OPTION.DOC" FOR OUTPUT AS #1
1770 PRINT #1,J.OPTION : CLOSE #1
1780 IF J.OPTION < 1 THEN 1980
1790 IF J.OPTION > 3 THEN 1980
1800 IF J.OPTION = 1 THEN GZX=1
1810 IF J.OPTION = 2 THEN GZX=2
1820 IF J.OPTION = 3 THEN GZX=3
1830 CLS : LOCATE 3,25 : PRINT "RESOURCE ALLOCATION MODEL"
1840 LOCATE 12,25 : PRINT "OPTIONS AVAILABLE:"
1850 LOCATE 14,25 : PRINT "1.....screen display only"
1860 LOCATE 16,25 : PRINT "2.....printer only"
1870 LOCATE 18,25 : PRINT "3.....screen and printer"
1880 LOCATE 22,20
1890 INPUT "select option 1, 2, or 3";J.OPTION
1900 OPEN "B:OPTION.DOC" FOR OUTPUT AS #1
1910 PRINT #1,J.OPTION : CLOSE #1
1920 IF J.OPTION < 1 THEN 1990
1930 IF J.OPTION > 3 THEN 1990
1940 IF J.OPTION = 1 THEN SZX=1
1950 IF J.OPTION = 2 THEN SZX=2
1960 IF J.OPTION = 3 THEN SZX=3
1970 GOTO 1460
1980 LOCATE 24,20 : PRINT "option must be between 1 and 3" : GOTO 1750
1990 LOCATE 24,20 : PRINT "option must be between 1 and 3" : GOTO 1830
2000 REM *****
2010 REM ***** ESTABLISH MODEL SPECIFICATIONS *****
2020 REM *****
2030 OPEN "I", #1 , "B:SPEC.DOC"
2040 IF EOF (1) THEN 2070
2050 INPUT #1, TSTART,TFIN,OFF1
2060 CLOSE #1 : GOTO 2100
2070 CLS : LOCATE 15,20 : PRINT "SPECIFICATIONS NOT FOUND"
2080 FOR J=1 TO 5000 : NEXT J : CLOSE #1 : GOTO 1460
2090 REM *****
2100 REM ***** ESTABLISH BUDGET AUTHORITY ***** TOA (TX) *****
2110 REM *****
2120 OPEN "I",#1,"B:TOA.DOC"
2130 IF EOF (1) THEN GOTO 2180
2140 INPUT #1, BAS,PSTART : GOSUB 7140
2150 INPUT #1, TOA(N1),TOA(N2),TOA(N3),TOA(N4),TOA(N5),TOA(N6),TOA(N7)
2160 FOR TX=N1 TO N7 : TOAP(TX)=TOA(TX) : NEXT TX
2170 CLOSE #1 : GOTO 2210
2180 CLS : LOCATE 15,20 : PRINT "TOA NOT IDENTIFIED"
2190 FOR J=1 TO 5000 : NEXT J : CLOSE #1 : GOTO 1460
2200 REM *****
2210 REM ***** ESTABLISH PROJECT(S) TO BE RUN *****
2220 REM *****
2230 OPEN "I", #4 , "B:PROJ.DOC"
2240 ZX=0 : PLC=0 : CBX = CBX+1 : IF EOF (4) THEN GOTO 2260
2250 INPUT #4 , PROJ$ : CLS : LOCATE 15,35 : PRINT PROJ$ : GOTO 2290
2260 CLS : LOCATE 15,30 : PRINT "PROGRAM COMPLETE" : CLOSE #4 : GOTO 2370
2270 FOR J=1 TO 5000 : NEXT J : GOTO 1280
2280 REM *****
2290 REM ***** ESTABLISH PROGRAM SPECIFICATIONS *****
2300 REM *****
2310 OPEN "I" , #1 , "b:PROG.DOC"

```

```

2320 IF EOF (1) GOTO 2360
2330 INPUT #1 , PROGS, TOTF, PL, OPTPL, FR, PTECHS, PDELAY, CDELAY, SUDELAY
2340 IF PROGS=PROJS THEN CLOSE #1 : GOTO 2390
2350 GOTO 2320
2360 CLS : LOCATE 15,30 : PRINT "PROGRAM NOT FOUND IN DATA BASE"
2370 FOR J=1 TO 5000 : NEXT J : GOTO 1290
2380 REM *****
2390 REM ***** ESTABLISH PROJECT REQUIREMENT ***** REQ (TX) *****
2400 REM *****
2410 OPEN "I", #2 , "B:REQDATA.DOC"
2420 FOR TX=TSTART TO TFIN : REQ(TX)=0 : NEXT TX
2430 IF EOF(2) GOTO 2510
2440 INPUT #2 , REQS, PSTART : GOSUB 7140
2450 INPUT #2 , PARAS, UNITS, P(N1),P(N2),P(N3),P(N4),P(N5),P(N6),P(N7),P(N8)
2460 INPUT #2 , PARAS, CONS, U(N1),U(N2),U(N3),U(N4),U(N5),U(N6),U(N7),U(N8)
2470 GOSUB 7720
2480 FOR TX=TSTART TO TFIN
2490 REQ(TX)=REQ(TX) + (P(TX)*U(TX)/PMAX) : NEXT TX
2500 IF CONS="GO" GOTO 2450 ELSE 2530
2510 CLS : LOCATE 15,25 : PRINT "PROGRAM REQUIREMENTS NOT FOUND"
2520 FOR J=1 TO 4000 : NEXT J : CLOSE #2 : GOTO 1290
2530 IF REQS=PROJS GOTO 2540 ELSE 2420
2540 CLOSE #2
2550 REM *****
2560 REM ***** DETERMINE PARAMETER VALUE AND UTILITY ***** UTILITY(TX) ***
2570 REM *****
2580 OPEN "I", #3, "B:PDATA.DOC"
2590 FOR TX=1 TO 100 : UTILITY(TX)=0 : OB(TX)=0 : NEXT TX
2600 IF EOF (3) THEN 2680
2610 INPUT #3 ,PARAS,PSTART : GOSUB 7140
2620 INPUT #3 ,PARS,UNITS, P(N1),P(N2),P(N3),P(N4),P(N5),P(N6)
2630 INPUT #3 ,PARS,CONS, U(N1),U(N2),U(N3),U(N4),U(N5),U(N6)
2640 GOSUB 7720
2650 FOR TX=TSTART TO TFIN : UTILITY(TX)=UTILITY(TX)+(P(TX)*U(TX)/PMAX) : NEXT TX
2660 IF CONS="GO" THEN 2620
2670 IF PARAS=PROGS THEN 2700 ELSE 2590
2680 CLS : LOCATE 15,25 : PRINT "PROGRAM UTILITY DESCRIPTION NOT FOUND"
2690 FOR J=1 TO 5000 : NEXT J : CLOSE #3 : GOTO 1290
2700 CLOSE #3
2710 FOR TX=TSTART TO TFIN : TUTILITY(TX)=TUTILITY(TX)+UTILITY(TX) : NEXT TX
2720 REM *****
2730 REM ***** DETERMINE OBLIGATIONS ***** OB(TX) ***
2740 REM *****
2750 OPEN "I", #1, "B:OBLIG.DOC"
2760 FOR TX=1 TO 100 : OB(TX)=0 : OBP(TX)=0 : NEXT TX
2770 IF EOF (1) GOTO 2810
2780 INPUT #1 ,NS, PSTART : GOSUB 7140
2790 INPUT #1 ,OB(N1),OB(N2),OB(N3),OB(N4),OB(N5),OB(N6)
2800 IF NS=PROGS GOTO 2830 ELSE 2760
2810 CLS : LOCATE 15,25 : PRINT "OBLIGATION PROFILE NOT FOUND"
2820 FOR J=1 TO 5000 : NEXT J : CLOSE #1 : GOTO 1290
2830 FOR TX=N1 TO N6 : OBP(TX)=OB(TX) : NEXT TX : CLOSE #1
2840 IF PSTART < TSTART THEN TSTART=PSTART
2850 REM *****
2860 REM ***** CALCULATE TABLE VALUES *****B:TABMAK.DOC*****
2870 REM *****
2880 PLC=0 : TERM=0 : FOR TX=TSTART TO TFIN : APL(TX)=0 : DPL(TX)=0 : NEXT TX
2890 FOR TX=TSTART TO TFIN
2900 OPEN "I", #2, "B:TABMAK.DOC"
2910 REM *****
2920 REM ***** CALCULATE VALUE FOR DELTA FUNDS SCALAR *****DFUNDS*****
2930 REM *****
2940 INPUT #2,PS,UL,LL,IN
2950 INPUT #2,T(0),T(1),T(2),T(3),T(4),T(5),T(6),T(7),T(8),T(9),T(10)
2960 IX=((REQ(TX)-UTIL(TX-1))/(REQ(TX)-.0001))-LL)/IN
2970 IF IX > 10 THEN IX = 10

```

```

2980 IF IX < 0 THEN IX = 0
2990 DFUNDS(TX)=T(IX)
3000 REM *****
3010 REM ***** CALCULATE VALUE FOR EXPENDITURES *****EFUND*****
3020 REM *****
3030 DELTAF(TX)= 0
3040 IF EFUND(TX-1) > TOTF THEN GOSUB 3190 : GOTO 3110
3050 IF (TOA(TX)-OB(TX)) < 0 THEN OB(TX) = TOA(TX)
3060 DELTAF(TX)= DFUNDS(TX) * OBP(TX) * OFF1
3070 IF (TOA(TX)-OB(TX)-DELTAF(TX)) <=0 THEN DELTAF(TX)=0
3080 OB(TX)= OB(TX) + DELTAF(TX)
3090 OB(TX+1)= OB(TX+1) - DELTAF(TX)
3100 TOA(TX)= TOA(TX) - OB(TX)
3110 IF TX > PSTART THEN SUDELAY=1
3120 IF TX > PSTART THEN CDELAY =1
3130 IF TX > PSTART THEN FDELAY =.98
3140 EXPEND(TX)= (OB(TX) * FDELAY * CDELAY * SUDELAY) + FFUND(TX-1)
3150 EFUND(TX)= EFUND(TX-1) + EXPEND(TX)
3160 FFUND(TX)= OB(TX) + FFUND(TX-1) - EXPEND(TX)
3170 GOTO 3210
3180 REM ***** COMPLETION OF FUNDING SUBROUTINE *****
3190 FOR TTX=TX TO 100 : OB(TTX)=0 : NEXT TTX
3200 RETURN
3210 REM *****
3220 REM ***** DETERMINE ACCOMPLISHMENT *****ACCOM*****
3230 REM *****
3240 INPUT #2,PS,UL,LL,IN
3250 INPUT #2,T(0),T(1),T(2),T(3),T(4),T(5),T(6),T(7),T(8),T(9),T(10)
3260 AX=((EFUND(TX)/TOTF)-LL)/IN
3270 IF AX > 10 THEN AX=10
3280 IF AX < 0 THEN AX=0
3290 ACCOM(TX)=T(AX)
3300 REM *****
3310 REM ***** DETERMINE PROBABILITY OF SUCCESS BASED ON SCHEDULE *****PSS*****
3320 REM *****
3330 INPUT #2,PS,UL,LL,IN
3340 INPUT #2,T(0),T(1),T(2),T(3),T(4),T(5),T(6),T(7),T(8),T(9),T(10)
3350 SX=((PL/OPTPL)-LL)/IN
3360 IF SX > 10 THEN SX=10
3370 IF SX < 0 THEN SX=0
3380 PSS(TX)=T(SX)
3390 REM *****
3400 REM ***** DETERMINE PROBABILITY OF SUCCESS BASED ON FUNDING *****PSF*****
3410 REM *****
3420 INPUT #2,PS,UL,LL,IN
3430 INPUT #2,T(0),T(1),T(2),T(3),T(4),T(5),T(6),T(7),T(8),T(9),T(10)
3440 FX=((TOTF/FR)-LL)/IN
3450 IF FX > 10 THEN FX=10
3460 IF FX < 0 THEN FX=0
3470 PSF(TX)=T(FX)
3480 REM *****
3490 REM ***** ROLL UP FOR PROBABILITY OF SUCCESS, VALUE, BENEFIT,AND UTILITY**
3500 REM *****
3510 PSUCC(TX)=PTECHS*PSS(TX)*PSF(TX)
3520 VALU(TX)=ACCOM(TX)*PSUCC(TX)
3530 UTIL(TX)=UTILITY(TX)*VALU(TX)
3540 TUTIL(TX)= TUTIL(TX)+UTIL(TX) : IF CBX > 1 THEN TUTIL(TX)=TUTIL(TX)/2
3550 REM *****
3560 REM ***** COST/BENEFIT RATIO CALCULATION *****
3570 REM *****
3580 DUTIL= UTIL(TX) / REQ(TX)
3590 COSTBEN(TX)=EFUND(TX)/(FR * (DUTIL + .001))
3600 TCOSTB(TX) = TCOSTB(TX) + COSTBEN(TX) : IF CBX > 1 THEN TCOSTB(TX)=TCOSTB(TX)/2
3610 REM *****
3620 REM ***** PROGRAM LENGTH EVALUATION ***** APL, DPL *****
3630 REM *****

```

