NASA TECHNICAL MEMORANDUM

NASA TM-82419

(NASA-TM-82419) PROJECT RESOURCE REALLOCATION ALGORITHM (NASA) 52 p HC A04/MF A01 CSCL 05A

N81-25861

Unclas G3/81 26618

PROJECT RESOURCE REALLOCATION ALGORITHM

By J. E. Myers
Systems Analysis and Integration Laboratory

May 1981

NASA

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
NASA TM-82419		

4. TITLE AND SUBTITLE	5. REPORT DATE / 6. PERFORMING ORGANIZATION CODE
Project Resource Reallocation Algorithm	5. May 1981 — 6.
7. AUTHOR(S) J. E. Myers	8. PERFORMING ORGANIZATION REPORT #
9. PERFORMING ORGANIZATION NAME AND ADDRESS George C. Marshall Space Flight Center Marshall Space Flight Center, Alabama 35812	10. WORK UNIT NO. — 11. CONTRACT OR GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS National Aeronautics and Space Administration Washington, D.C. 20546	13. TYPE OF REPORT & PERIOD COVERED Technical Memorandem — 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Prepared by: Cost Analysis Office

16. ABSTRACT

Project schedules are an important parameter in industrial-engineering-type manhour and material cost estimates. An existing computer tool (PACE-Pricing and Cost Estimating) generates a cost estimate from resource estimates by Work Breakdown Structure (WBS) and element-of-cost based on a specific project schedule. Project schedules often change, requiring some methodology for adjusting baseline cost estimates. An algorithm has been developed and is described herein which performs a linear expansion or contraction of the baseline project resource distribution in proportion to the project schedule expansion or contraction. Input to the algorithm consists of the deck of cards (PACE input data) prepared for the baseline project schedule as well as a specification of the nature of the baseline schedule change. Output of the algorithm is a new deck of cards with all WBS block and element-of-cost estimates redistributed for the new project schedule. This new deck can be processed through PACE to produce a detailed cost estimate for the new schedule.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
	Unclassified-Unlimited

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified	51	NTIS

MSFC - Form 3292 (Rev. December 1972)

For sale by National Technical Information Service, Springfield, Virginia 22151

TABLE OF CONTENTS

TECHNICAL MEMORANDUM

PROJECT RESOURCE REALLOCATION ALGORITHM

I. INTRODUCTION AND BACKGROUND

Industrial-engineering-type manhour and material cost estimates are a major activity performed at MSFC in support of new projects in their early definition phase. Automatic