```

3640 SK=1
3650 IF TX < PSTART THEN 3790
3660 IF TX < TFIN THEN 3670 ELSE 3720
3670 IF TERM=0 THEN 3680 ELSE 3790
3680 IF EFUND(TX) > TOTF THEN 3770 ELSE 3690
3690 IF OB(TX+1) <= SK THEN 3700 ELSE 3710
3700 IF OB(TX+1) <= SK AND FFUND(TX) <=SK THEN 3770 ELSE 3710
3710 PLC = PLC + 1 : GOTO 3790
3720 IF TX = TFIN AND TERM=0 THEN 3730 ELSE 3790
3730 IF OB(TX+1) <= SK THEN 3740 ELSE 3750
3740 IF FFUND(TX)<= SK THEN 3770 ELSE 3750
3750 PLC = PLC + 1 : APL(TX)= PLC + ((FFUND(TX)+OB(TX+1))/(EXPEND(TX)+.0001))
3760 DPL(TX)= APL(TX) - PL : GOTO 3790
3770 APL(TX)= PLC + (EXPEND(TX)/(EXPEND(TX-1)+.0001))
3780 DPL(TX)= APL(TX) - PL : TERM=1
3790 REM *****
3800 REM *****
3810 REM ***** COMPLETE TABLE FUNCTIONS *****
3820 REM *****
3830 CLOSE #2 : NEXT TX
3840 REM *****
3850 REM ***** GRAPHICS *****
3860 REM *****
3870 IF GZX=1 THEN GOSUB 4600 : GOTO 2240
3880 IF GZX=2 THEN GOSUB 3920 : GOTO 2240
3890 IF GZX=3 THEN GOSUB 3920 : GOSUB 4600 : GOTO 2240
3900 REM *****
3910 REM ***** TABLE PRODUCTION *****
3920 REM *****
3930 IF SZX=1 THEN GOSUB 3980
3940 IF SZX=2 THEN GOSUB 4140
3950 IF SZX=3 THEN GOSUB 3980 : ZX=0 : GOSUB 4140
3960 FOR TX=TSTART TO TFIN : TOAP(TX)=TOA(TX) : NEXT TX
3970 RETURN
3980 FOR TX=TSTART TO TFIN
3990 ZX=ZX+1 : IF ZX=1 THEN GOSUB 4270
4000 PRINT USING "####" ;TX
4010 PRINT SPC(15) USING "#####.##" ;REQ(TX);UTILITY(TX);UTIL(TX);TUTIL(TX)
4020 PRINT SPC(15) USING "#####.##" ;TOAP(TX);TOA(TX);OBP(TX);OB(TX)
4030 PRINT SPC(15) USING "#####.##" ;DELTA(TX);EXPEND(TX);FFUND(TX);EFUND(TX)
4040 PRINT SPC(15) USING "#####.##" ;PSUCC(TX);PTECHS;PSS(TX);PSF(TX)
4050 PRINT SPC(15) USING "#####.##" ;ACCOM(TX);VALU(TX);COSTBEN(TX);TCOSTB(TX)
4060 PRINT SPC(15) USING "#####.##" ;OPTPL;PL;APL(TX);DPL(TX)
4070 PRINT"-----"
4080 INPUT "CONTINUE (Y)";J.OPTIONS : IF J.OPTIONS="Y" THEN GOTO 4090
4090 OPEN "B:OPTIONS.DOC" FOR OUTPUT AS #1
4100 PRINT #1,J.OPTIONS : CLOSE #1
4110 NEXT TX
4120 RETURN
4130 REM *****
4140 FOR TX=TSTART TO TFIN
4150 ZX=ZX+1 : IF ZX=1 THEN GOSUB 4440
4160 LPRINT USING "####" ;TX
4170 LPRINT SPC(15) USING "#####.##" ;REQ(TX);UTILITY(TX);UTIL(TX);TUTIL(TX)
4180 LPRINT SPC(15) USING "#####.##" ;TOAP(TX);TOA(TX);OBP(TX);OB(TX)
4190 LPRINT SPC(15) USING "#####.##" ;DELTA(TX);EXPEND(TX);FFUND(TX);EFUND(TX)
4200 LPRINT SPC(15) USING "#####.##" ;PSUCC(TX);PTECHS;PSS(TX);PSF(TX)
4210 LPRINT SPC(15) USING "#####.##" ;ACCOM(TX);VALU(TX);COSTBEN(TX);TCOSTB(TX)
4220 LPRINT SPC(15) USING "#####.##" ;OPTPL;PL;APL(TX);DPL(TX)
4230 LPRINT"-----"
4240 NEXT TX
4250 RETURN
4260 REM *****
4270 REM ***** TABLE HEADER SUBROUTINE *****
4280 REM *****
4290 CLS

```

```

4300 PRINT "*****"
4310 PRINT "                      RESOURCE ALLOCATION MODEL RESULTS                      "
4320 PRINT SPC(35) PROJS
4330 ADATES=DATES : ATIMES=TIMES : PRINT SPC(2) ADATES SPC(45) ATIMES
4340 PRINT "*****"
4350 PRINT "      TX"
4360 PRINT SPC(15)"      REQ      UTILITY      UTIL      TUTIL      "
4370 PRINT SPC(15)"      TOAP      TOA      OBP      OB      "
4380 PRINT SPC(15)"      DELTAF      EXPEND      FFUND      EFUND      "
4390 PRINT SPC(15)"      PSUCC      PTECHS      PSS      PSF      "
4400 PRINT SPC(15)"      ACCOM      VALU      COSTBEN      TCOSTBEN      "
4410 PRINT SPC(15)"      OPTPL      PL      APL      DPL      "
4420 PRINT "*****"
4430 RETURN
4440 CLS
4450 LPRINT "*****"
4460 LPRINT "                      RESOURCE ALLOCATION MODEL RESULTS                      "
4470 LPRINT SPC(35) PROJS
4480 ADATES=DATES : ATIMES=TIMES : LPRINT SPC(2) ADATES SPC(45) ATIMES
4490 LPRINT "*****"
4500 LPRINT "      TX"
4510 LPRINT SPC(15)"      REQ      UTILITY      UTIL      TUTIL      "
4520 LPRINT SPC(15)"      TOAP      TOA      OBP      OB      "
4530 LPRINT SPC(15)"      DELTAF      EXPEND      FFUND      EFUND      "
4540 LPRINT SPC(15)"      PSUCC      PTECHS      PSS      PSF      "
4550 LPRINT SPC(15)"      ACCOM      VALU      COSTBEN      TCOSTBEN      "
4560 LPRINT SPC(15)"      OPTPL      PL      APL      DPL      "
4570 LPRINT "*****"
4580 RETURN
4590 REM *****
4600 REM ***** GRAPH PRODUCTION *****
4610 REM *****
4620 CLS : LOCATE 3,25 : PRINT "RESOURCE ALLOCATION MODEL"
4630 LOCATE 8,10 : PRINT " GRAPHIC OPTIONS AVAILABLE:"
4640 LOCATE 13,25 : PRINT "1.....requirements graph only"
4650 LOCATE 14,25 : PRINT "2.....funds graph only"
4660 LOCATE 15,25 : PRINT "3.....both graphs"
4670 LOCATE 16,25 : PRINT "4.....continue with program"
4680 LOCATE 20,20 : INPUT "select option 1, 2, 3, or 4";J.OPTION
4690 OPEN "B:OPTION.DOC" FOR OUTPUT AS #2
4700 PRINT #2, J.OPTION : CLOSE #2
4710 IF J.OPTION<1 THEN 4780
4720 IF J.OPTION>4 THEN 4780
4730 IF J.OPTION=1 THEN GS="REQUIREMENTS" : GOSUB 4790
4740 IF J.OPTION=2 THEN GS="FUNDS" : GOSUB 5010
4750 IF J.OPTION=3 THEN CX=1 : GS="REQUIREMENTS" : GOSUB 4790 : CX=2 : PZX=0 : GS="FUNDS" : GOSUB 50
4760 IF J.OPTION = 4 THEN 2240
4770 PZX=0 : GOTO 4600
4780 LOCATE 24,20 : PRINT "OPTION MUST BE BETWEEN 1 AND 4" : GOTO 4680
4790 REM *****
4800 REM **** REQUIREMENTS GRAPH SUBROUTINE *****
4810 REM *****
4820 LOCATE 22,10: PRINT PROJS,GS
4830 LOCATE 23,10 : INPUT "LOWER LIMIT DESIRED ";LL
4840 LOCATE 24,10 : INPUT "UPPER LIMIT DESIRED ";UL
4850 IN=UL-LL
4860 AS="R" : BS="A" : CS="U" : INV=63
4870 FOR TX=TSTART TO TFIN
4880 A(TX)=INV/(UL-LL)*(REQ(TX)-LL)
4890 B(TX)=INV/(UL-LL)*(UTIL(TX)-LL)
4900 C(TX)=INV/(UL-LL)*(UTILITY(TX)-LL)
4910 NEXT TX
4920 IF SZX=1 THEN GOSUB 5220: GOSUB 5460
4930 IF SZX=2 THEN PZX=1 : GOSUB 5350: GOSUB 5620
4940 IF SZX=3 AND PZX=0 THEN GOSUB 5220: GOSUB 5460 : PZX=1 : GOTO 4860
4950 IF SZX=3 AND PZX=1 THEN GOSUB 5350 : GOSUB 5620

```

```

4960 IF PZX=1 THEN LPRINT "R = REQUIREMENTS - REQ(TX)"
4970 IF PZX=1 THEN LPRINT "C = CAPABILITY ACHIEVED - UTIL(TX)"
4980 IF PZX=1 THEN LPRINT "U = UTILITY FORECAST - UTILITY(TX)"
4990 RETURN
5000 REM *****
5010 REM **** FUNDS GRAPH SUBROUTINE *****
5020 REM *****
5030 LOCATE 22,10: PRINT PROJS,GS
5040 LOCATE 23,10 : INPUT "LOWER LIMIT DESIRED ";LL
5050 LOCATE 24,10 : INPUT "UPPER LIMIT DESIRED ";UL
5060 IN=UL-LL
5070 AS="E" : BS="O" : CS="D" : INV=63
5080 FOR TX=TSTART TO TFIN
5090 A(TX)=INV/(UL-LL)*(EFUND(TX)-LL)
5100 B(TX)=INV/(UL-LL)*(OB(TX)-LL)
5110 C(TX)=INV/(UL-LL)*(DELTA(TX)-LL)
5120 NEXT TX
5130 IF SZX=1 THEN GOSUB 5220: GOSUB 5460
5140 IF SZX=2 THEN PZX=1 : GOSUB 5350: GOSUB 5620
5150 IF SZX=3 AND PZX=0 THEN GOSUB 5220: GOSUB 5460 : PZX=1 : GOTO 5070
5160 IF SZX=3 AND PZX=1 THEN GOSUB 5350 : GOSUB 5620
5170 IF PZX=1 THEN LPRINT "E = EARNED FUNDS - EFUND(TX)"
5180 IF PZX=1 THEN LPRINT "O = FUNDS OBLIGATED - OBLIG(TX)"
5190 IF PZX=1 THEN LPRINT "D = DELTA FUNDS - DFUNDS(TX)"
5200 RETURN
5210 REM *****
5220 REM **** GRAPH HEADER SUBROUTINE *****
5230 REM *****
5240 CLS
5250 PRINT"*****"
5260 PRINT "          RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION "
5270 PRINT SPC(25) PROJS , GS
5280 ADATES=DATES : ATIMES=TIMES : PRINT SPC(6) ADATES SPC(47) ATIMES
5290 PRINT"*****"
5300 PRINT AS;BS;CS SPC(1) USING "####.#" ;LL,LL+IN/3,LL+IN/3*2,UL
5310 PRINT "*" SPC(7) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC(6) "*"
5320 PRINT"*****"
5330 PRINT "*" SPC(7) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC(6) "*"
5340 RETURN
5350 LPRINT"*****"
5360 LPRINT "          RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION "
5370 LPRINT SPC(25) PROJS , GS
5380 ADATES=DATES : ATIMES=TIMES : LPRINT SPC(6) ADATES SPC(47) ATIMES
5390 LPRINT"*****"
5400 LPRINT AS;BS;CS SPC(1) USING "####.#" ;LL,LL+IN/3,LL+IN/3*2,UL
5410 LPRINT "*" SPC(7) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC(6) "*"
5420 LPRINT"*****"
5430 LPRINT "*" SPC(7) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC(6) "*"
5440 RETURN
5450 REM *****
5460 REM **** GRAPH PRINT SUBROUTINE *****
5470 REM *****
5480 FOR TX=TSTART TO TFIN
5490 GOSUB 5780
5500 SPA(TX)=A(TX)
5510 SPB(TX)=B(TX)-A(TX)-1
5520 SPD(TX)=C(TX)-B(TX)-1
5530 SPE(TX)=INV - C(TX)
5540 PRINT TX SPC(4) SPC(SPA(TX)) AS SPC(SPB(TX)) BS SPC(SPD(TX)) CS
5550 PRINT "*" SPC(7) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC(6) "*"
5560 NEXT TX
5570 PRINT"*****"
5580 LOCATE 24,5 : INPUT "CONTINUE (Y)";J.OPTIONS : IF J.OPTIONS="Y" THEN GOTO 5590
5590 OPEN "B:OPTIONS.DOC" FOR OUTPUT AS #1
5600 PRINT #1,J.OPTIONS : CLOSE #1 : CLS
5610 RETURN

```

```

5620 REM *****
5630 FOR TX=TSTART TO TFIN
5640 GOSUB 5780
5650 SPA(TX)=A(TX)
5660 SPB(TX)=B(TX)-A(TX)-1
5670 SPD(TX)=C(TX)-B(TX)-1
5680 SPE(TX)=INV - C(TX)
5690 LPRINT TX SPC(4) SPC(SPA(TX)) AS SPC(SPB(TX)) BS SPC(SPD(TX)) CS
5700 LPRINT "*" SPC(7) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC((INV/3)-1) "." SPC(6) "*"
5710 NEXT TX
5720 LPRINT"*****"
5730 LOCATE 24,5 : INPUT "CONTINUE (Y)";J.OPTIONS : IF J.OPTIONS="Y" THEN GOTO 5590
5740 OPEN "B:OPTIONS.DOC" FOR OUTPUT AS #1
5750 PRINT #1,J.OPTIONS : CLOSE #1 : CLS
5760 RETURN
5770 REM *****
5780 REM ***** GRAPH SORT SUBROUTINE *****
5790 REM *****
5800 IF J.OPTION=1 THEN AS="R" : BS="C" : CS="U"
5810 IF J.OPTION=2 THEN AS="E" : BS="O" : CS="D"
5820 IF J.OPTION=3 AND CX=1 THEN AS="R" : BS="C" : CS="U"
5830 IF J.OPTION=3 AND CX=2 THEN AS="E" : BS="O" : CS="D"
5840 IF A(TX) <= B(TX) THEN 5880
5850 Z(TX)=A(TX) : ZS=AS
5860 A(TX)=B(TX) : AS=BS
5870 B(TX)=Z(TX) : BS=ZS
5880 IF B(TX) <= C(TX) THEN 5930
5890 Z(TX)=B(TX) : ZS=BS
5900 B(TX)=C(TX) : BS=CS
5910 C(TX)=Z(TX) : CS=ZS
5920 GOTO 5840
5930 RETURN
5940 REM *****
5950 REM ***** MENU # 6 *****
5960 REM *****
5970 CLS : LOCATE 3,25 : PRINT "RESOURCE ALLOCATION MODEL"
5980 LOCATE 8,10 : PRINT " PROGRAMS AVAILABLE FOR REVIEW:"
5990 TTX=0
6000 OPEN "I", #1, "B:PROG.DOC"
6010 IF EOF(1) THEN 6050
6020 TTX=TTX+1
6030 INPUT #1, PROGS, TOTF, PL, OPTPL, FR, PTECHS, FDELAY, CDELAY, SUDELAY
6040 PROJS(TTX)=PROGS : PTECHS(TTX)=PTECHS : GOTO 6010
6050 CLOSE #1
6060 LOCATE 13,25 : PRINT "1.....";PROJS(1)
6070 LOCATE 14,25 : PRINT "2.....";PROJS(2)
6080 LOCATE 15,25 : PRINT "3.....";PROJS(3)
6090 LOCATE 16,25 : PRINT "4.....ALL"
6100 LOCATE 22,20 : INPUT "select option 1, 2, 3, or 4";J.OPTION
6110 OPEN "B:OPTION.DOC" FOR OUTPUT AS #2
6120 PRINT #2, J.OPTION : CLOSE #2
6130 OPEN "O", #2, "b:PROJ.DOC"
6140 IF J.OPTION < 1 THEN 6250
6150 IF J.OPTION > 4 THEN 6250
6160 IF J.OPTION = 1 THEN 6200
6170 IF J.OPTION = 2 THEN 6210
6180 IF J.OPTION = 3 THEN 6220
6190 IF J.OPTION = 4 THEN GOSUB 7220 : GOTO 6230
6200 PRINT #2, PROJS(1); " " : GOTO 6240
6210 PRINT #2, PROJS(2); " " : GOTO 6240
6220 PRINT #2, PROJS(3); " " : GOTO 6240
6230 PRINT #2, PROJS(1); ",", PROJS(2); ",", PROJS(3); " "
6240 CLOSE #2 : GOTO 1460
6250 LOCATE 24,20 : PRINT "OPTION MUST BE BETWEEN 1 AND 4" : GOTO 6100
6260 REM *****
6270 REM ***** MENU #7 *****

```

```

6280 REM *****
6290 CLS : LOCATE 3, 25 : PRINT "RESOURCE ALLOCATION MODEL"
6300 LOCATE 8,25 : PRINT "OPTIONS AVAILABLE:"
6310 LOCATE 12,25 : PRINT "1.....review specifications"
6320 LOCATE 14,25 : PRINT "2.....revise specifications"
6330 LOCATE 16,25 : PRINT "3.....return"
6340 LOCATE 22,20
6350 INPUT "SELECT OPTION 1, 2 OR 3";J.OPTION
6360 OPEN "B:OPTION.DOC" FOR OUTPUT AS #1
6370 PRINT #1, J.OPTION : CLOSE #1
6380 IF J.OPTION<1 THEN 6430
6390 IF J.OPTION>3 THEN 6430
6400 IF J.OPTION=1 THEN 6440
6410 IF J.OPTION=2 THEN 6640
6420 IF J.OPTION=3 THEN 1460
6430 LOCATE 24,20 : PRINT "OPTION MUST BE BETWEEN 1 AND 3" : GOTO 6350
6440 OPEN "I", #1 , "B:SPEC.DOC"
6450 IF EOF (1) THEN 6620
6460 INPUT #1, TSTART,TFIN,OFF1
6470 CLOSE #1
6480 CLS : LOCATE 3, 25 : PRINT "RESOURCE ALLOCATION MODEL"
6490 LOCATE 8,15 : PRINT "MODEL SPECIFICATIONS:"
6500 LOCATE 12,25 : PRINT "START TIME :           ",TSTART
6510 LOCATE 14,25 : PRINT "FINISH TIME:           ",TFIN
6520 IF OFF1=1 THEN OPTS="YES"
6530 IF OFF1=0 THEN OPTS="NO"
6540 LOCATE 16,25 : PRINT "DELTA FUNDS OPTION:      ",OPTS
6550 LOCATE 22,20
6560 INPUT "MODIFY OPTIONS (Y OR N)";J.OPTIONS
6570 OPEN "B:J.OPTIONS.DOC" FOR OUTPUT AS #1
6580 PRINT #1 , J.OPTIONS : CLOSE #1
6590 IF J.OPTIONS="Y" THEN 6640
6600 IF J.OPTIONS="N" THEN 1460
6610 GOTO 6270
6620 LOCATE 24,20 : PRINT "SPECIFICATIONS NOT FOUND"
6630 FOR J=1 TO 5000 : NEXT J : GOTO 6270
6640 OPEN "O",#1 , "B:SPEC.DOC"
6650 CLS : LOCATE 3, 25 : PRINT "RESOURCE ALLOCATION MODEL"
6660 LOCATE 8,15 : PRINT "REVISIONS TO SPECIFICATIONS:"
6670 LOCATE 12,25 : INPUT " START TIME (XX)"           ;TSTART
6680 LOCATE 14,25 : INPUT " FINISH TIME (XX)"           ;TFIN
6690 LOCATE 16,25 : INPUT " DELTA FUNDS OPTION (Y or N)";OPTS
6700 IF OPTS="Y" THEN OFF1=1
6710 IF OPTS="N" THEN OFF1=0
6720 PRINT #1, TSTART, " , " , TFIN , " , " , OFF1 , " "
6730 CLOSE #1 : GOTO 6270
6740 REM *****
6750 REM ***** MENU #8 *****
6760 REM *****
6770 CLS : LOCATE 3,25 : PRINT "RESOURCE ALLOCATION MODEL"
6780 LOCATE 8,15 : PRINT "OPTIONS AVAILABLE:"
6790 LOCATE 11,25 : PRINT "1.....accomplishment"
6800 LOCATE 13,25 : PRINT "2.....probability of schedule success"
6810 LOCATE 15,25 : PRINT "3.....probability of funding success"
6820 LOCATE 17,25 : PRINT "4.....delta funds"
6830 LOCATE 19,25 : PRINT "5.....return to start"
6840 LOCATE 22,20
6850 INPUT "select option 1, 2, 3, 4 or 5";J.OPTION
6860 OPEN "B:OPTION.DOC" FOR OUTPUT AS #1
6870 PRINT #1,J.OPTION : CLOSE #1
6880 IF J.OPTION < 1 THEN 6960
6890 IF J.OPTION > 5 THEN 6960
6900 IF J.OPTION = 1 THEN PPS="ACCOM"
6910 IF J.OPTION = 2 THEN PPS="PSS"
6920 IF J.OPTION = 3 THEN PPS="PSF"
6930 IF J.OPTION = 4 THEN PPS="DFUNDS"

```

```

6940 IF J.OPTION = 5 THEN GOTO 1250
6950 GOTO 6970
6960 LOCATE 24,20 : PRINT "option must be between 1 and 3" : GOTO 6850
6970 OPEN "I", #1, "B:TABMAK.DOC"
6980 IF EOF(1) THEN 7120
6990 INPUT #1,PS,UL,LL,IN,T(0),T(1),T(2),T(3),T(4),T(5),T(6),T(7),T(8),T(9),T(10)
7000 IF PS=PPS THEN 7010 ELSE 6980
7010 CLS : LOCATE 7,30: PRINT PS
7020 LOCATE 10,25 : PRINT "UPPER LIMIT.....", UL
7030 LOCATE 12,25 : PRINT "LOWER LIMIT.....", LL
7040 LOCATE 15,3
7050 PRINT " TO      T1      T2      T3      T4      T5      T6      T7      T8      T9      T10"
7060 LOCATE 16,3
7070 PRINT USING "##.## ";T(0);T(1);T(2);T(3);T(4);T(5);T(6);T(7);T(8);T(9);T(10)
7080 LOCATE 22,5
7090 INPUT "continue (Y)";J.OPTIONS
7100 OPEN "B:OPTIONS.DOC" FOR OUTPUT AS #2
7110 PRINT #2, J.OPTIONS : CLOSE #2 : CLS : CLOSE #1 : GOTO 6750
7120 PRINT "FUNCTION NOT LOCATED IN FILE" : I=1 : FOR I=1 TO 5000 : NEXT I : CLS
7130 GOTO 1250
7140 REM *****
7150 REM **** TIME SUBROUTINE *****
7160 REM *****
7170 N1=PSTART : N2=N1+1 : N3=N1+2 : N4=N1+3 : N5=N1+4 : N6=N1+5 : N7=N1+6
7180 N8=N1+7 : N9=N1+8 : N10=N1+9
7190 RETURN
7200 REM *****
7210 REM *****
7220 REM **** PROJECT PRIORITY SUBROUTINE *****
7230 REM *****
7240 OPEN "I", #1, "B:SPEC.DOC"
7250 IF EOF (1) THEN 7280
7260 INPUT #1, TSTART,TFIN,OFF1
7270 CLOSE #1 : GOTO 7300
7280 CLS : LOCATE 15,20 : PRINT "SPECIFICATIONS NOT FOUND"
7290 FOR J=1 TO 5000 : NEXT J : CLOSE #1 : GOTO 1460
7300 TTX=TTX : TTX=TTX
7310 FOR TTX=1 TO TTX
7320 OPEN "I", #3, "B:PDATA.DOC"
7330 FOR TX=TSTART TO TFIN : UTILITY(TX)=0 : NEXT TX
7340 IF EOF (3) THEN 7410
7350 INPUT #3 ,PARAS, PSTART : GOSUB 7150
7360 INPUT #3 ,PARS,UNITS, P(N1),P(N2),P(N3),P(N4),P(N5),P(N6)
7370 INPUT #3 ,PARS,CONS, U(N1),U(N2),U(N3),U(N4),U(N5),U(N6)
7380 FOR TX=TSTART TO TFIN : UTILITY(TX)=UTILITY(TX)+(P(TX)*U(TX)) : NEXT TX
7390 IF CONS="GO" THEN 7360
7400 IF PARAS=PROJS(TTX) THEN 7430 ELSE 7340
7410 CLS : LOCATE 15,25 : PRINT "PROGRAM UTILITY DESCRIPTION NOT FOUND"
7420 FOR J=1 TO 5000 : NEXT J : CLOSE #3 : CLOSE #2 : GOTO 1290
7430 PSTART(TTX)=PSTART : UTILITY(TTX)=UTILITY(TFIN)
7440 CLOSE #3 : NEXT TTX
7450 TYX=0
7460 FOR TTX=1 TO TTX
7470 TYX=TYX+1
7480 FOR TX=1 TO (TTX-TYX)
7490 IF UTILITY(TTX) < UTILITY(TTX+TX) THEN GOSUB 7580
7500 IF PTECHS(TTX) < PTECHS(TTX+TX)-.1 THEN GOSUB 7580
7510 IF PSTART(TTX) > PSTART(TTX+TX) THEN GOSUB 7580
7520 NEXT TX
7530 NEXT TTX
7540 RETURN
7550 REM *****
7560 REM **** PROJECT SWITCH SUBROUTINE *****
7570 REM *****
7580 XPROJS=PROJS(TTX+TX)
7590 PROJS(TTX+TX)= PROJS(TTX)

```

```

7600 PROJS(TTX)=XPROJS
7610 XSTART= PSTART(TTX+TX)
7620 PSTART(TTX+TX)= PSTART(TTX)
7630 PSTART(TTX)= XSTART
7640 XUTIL = UTILITY(TTX+TX)
7650 UTILITY(TTX+TX) = UTILITY(TTX)
7660 UTILITY(TTX) = XUTIL
7670 XPTECHS= PTECHS(TTX+TX)
7680 PTECHS(TTX+TX)= PTECHS(TTX)
7690 PTECHS(TTX)= XPTECHS
7700 RETURN
7710 REM *****
7720 REM ***** PMAX DETERMINATION SUBROUTINE *****
7730 REM *****
7740 PMAX= P(TSTART)
7750 FOR TX=TSTART TO TFIN
7760 IF PMAX < P(TX+1) THEN PMAX = P(TX+1)
7770 NEXT TX
7780 RETURN
7790 REM *****
7800 REM ***** PROGRAM WRAPUP *****
7810 REM *****
7820 CLS : LOCATE 12,33 : PRINT "THE END" : LOCATE 24,1 : END
7830 REM *****

```

APPENDIX B
PROGRAM DATA

FILENAME: SPEC.DOC

SPECIFICATIONS FOR PROJECT RUN

DATA

TSTART,TFIN,OFF1

85 , 90 , 1

KEY

TSTART = Start time for project run.
TFIN = Finish time for project run.
OFF1 = Delta funds option (0= off, 1=on).

FILENAME: TABMAK.DOC

TABLE FUNCTIONS

DATA

PS,UL,LL,IN,
T(1),T(2),T(3),T(4),T(5),T(6),T(7),T(8),T(9),T(10)

DFUNDS , 1 , 0 , .1 ,
-.3 , -.2 , -.1 , .0 , .05 , .10 , .12 , .14 , .16 , .18 , .20 ,

ACCOM , 1 , 0 , .1 ,
0 , .1 , .2 , .3 , .4 , .5 , .6 , .7 , .8 , .9 , 1 ,

PSS , 2 , 0 , .2 ,
0 , .15 , .40 , .65 , .80 , .98 , 1 , 1 , 1 , 1 , 1 ,

PSF , 2 , 0 , .2 ,
0 , .15 , .40 , .65 , .80 , .98 , 1 , 1 , 1 , 1 , 1

KEY

PS = Parameter name.
 DFUNDS = Delta funds multiplier based on shortfall in meeting
 requirements.
 ACCOM = Accomplishment multiplier based on earned funding
 comparision to planned funding.
 PSS = Probability of schedular success based on planned program
 length compared to optimum program length.
 PSF = Probability of funding success based on comparison between
 planned funding and estimate of required funding.
UL = Upper limit for T(N) value.
LL = Lower limit for T(N) value.
IN = Interval size (equal to UL-LL).
T(N) = Parameter value.

FILENAME: PROJ.DOC

PROJECT REVIEW AGENDA

DATA

PROJS

CONCENTRATOR,

BATTERY,

SOLAR

KEY

PROJS - Project which is to be evaluated.

FILENAME: PROG.DOC

PROJECT SPECIFICATIONS

FILE DATA

PROGS, TOTF, PL, OPTPL, FR, PTECHS, FDELAY, CDELAY, SUDELAY

SOLAR , 1600 , 5 , 4 , 2000 , .95 , .90 , .98 , 1.0 ,

BATTERY , 2500 , 6 , 5 , 3000 , .75 , .90 , .90 , .95 ,

CONCENTRATOR , 1650 , 5 , 6 , 2000 , .88 , .90 , .90 , .98

KEY

PROGS = Name of project being reviewed.
TOTF = Total funding allocated to project (FY85\$K).
PL = Planned project length (years).
OPTPL = Optimum project length to meet capability objectives (years).
FR = Funding expected to be required for project to meet objectives (FY85\$K).
PTECHS = Probability of technical success (non-dimensional).
FDELAY = Funding efficiency (non-dimensional).
CDELAY = Contracting efficiency (non-dimensional).
SUDELAY = Project start-up efficiency (non-dimensional).

FILENAME: REQDATA.DOC

TECHNOLOGY REQUIREMENT FORECAST

DATA

REQ\$,PSTART

PARA\$,UNITS\$,P(N1),P(N2),P(N3),P(N4),P(N5),P(N6),P(N7),P(N8)

PARA\$,CONS,U(N1),U(N2),U(N3),U(N4),U(N5),U(N6),U(N7),U(N8)

SOLAR , 85 ,

PERFORMANCE , W/LB , 30 , 30 , 30 , 45 , 45 , 45 , 45 , 60 ,

PERFORMANCE , GO , .9 , .9 , .85 , .85 , .85 , .85 , .85 , .85 ,

SURVIVABILITY , NONDIM , 3 , 3 , 3 , 5 , 5 , 5 , 5 , 5 ,

SURVIVABILITY , STOP , .60 , .65 , .70 , .70 , .75 , .80 , .80 , .82 ,

BATTERY , 85 ,

PERFORMANCE , W/LB , 12 , 12 , 15 , 15 , 15 , 15 , 18 , 18 ,

PERFORMANCE , GO , .95 , .95 , .95 , .95 , .95 , .95 , .90 , .90 ,

SURVIVABILITY , NONDIM , 5 , 5 , 5 , 5 , 5 , 5 , 5 , 5 ,

SURVIVABILITY , STOP , .60 , .65 , .70 , .70 , .75 , .80 , .80 , .82 ,

CONCENTRATOR , 86 ,

PERFORMANCE , W/LB , 30 , 30 , 30 , 45 , 45 , 45 , 45 , 60 ,

PERFORMANCE , GO , .9 , .9 , .85 , .85 , .85 , .85 , .85 , .85 ,

SURVIVABILITY , NONDIM , 3 , 3 , 3 , 5 , 5 , 5 , 5 , 5 ,

SURVIVABILITY , STOP , .60 , .65 , .70 , .70 , .75 , .80 , .80 , .82

KEY

PARA\$ - Name of project for which parametric forecast is established.

PSTART - Project start date.

PAR\$ - Name of parameter being evaluated.

UNITS\$ - Unit of parameter being evaluated.

CONS\$ - Key word for program which identifies end of parameter list for project.

P(N) - Parameter value by fiscal year N.

U(N) - Utility of parameter by fiscal year N.

FILENAME: PDATA.DOC

TECHNOLOGY CAPABILITY FORECAST

DATA

PARA\$,PSTART,
PAR\$,UNITS\$,P(N1),P(N2),P(N3),P(N4),P(N5),P(N6)
PAR\$,UNITS\$,U(N1),U(N2),U(N3),U(N4),U(N5),P(N6)

SOLAR , 85 ,
PERFORMANCE , W/LB , 22 , 22 , 25 , 25 , 25 , 26.8 ,
PERFORMANCE , GO , .9 , .9 , .85 , .85 , .85 , .85 ,
SURVIVABILITY , NONDI , 3 , 3 , 3 , 4 , 4 , 4 ,
SURVIVABILITY , STOP , .60 , .65 , .70 , .70 , .75 , .80 ,

BATTERY , 85 ,
PERFORMANCE , W/LB , 10.5 , 10.5 , 12 , 12 , 12 , 13.5 ,
PERFORMANCE , GO , .95 , .95 , .95 , .95 , .95 , .95 ,
SURVIVABILITY , NONDI , 5 , 5 , 5 , 5 , 5 , 5 ,
SURVIVABILITY , STOP , .60 , .65 , .70 , .70 , .75 , .80 ,

CONCENTRATOR , 86 ,
PERFORMANCE , W/LB , 20 , 21 , 24 , 24 , 24 , 25 ,
PERFORMANCE , GO , .9 , .9 , .85 , .85 , .80 , .75 ,
SURVIVABILITY , NONDI , 4 , 5 , 6 , 6 , 6 , 7 ,
SURVIVABILITY , STOP , .65 , .70 , .70 , .75 , .80 , .85

KEY

PARA\$ - Name of project for which parametric forecast is established.
PSTART - Project start date.
PAR\$ - Name of parameter being evaluated.
UNITS\$ - Unit of parameter being evaluated.
CONS\$ - Key word for program which identifies end of parameter list for project.
P(Nx) - Parameter value by fiscal year Nx.
U(Nx) - Utility of parameter by fiscal year Nx.

FILENAME: OBLIG.DOC

OBLIGATIONS PLAN
FY85\$K

DATA

N\$,PSTART,OB(N1),OB(N2),OB(N3),OB(N4),OB(N5),OB(N6)

SOLAR , 85 , 100 , 300 , 600 , 500 , 100 , 0 ,

BATTERY , 85 , 250 , 400 , 900 , 700 , 200 , 50 ,

CONCENTRATOR , 86 , 50 , 300 , 500 , 500 , 200 , 100

KEY

N\$ = Project Name.

PSTART = Project Start Date.

OB(N) = Funding allocation planned by fiscal year N.

FILENAME: TOA.DOC

TOTAL OBLIGATION AUTHORITY
FY85\$K

DATA

BA\$,PSTART,
TOA(N1),TOA(N2),TOA(N3),TOA(N4),TOA(N5),TOA(N6),TOA(N7)

P3145 , 85 ,
1500 , 1600 , 1700 , 1700 , 2000 , 2000 , 2100

KEY

BA\$ = Program funding source.
PSTART = Project Start Date.
TOA(N) = Funding authority planned by fiscal year N.

APPENDIX C
SAMPLE RUNS

SAMPLE RUN #1

CONSTRAINED FUNDING, DELTA FUNDS OFF

RESOURCE ALLOCATION MODEL RESULTS

SOLAR

03-04-1987

14:08:11

TZ

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTA	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

0.96	1.10	0.08	0.08
1000.00	900.00	100.00	100.00
0.00	88.20	11.80	88.20
0.76	0.95	1.00	0.80
0.10	0.08	0.50	0.50
4.00	5.00	0.00	0.00

86

0.99	1.13	0.17	0.17
1000.00	700.00	300.00	300.00
0.00	305.80	6.00	394.00
0.76	0.95	1.00	0.80
0.20	0.15	1.13	1.13
4.00	5.00	0.00	0.00

87

0.99	1.21	0.55	0.55
1000.00	400.00	600.00	600.00
0.00	594.00	12.00	988.00
0.76	0.95	1.00	0.80
0.60	0.46	0.88	0.88
4.00	5.00	0.00	0.00

88

1.55	1.35	0.93	0.93
1000.00	500.00	500.00	500.00
0.00	502.00	10.00	1490.00
0.76	0.95	1.00	0.80
0.90	0.68	1.25	1.25
4.00	5.00	0.00	0.00

89

1.60	1.39	1.06	1.06
1000.00	900.00	100.00	100.00
0.00	108.00	2.00	1598.00
0.76	0.95	1.00	0.80
1.00	0.76	1.21	1.21
4.00	5.00	0.00	0.00

90

1.65	1.49	1.13	1.13
1000.00	1000.00	0.00	0.00
0.00	2.00	0.00	1600.00
0.76	0.95	1.00	0.80
1.00	0.76	1.16	1.16
4.00	5.00	5.02	0.02

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
SOLAR REQUIREMENTS

03-04-1987

14:10:16

RAU	0.0	0.7	1.3	2.0	
*	.	.	.	.	*
85	C		R U		*
86	C		R U		*
87		C	R U		*
88			C U R		*
89			C U R		*
90			C U R		*

R = REQUIREMENTS - REQ(T%)

C = CAPABILITY ACHEIVED - UTIL(T%)

U = UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
SOLAR FUNDS

03-04-1987

14:10:37

EOD	0.0	1000.0	2000.0	3000.0	
*	.	.	.	.	*
85	D EO				*
86	D O E				*
87	D O E				*
88	D O		E		*
89	D O		E		*
90	OD		E		*

E = EARNED FUNDS - EFUND(T%)

O = FUNDS OBLIGATED - OB(T%)

D = DELTA FUNDS - DFUNDS(T%)

RESOURCE ALLOCATION MODEL RESULTS
BATTERY

03-04-1987

14:11:19

TX

REO	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTA	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

1.23	1.34	0.08	0.08
900.00	650.00	250.00	250.00
0.00	192.38	57.63	192.38
0.60	0.75	1.00	0.80
0.10	0.06	0.97	0.74
5.00	6.00	0.00	0.00

86

1.28	1.39	0.25	0.21
700.00	300.00	400.00	400.00
0.00	449.63	8.00	642.00
0.60	0.75	1.00	0.80
0.30	0.18	1.09	1.11
5.00	6.00	0.00	0.00

87

1.49	1.54	0.37	0.46
400.00	0.00	900.00	400.00
0.00	400.00	8.00	1042.00
0.60	0.75	1.00	0.80
0.40	0.24	1.39	1.14
5.00	6.00	0.00	0.00

88

1.49	1.54	0.56	0.74
500.00	0.00	700.00	500.00
0.00	498.00	10.00	1540.00
0.60	0.75	1.00	0.80
0.60	0.36	1.37	1.31
5.00	6.00	0.00	0.00

89

1.54	1.59	0.67	0.86
900.00	700.00	200.00	200.00
0.00	206.00	4.00	1746.00
0.60	0.75	1.00	0.80
0.70	0.42	1.34	1.27
5.00	6.00	0.00	0.00

90

1.59	1.75	0.74	0.93
1000.00	950.00	50.00	50.00
0.00	53.00	1.00	1799.00
0.60	0.75	1.00	0.80
0.70	0.42	1.30	1.23
5.00	6.00	5.26	-0.74

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
BATTERY REQUIREMENTS

03-04-1987

14:12:00

P	0.0	0.7	1.3	2.0
85	C		R U	
86		C	R U	
87		C		R U
88		C		R U
89		C		R U
90		C		R U

R = REQUIREMENTS - REQ(T%)

C = CAPABILITY ACHEIVED - UTIL(T%)

U = UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
BATTERY FUNDS

03-04-1987

14:12:15

EOD	0.0	1000.0	2000.0	3000.0
85	D EO			
86	D	O E		
87	D	O E		
88	D	O	E	
89	D	O	E	
90	DO		E	

E = EARNED FUNDS - EFUND(T%)

O = FUNDS OBLIGATED - OB(T%)

D = DELTA FUNDS - DFUNDS(T%)

RESOURCE ALLOCATION MODEL RESULTS
CONCENTRATOR

03-04-1987

14:12:58

TX

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTA	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

0.67	0.55	0.00	0.04
650.00	650.00	0.00	0.00
0.00	0.00	0.00	0.00
0.56	0.88	0.80	0.80
0.00	0.00	0.00	0.37
6.00	5.00	0.00	0.00

86

0.96	1.09	0.00	0.11
300.00	250.00	50.00	50.00
0.00	39.69	10.31	39.69
0.56	0.88	0.80	0.80
0.00	0.00	19.85	10.48
6.00	5.00	0.00	0.00

87

0.99	1.26	0.00	0.23
0.00	0.00	300.00	0.00
0.00	10.31	0.00	50.00
0.56	0.88	0.80	0.80
0.00	0.00	25.00	13.07
6.00	5.00	0.00	0.00

88

0.99	1.42	0.00	0.37
0.00	0.00	500.00	0.00
0.00	0.00	0.00	50.00
0.56	0.88	0.80	0.80
0.00	0.00	25.00	13.15
6.00	5.00	0.00	0.00

89

1.55	1.46	0.25	0.56
700.00	200.00	500.00	500.00
0.00	490.00	10.00	540.00
0.56	0.88	0.80	0.80
0.30	0.17	1.69	1.48
6.00	5.00	0.00	0.00

90

1.60	1.45	0.41	0.67
950.00	750.00	200.00	200.00
0.00	206.00	4.00	746.00
0.56	0.88	0.80	0.80
0.50	0.28	1.45	1.34
6.00	5.00	5.50	0.50

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
CONCENTRATOR REQUIREMENTS

03-04-1987

14:14:02

RAU	0.0	0.7	1.3	2.0	
85	C	U R			*
86	C		R U		*
87	C		R U		*
88	C		R	U	*
89		C		U R	*
90		C		U R	*

R = REQUIREMENTS - REQ(T%)
C = CAPABILITY ACHIEVED - UTIL(T%)
U = UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
CONCENTRATOR FUNDS

03-04-1987

14:14:21

EOD	0.0	1000.0	2000.0	3000.0	
85	EOD				*
86	DEO				*
87	ODE				*
88	ODE				*
89	D	OE			*
90	D O	E			*

E = EARNED FUNDS - EFUND(T%)
O = FUNDS OBLIGATED - OB(T%)
D = DELTA FUNDS - DFUNDS(T%)

SAMPLE RUN #2

CONSTRAINED FUNDING, DELTA FUNDS ON

RESOURCE ALLOCATION MODEL RESULTS
SOLAR

03-04-1987

13:54:28

T%

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTAF	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

0.96	1.10	0.08	0.08
1000.00	880.00	100.00	120.00
20.00	105.84	14.16	105.84
0.76	0.95	1.00	0.80
0.10	0.08	0.60	0.60
4.00	5.00	0.00	0.00

86

0.99	1.13	0.26	0.26
1000.00	666.00	300.00	334.00
54.00	341.48	6.68	447.32
0.76	0.95	1.00	0.80
0.30	0.23	0.86	0.86
4.00	5.00	0.00	0.00

87

0.99	1.21	0.65	0.65
1000.00	370.00	600.00	630.00
84.00	624.08	12.60	1071.40
0.76	0.95	1.00	0.80
0.70	0.53	0.82	0.82
4.00	5.00	0.00	0.00

88

1.55	1.35	1.03	1.03
1000.00	524.00	500.00	476.00
60.00	479.08	9.52	1550.48
0.76	0.95	1.00	0.80
1.00	0.76	1.17	1.17
4.00	5.00	0.00	0.00

89

1.60	1.39	1.06	1.06
1000.00	955.00	100.00	45.00
5.00	53.62	0.90	1604.10
0.76	0.95	1.00	0.80
1.00	0.76	1.21	1.21
4.00	5.00	4.11	-0.89

90

1.65	1.49	1.13	1.13
1000.00	1000.00	0.00	0.00
0.00	0.90	0.00	1605.00
0.76	0.95	1.00	0.80
1.00	0.76	1.17	1.17
4.00	5.00	0.00	0.00

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
SOLAR REQUIREMENTS

03-04-1987

13:55:19

U	0.0	0.7	1.3	2.0
85	C		R U	
86		C	R U	
87		C	R U	
88			C U R	
89			C U R	
90			C U R	

R = REQUIREMENTS - REQ(T%)

C = CAPABILITY ACHEIVED - UTIL(T%)

U = UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
SOLAR FUNDS

03-04-1987

13:55:58

EOD	0.0	1000.0	2000.0	3000.0
85	D E0			
86	D	O E		
87	D	O E		
88	D	O	E	
89	DO		E	
90	OD		E	

E = EARNED FUNDS - EFUND(T%)

O = FUNDS OBLIGATED - OB(T%)

D = DELTA FUNDS - DFUNDS(T%)

RESOURCE ALLOCATION MODEL RESULTS
BATTERY

03-04-1987

14:01:11

T%

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTA	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

1.23	1.34	0.08	0.08
880.00	580.00	250.00	300.00
50.00	230.85	69.15	230.85
0.60	0.75	1.00	0.80
0.10	0.06	1.16	0.88
5.00	6.00	0.00	0.00

86

1.28	1.39	0.25	0.25
666.00	244.00	400.00	422.00
72.00	482.71	8.44	713.56
0.60	0.75	1.00	0.80
0.30	0.18	1.21	1.04
5.00	6.00	0.00	0.00

87

1.49	1.54	0.37	0.51
370.00	0.00	900.00	370.00
0.00	371.04	7.40	1084.60
0.60	0.75	1.00	0.80
0.40	0.24	1.45	1.13
5.00	6.00	0.00	0.00

88

1.49	1.54	0.56	0.79
524.00	0.00	700.00	524.00
0.00	520.92	10.48	1605.52
0.60	0.75	1.00	0.80
0.60	0.36	1.43	1.30
5.00	6.00	0.00	0.00

89

1.54	1.59	0.67	0.86
955.00	731.00	200.00	224.00
24.00	230.00	4.48	1835.52
0.60	0.75	1.00	0.80
0.70	0.42	1.41	1.31
5.00	6.00	0.00	0.00

90

1.59	1.75	0.74	0.93
1000.00	968.00	50.00	32.00
6.00	35.84	0.64	1871.36
0.60	0.75	1.00	0.80
0.70	0.42	1.35	1.26
5.00	6.00	5.16	-0.84

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
BATTERY REQUIREMENTS

03-04-1987

14:02:06

PAU	0.0	0.7	1.3	2.0	
85	C		R U		*
86		C	R U		*
87		C		R U	*
88		C		R U	*
89		C		R U	*
90		C		R U	*

R = REQUIREMENTS - REQ(T%)
C = CAPABILITY ACHIEVED - UTIL(T%)
U = UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
BATTERY FUNDS

03-04-1987

14:02:26

EOD	0.0	1000.0	2000.0	3000.0	
85	D EO				*
86	D O E				*
87	D O E				*
88	D O E				*
89	D O E				*
90	DO E				*

E = EARNED FUNDS - EFUND(T%)
O = FUNDS OBLIGATED - OB(T%)
D = DELTA FUNDS - DFUNDS(T%)

RESOURCE ALLOCATION MODEL RESULTS
CONCENTRATOR

03-04-1987

14:03:14

T%

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTA	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

0.67	0.55	0.00	0.04
580.00	580.00	0.00	0.00
0.00	0.00	0.00	0.00
0.56	0.88	0.80	0.80
0.00	0.00	0.00	0.44
6.00	5.00	0.00	0.00

86

0.96	1.09	0.00	0.13
244.00	184.00	50.00	60.00
10.00	47.63	12.37	47.63
0.56	0.88	0.80	0.80
0.00	0.00	23.81	12.42
6.00	5.00	0.00	0.00

87

0.99	1.26	0.00	0.25
0.00	0.00	300.00	0.00
0.00	12.37	0.00	60.00
0.56	0.88	0.80	0.80
0.00	0.00	30.00	15.57
6.00	5.00	0.00	0.00

88

0.99	1.42	0.00	0.40
0.00	0.00	500.00	0.00
0.00	0.00	0.00	60.00
0.56	0.88	0.80	0.80
0.00	0.00	30.00	15.65
6.00	5.00	0.00	0.00

89

1.55	1.46	0.33	0.60
731.00	131.00	500.00	600.00
100.00	588.00	12.00	648.00
0.56	0.88	0.80	0.80
0.40	0.23	1.52	1.41
6.00	5.00	0.00	0.00

90

1.60	1.45	0.41	0.67
968.00	836.00	200.00	132.00
32.00	141.36	2.64	789.36
0.56	0.88	0.80	0.80
0.50	0.28	1.54	1.40
6.00	5.00	5.50	0.50

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
CONCENTRATOR REQUIREMENTS

03-04-1987

14:03:50

RAU	0.0	0.7	1.3	2.0	
*	.	.	.	.	*
85	C	U R	.	.	*
86	C	.	R U	.	*
87	C	.	R U	.	*
88	C	.	R	U	*
89	.	C	.	U R	*
90	.	C	.	U R	*

R = REQUIREMENTS - REQ(T%)
C = CAPABILITY ACHEIVED - UTIL(T%)
U = UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
CONCENTRATOR FUNDS

03-04-1987

14:04:23

EOD	0.0	1000.0	2000.0	3000.0	
*	.	.	.	.	*
85	EOD	.	.	.	*
86	DEO	.	.	.	*
87	ODE	.	.	.	*
88	ODE	.	.	.	*
89	D	OE	.	.	*
90	D O	E	.	.	*

E = EARNED FUNDS - EFUND(T%)
O = FUNDS OBLIGATED - OB(T%)
D = DELTA FUNDS - DFUNDS(T%)

SAMPLE RUN #3

SINGLE LAYER PROBLEM STRUCTURE

RESOURCE ALLOCATION MODEL RESULTS

SOLAR

03-04-1987

14:25:32

TX

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTA	EXPEND	PFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

0.96	1.10	0.08	0.08
1000.00	880.00	100.00	120.00
20.00	105.84	14.16	105.84
0.76	0.95	1.00	0.80
0.10	0.08	0.60	0.60
4.00	5.00	0.00	0.00

86

0.99	1.13	0.26	0.26
1000.00	666.00	300.00	334.00
54.00	341.48	6.68	447.32
0.76	0.95	1.00	0.80
0.30	0.23	0.86	0.86
4.00	5.00	0.00	0.00

87

0.99	1.21	0.65	0.65
1000.00	370.00	600.00	630.00
84.00	624.08	12.60	1071.40
0.76	0.95	1.00	0.80
0.70	0.53	0.82	0.82
4.00	5.00	0.00	0.00

88

1.55	1.35	1.03	1.03
1000.00	524.00	500.00	476.00
60.00	479.08	9.52	1550.48
0.76	0.95	1.00	0.80
1.00	0.76	1.17	1.17
4.00	5.00	0.00	0.00

89

1.60	1.39	1.06	1.06
1000.00	955.00	100.00	45.00
5.00	53.62	0.90	1604.10
0.76	0.95	1.00	0.80
1.00	0.76	1.21	1.21
4.00	5.00	4.11	-0.89

90

1.65	1.49	1.13	1.13
1000.00	1000.00	0.00	0.00
0.00	0.90	0.00	1605.00
0.76	0.95	1.00	0.80
1.00	0.76	1.17	1.17
4.00	5.00	0.00	0.00

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
SOLAR REQUIREMENTS

03-04-1987

14:26:13

RAU	0.0	0.7	1.3	2.0	
*	.	.	.	.	*
85	C	.	R U	.	*
86	C	.	R U	.	*
87	.	C	R U	.	*
88	.	.	C U R	.	*
89	.	.	C U R	.	*
90	.	.	C U R	.	*

R = REQUIREMENTS - REQ(T%)

C = CAPABILITY ACHIEVED - UTIL(T%)

U = UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
SOLAR FUNDS

03-04-1987

14:26:31

EOD	0.0	1000.0	2000.0	3000.0	
*	.	.	.	.	*
85	D E0	.	.	.	*
86	D O E	.	.	.	*
87	D O E	.	.	.	*
88	D O E	.	.	.	*
89	D0	.	E	.	*
90	OD	.	E	.	*

E = EARNED FUNDS - EFUND(T%)

O = FUNDS OBLIGATED - OB(T%)

D = DELTA FUNDS - DFUNDS(T%)

RESOURCE ALLOCATION MODEL RESULTS
BATTERY

03-04-1987

14:27:36

TX

	REQ TOAP DELTA PSUCC ACCOM OPTPL	UTILITY TOA EXPEND PTECHS VALU PL	UTIL OBP FFUND PSS COSTBEN APL	TUTIL OB EFUND PSF TCOSTBEN DPL

85	1.23 1000.00 0.00 0.60 0.10 5.00	1.34 750.00 192.38 0.75 0.06 6.00	0.08 250.00 57.63 1.00 0.97 0.00	0.08 250.00 192.38 0.80 0.97 0.00

86	1.28 1000.00 0.00 0.60 0.30 5.00	1.39 600.00 449.63 0.75 0.18 6.00	0.25 400.00 8.00 1.00 1.09 0.00	0.25 400.00 642.00 0.80 1.09 0.00

87	1.49 1000.00 0.00 0.60 0.60 5.00	1.54 100.00 890.00 0.75 0.36 6.00	0.56 900.00 18.00 1.00 1.37 0.00	0.56 900.00 1532.00 0.80 1.37 0.00

88	1.49 1000.00 0.00 0.60 0.90 5.00	1.54 300.00 704.00 0.75 0.54 6.00	0.83 700.00 14.00 1.00 1.33 0.00	0.83 700.00 2236.00 0.80 1.33 0.00

89	1.54 1000.00 0.00 0.60 1.00 5.00	1.59 800.00 210.00 0.75 0.60 6.00	0.96 200.00 4.00 1.00 1.31 0.00	0.96 200.00 2446.00 0.80 1.31 0.00

90	1.59 1000.00 0.00 0.60 1.00 5.00	1.75 950.00 53.00 0.75 0.60 6.00	1.05 50.00 1.00 1.00 1.26 5.25	1.05 50.00 2499.00 0.80 1.26 -0.75

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
BATTERY REQUIREMENTS

03-04-1987

14:30:02

U 0.0 0.7 1.3 2.0

* *

* 85 C . R U . *

* *

* 86 C R U . *

* *

* 87 C R U . *

* *

* 88 C R U . *

* *

* 89 C R U . *

* *

* 90 C R U . *

* *

R = REQUIREMENTS - REQ(T%)

C = CAPABILITY ACHEIVED - UTIL(T%)

U = UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION

BATTERY FUNDS

03-04-1987

14:30:22

EOD 0.0 1000.0 2000.0 3000.0

* 85 D EO . . *

* *

* 86 D O E . . *

* *

* 87 D O E . . *

* *

* 88 D O E . . *

* *

* 89 D O E . . *

* *

* 90 D O E . . *

* *

E = EARNED FUNDS - EFUND(T%)

O = FUNDS OBLIGATED - OB(T%)

D = DELTA FUNDS - DFUNDS(T%)

RESOURCE ALLOCATION MODEL RESULTS
CONCENTRATOR

03-04-1987

14:30:52

T%

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTAF	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

0.67	0.55	0.00	0.00
1000.00	1000.00	0.00	0.00
0.00	0.00	0.00	0.00
0.56	0.88	0.80	0.80
0.00	0.00	0.00	0.00
6.00	5.00	0.00	0.00

86

0.96	1.09	0.00	0.00
1000.00	950.00	50.00	50.00
0.00	39.69	10.31	39.69
0.56	0.88	0.80	0.80
0.00	0.00	19.85	9.92
6.00	5.00	0.00	0.00

87

0.99	1.26	0.14	0.07
1000.00	700.00	300.00	300.00
0.00	304.31	6.00	344.00
0.56	0.88	0.80	0.80
0.20	0.11	1.20	0.60
6.00	5.00	0.00	0.00

88

0.99	1.42	0.40	0.20
1000.00	500.00	500.00	500.00
0.00	496.00	10.00	840.00
0.56	0.88	0.80	0.80
0.50	0.28	1.04	0.52
6.00	5.00	0.00	0.00

89

1.55	1.46	0.66	0.33
1000.00	500.00	500.00	500.00
0.00	500.00	10.00	1340.00
0.56	0.88	0.80	0.80
0.80	0.45	1.58	0.79
6.00	5.00	0.00	0.00

90

1.60	1.45	0.74	0.37
1000.00	800.00	200.00	200.00
0.00	206.00	4.00	1546.00
0.56	0.88	0.80	0.80
0.90	0.51	1.67	0.84
6.00	5.00	5.50	0.50

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
CONCENTRATOR REQUIREMENTS

03-04-1987

14:33:58

U	0.0	0.7	1.3	2.0	
85	C	U R			*
86	C		R U		*
87	C		R U		*
88		C	R	U	*
89			C	U R	*
90			C	U R	*

R = REQUIREMENTS - REQ(T%)

C = CAPABILITY ACHEIVED - UTIL(T%)

U = UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
CONCENTRATOR FUNDS

03-04-1987

14:34:17

EOD	0.0	1000.0	2000.0	3000.0	
85	EOD				*
86	DEO				*
87	D	OE			*
88	D	O	E		*
89	D	O	E		*
90	D O		E		*

E = EARNED FUNDS - EFUND(T%)

O = FUNDS OBLIGATED - OB(T%)

D = DELTA FUNDS - DFUNDS(T%)

SAMPLE RUN #4

FUNDING CONSTRAINT RELIEF

FILENAME: TOA.DOC

TOTAL OBLIGATION AUTHORITY
FY85\$K

DATA

BAS, PSTART,
TOA(N1), TOA(N2), TOA(N3), TOA(N4), TOA(N5), TOA(N6), TOA(N7)

P3145 , 85 ,
1500 , 1500 , 1500 , 1500 , 1500 , 2000 , 2000

KEY

BAS = Program funding source.
PSTART = Project Start Date.
TOA(N) = Funding authority planned by fiscal year N.

RESOURCE ALLOCATION MODEL RESULTS

SOLAR

03-04-1987

14:43:13

T%

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTA	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

0.96	1.10	0.08	0.08
1500.00	1380.00	100.00	120.00
20.00	105.84	14.16	105.84
0.76	0.95	1.00	0.80
0.10	0.08	0.60	0.60
4.00	5.00	0.00	0.00

86

0.99	1.13	0.26	0.26
1500.00	1166.00	300.00	334.00
54.00	341.48	6.68	447.32
0.76	0.95	1.00	0.80
0.30	0.23	0.86	0.86
4.00	5.00	0.00	0.00

87

0.99	1.21	0.65	0.65
1500.00	870.00	600.00	630.00
84.00	624.08	12.60	1071.40
0.76	0.95	1.00	0.80
0.70	0.53	0.82	0.82
4.00	5.00	0.00	0.00

88

1.55	1.35	1.03	1.03
1500.00	1024.00	500.00	476.00
60.00	479.08	9.52	1550.48
0.76	0.95	1.00	0.80
1.00	0.76	1.17	1.17
4.00	5.00	0.00	0.00

89

1.60	1.39	1.06	1.06
1500.00	1455.00	100.00	45.00
5.00	53.62	0.90	1604.10
0.76	0.95	1.00	0.80
1.00	0.76	1.21	1.21
4.00	5.00	4.11	-0.89

90

1.65	1.49	1.13	1.13
2000.00	2000.00	0.00	0.00
0.00	0.90	0.00	1605.00
0.76	0.95	1.00	0.80
1.00	0.76	1.17	1.17
4.00	5.00	0.00	0.00

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
SOLAR REQUIREMENTS

03-04-1987

14:43:54

RAU	0.0	0.7	1.3	2.0	
85	C		R U		*
86			R U		*
87		C	R U		*
88			C U R		*
89			C U R		*
90			C U R		*

R = REQUIREMENTS - REQ(TX)
C = CAPABILITY ACHEIVED - UTIL(TX)
U = UTILITY FORECAST - UTILITY(TX)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
SOLAR FUNDS

03-04-1987

14:44:11

EOD	0.0	1000.0	2000.0	3000.0	
85	D EO				*
86	D O E				*
87	D O E				*
88	D O		E		*
89	DO		E		*
90	OD		E		*

E = EARNED FUNDS - EFUND(TX)
O = FUNDS OBLIGATED - OB(TX)
D = DELTA FUNDS - DFUNDS(TX)

RESOURCE ALLOCATION MODEL RESULTS
BATTERY

03-04-1987

14:44:46

TX

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTA	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

1.23	1.34	0.08	0.08
1380.00	1080.00	250.00	300.00
50.00	230.85	69.15	230.85
0.60	0.75	1.00	0.80
0.10	0.06	1.16	0.88
5.00	6.00	0.00	0.00

86

1.28	1.39	0.25	0.25
1166.00	744.00	400.00	422.00
72.00	482.71	8.44	713.56
0.60	0.75	1.00	0.80
0.30	0.18	1.21	1.04
5.00	6.00	0.00	0.00

87

1.49	1.54	0.56	0.60
870.00	42.00	900.00	828.00
0.00	819.88	16.56	1533.44
0.60	0.75	1.00	0.80
0.60	0.36	1.37	1.09
5.00	6.00	0.00	0.00

88

1.49	1.54	0.83	0.93
1024.00	240.00	700.00	784.00
84.00	784.88	15.68	2318.32
0.60	0.75	1.00	0.80
0.90	0.54	1.38	1.27
5.00	6.00	0.00	0.00

89

1.54	1.59	0.96	1.01
1455.00	1319.00	200.00	136.00
20.00	148.96	2.72	2467.28
0.60	0.75	1.00	0.80
1.00	0.60	1.32	1.27
5.00	6.00	0.00	0.00

90

1.59	1.75	1.05	1.09
2000.00	1967.50	50.00	32.50
2.50	34.57	0.65	2501.85
0.60	0.75	1.00	0.80
1.00	0.60	1.26	1.21
5.00	6.00	5.23	-0.77

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
BATTERY REQUIREMENTS

03-04-1987

14:45:38

	U	0.0	0.7	1.3	2.0	
	.	.	.	.	.	*
85	C			R U		*
86		C		R U		*
87			C		R U	*
88				C	R U	*
89				C	R U	*
90				C	R U	*

R = REQUIREMENTS - REQ(T%)

C = CAPABILITY ACHEIVED - UTIL(T%)

U = UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
BATTERY FUNDS

03-04-1987

14:45:58

	EOD	0.0	1000.0	2000.0	3000.0	
	.	.	.	.	.	*
85	D	EO				*
86	D	O	E			*
87	D		O	E		*
88	D		O		E	*
89	D	O			E	*
90	D	O			E	*

E = EARNED FUNDS - EFUND(T%)

O = FUNDS OBLIGATED - OB(T%)

D = DELTA FUNDS - DFUNDS(T%)

RESOURCE ALLOCATION MODEL RESULTS
CONCENTRATOR

03-04-1987

14:46:49

TZ

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTAF	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

0.67	0.55	0.00	0.04
1080.00	1080.00	0.00	0.00
0.00	0.00	0.00	0.00
0.56	0.88	0.80	0.80
0.00	0.00	0.00	0.44
6.00	5.00	0.00	0.00

86

0.96	1.09	0.00	0.13
744.00	684.00	50.00	60.00
10.00	47.63	12.37	47.63
0.56	0.88	0.80	0.80
0.00	0.00	23.81	12.42
6.00	5.00	0.00	0.00

87

0.99	1.26	0.07	0.34
42.00	0.00	300.00	42.00
0.00	53.53	0.84	101.16
0.56	0.88	0.80	0.80
0.10	0.06	0.70	0.90
6.00	5.00	0.00	0.00

88

0.99	1.42	0.16	0.55
240.00	0.00	500.00	240.00
0.00	236.04	4.80	337.20
0.56	0.88	0.80	0.80
0.20	0.11	1.04	1.15
6.00	5.00	0.00	0.00

89

1.55	1.46	0.49	0.75
1319.00	729.00	500.00	590.00
90.00	583.00	11.80	920.20
0.56	0.88	0.80	0.80
0.60	0.34	1.44	1.35
6.00	5.00	0.00	0.00

90

1.60	1.45	0.49	0.79
1967.50	1829.50	200.00	138.00
28.00	147.04	2.76	1067.24
0.56	0.88	0.80	0.80
0.60	0.34	1.73	1.47
6.00	5.00	5.51	0.51

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
CONCENTRATOR REQUIREMENTS

03-04-1987

14:48:25

	U	0.0	0.7	1.3	2.0
*	.	.	.	.	*
85	C		U R		*
86	C			R U	*
87	C			R U	*
88		C		R U	*
89			C		U R
90			C		U R

R = REQUIREMENTS - REQ(T%)
C = CAPABILITY ACHEIVED - UTIL(T%)
U = UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
CONCENTRATOR FUNDS

03-04-1987

14:48:53

	EOD	0.0	1000.0	2000.0	3000.0
*	.	.	.	.	*
85	EOD				*
86	DEO				*
87	DOE				*
88	D O E				*
89	D O E				*
90	D O E				*

E = EARNED FUNDS - EFUND(T%)
O = FUNDS OBLIGATED - OB(T%)
D = DELTA FUNDS - DFUNDS(T%)

SAMPLE RUN #5

EFFICIENCY FACTOR EFFECTS

FILENAME: PROG.DOC

PROJECT SPECIFICATIONS

FILE DATA

PROGS,TOTF,PL,OPTPL,FR,PTECHS,FDELAY,CDELAY,SUDELAY

SOLAR , 1600 , 5 , 4 , 2000 , .99 , .90 , .98 , 1.0 ,

BATTERY , 2500 , 6 , 5 , 3000 , .99 , .90 , .90 , .95 ,

CONCENTRATOR , 1650 , 5 , 6 , 2000 , .99 , .90 , .90 , .98

KEY

PROGS = Name of project being reviewed.
TOTF = Total funding allocated to project (FY85\$K).
PL = Planned project length (years).
OPTPL = Optimum project length to meet capability objectives (years).
FR = Funding expected to be required for project to meet objectives (FY85\$K).
PTECHS = Probability of technical success (non-dimensional).
FDELAY = Funding efficiency (non-dimensional).
CDELAY = Contracting efficiency (non-dimensional).
SUDELAY = Project start-up efficiency (non-dimensional).

RESOURCE ALLOCATION MODEL RESULTS
BATTERY

03-04-1987

14:57:18

TX

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTA	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

1.23	1.34	0.11	0.11
1500.00	1200.00	250.00	300.00
50.00	230.85	69.15	230.85
0.79	0.99	1.00	0.80
0.10	0.08	0.88	0.88
5.00	6.00	0.00	0.00

86

1.28	1.39	0.33	0.33
1500.00	1078.00	400.00	422.00
72.00	482.71	8.44	713.56
0.79	0.99	1.00	0.80
0.30	0.24	0.92	0.92
5.00	6.00	0.00	0.00

87

1.49	1.54	0.86	0.86
1500.00	528.00	900.00	972.00
144.00	961.00	19.44	1674.56
0.79	0.99	1.00	0.80
0.70	0.55	0.97	0.97
5.00	6.00	0.00	0.00

88

1.49	1.54	1.10	1.10
1500.00	909.00	700.00	591.00
35.00	598.62	11.82	2273.18
0.79	0.99	1.00	0.80
0.90	0.71	1.03	1.03
5.00	6.00	0.00	0.00

89

1.54	1.59	1.26	1.26
1500.00	1335.00	200.00	165.00
0.00	173.52	3.30	2446.70
0.79	0.99	1.00	0.80
1.00	0.79	0.99	0.99
5.00	6.00	0.00	0.00

90

1.59	1.75	1.39	1.39
2000.00	1955.00	50.00	45.00
-5.00	47.40	0.90	2494.10
0.79	0.99	1.00	0.80
1.00	0.79	0.95	0.95
5.00	6.00	6.12	0.12

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
BATTERY REQUIREMENTS

03-04-1987

14:57:57

RAU	0.0	0.7	1.3	2.0	
*	.	.	.	.	*
85	C	.	R U	.	*
86	.	C	R U	.	*
87	.	.	C	R U	*
88	.	.	C	R U	*
89	.	.	C	R U	*
90	.	.	C	R U	*

R - REQUIREMENTS - REQ(T%)
C - CAPABILITY ACHEIVED - UTIL(T%)
U - UTILITY FORECAST - UTILITY(T%)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
BATTERY FUNDS

03-04-1987

14:58:16

EOD	0.0	1000.0	2000.0	3000.0	
*	.	.	.	.	*
85	D EO	.	.	.	*
86	D O E	.	.	.	*
87	D O E	.	.	.	*
88	D O E	.	.	.	*
89	D O E	.	.	.	*
90	DO E	.	.	.	*

E - EARNED FUNDS - EFUNDS(T%)
O - FUNDS OBLIGATED - OB(T%)
D - DELTA FUNDS - DFUNDS(T%)

SAMPLE RUN #6

TABLE FUNCTION MODIFICATION EFFECTS

FILENAME: TABMAK.DOC

TABLE FUNCTIONS

DATA

PS,UL,LL,IN,
T(1),T(2),T(3),T(4),T(5),T(6),T(7),T(8),T(9),T(10)

DFUNDS , 1 , 0 , .1 ,
-.3 , -.2 , -.1 , .0 , .05 , .10 , .15 , .20 , .25 , .35 , .40 ,

ACCOM , 1 , 0 , .1 ,
0 , .1 , .2 , .3 , .4 , .5 , .6 , .7 , .8 , .9 , 1 ,

PSS , 2 , 0 , .2 ,
0 , .15 , .40 , .65 , .80 , .98 , 1 , 1 , 1 , 1 , 1 ,

PSF , 2 , 0 , .2 ,
0 , .15 , .40 , .65 , .80 , .98 , 1 , 1 , 1 , 1 , 1 ,

KEY

PS = Parameter name.
 DFUNDS = Delta funds multiplier based on shortfall in meeting
 requirements.
 ACCOM = Accomplishment multiplier based on earned funding
 comparision to planned funding.
 PSS = Probability of schedular success based on planned program
 length compared to optimum program length.
 PSF = Probability of funding success based on comparison between
 planned funding and estimate of required funding.
UL = Upper limit for T(N) value.
LL = Lower limit for T(N) value.
IN = Interval size (equal to UL-LL).
T(N) = Parameter value.

FILENAME: PROG.DOC

PROJECT SPECIFICATIONS

FILE DATA

PROGS, TOTF, PL, OPTPL, FR, PTECHS, FDELAY, CDELAY, SUDELAY

SOLAR , 1600 , 5 , 4 , 2000 , .95 , .90 , .98 , 1.0 ,

BATTERY , 2500 , 6 , 5 , 3000 , .75 , .90 , .90 , .95 ,

CONCENTRATOR , 1650 , 5 , 6 , 2000 , .85 , .90 , .90 , .98

KEY

PROGS = Name of project being reviewed.

TOTF = Total funding allocated to project (FY85\$K).

PL = Planned project length (years).

OPTPL = Optimum project length to meet capability objectives (years).

FR = Funding expected to be required for project to meet objectives (FY85\$K).

PTECHS = Probability of technical success (non-dimensional).

FDELAY = Funding efficiency (non-dimensional).

CDELAY = Contracting efficiency (non-dimensional).

SUDELAY = Project start-up efficiency (non-dimensional).

RESOURCE ALLOCATION MODEL RESULTS
CONCENTRATOR

03-04-1987

15:08:29

T%

REQ	UTILITY	UTIL	TUTIL
TOAP	TOA	OBP	OB
DELTA	EXPEND	FFUND	EFUND
PSUCC	PTECHS	PSS	PSF
ACCOM	VALU	COSTBEN	TCOSTBEN
OPTPL	PL	APL	DPL

85

0.67	0.55	0.00	0.00
1500.00	1500.00	0.00	0.00
0.00	0.00	0.00	0.00
0.54	0.85	0.80	0.80
0.00	0.00	0.00	0.00
6.00	5.00	0.00	0.00

86

0.96	1.09	0.00	0.00
1500.00	1430.00	50.00	70.00
20.00	55.57	14.43	55.57
0.54	0.85	0.80	0.80
0.00	0.00	27.78	27.78
6.00	5.00	0.00	0.00

87

0.99	1.26	0.20	0.20
1500.00	1100.00	300.00	400.00
120.00	406.43	8.00	462.00
0.54	0.85	0.80	0.80
0.30	0.16	1.11	1.11
6.00	5.00	0.00	0.00

88

0.99	1.42	0.46	0.46
1500.00	995.00	500.00	505.00
125.00	502.90	10.10	964.90
0.54	0.85	0.80	0.80
0.60	0.33	1.03	1.03
6.00	5.00	0.00	0.00

89

1.55	1.46	0.71	0.71
1500.00	1025.00	500.00	475.00
100.00	475.60	9.50	1440.50
0.54	0.85	0.80	0.80
0.90	0.49	1.56	1.56
6.00	5.00	0.00	0.00

90

1.60	1.45	0.79	0.79
2000.00	1870.00	200.00	130.00
30.00	136.90	2.60	1577.40
0.54	0.85	0.80	0.80
1.00	0.54	1.59	1.59
6.00	5.00	5.53	0.53

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
CONCENTRATOR REQUIREMENTS

03-04-1987

15:09:04

	0.0	0.7	1.3	2.0
85	C	U R		
86	C		R U	
87		C	R U	
88		C	R	U
89			C	U R
90			C	U R

R = REQUIREMENTS - REQ(TX)

C = CAPABILITY ACHIEVED - UTIL(TX)

U = UTILITY FORECAST - UTILITY(TX)

RESOURCE ALLOCATION MODEL - GRAPHICAL PRESENTATION
CONCENTRATOR FUNDS

03-04-1987

15:09:21

	0.0	1000.0	2000.0	3000.0
85	EOD			
86	DEO			
87	D	OE		
88	D	O	E	
89	D	O	E	
90	D O		E	

E = EARNED FUNDS - EFUND(TX)

O = FUNDS OBLIGATED - OB(TX)

D = DELTA FUNDS - DFUNDS(TX)
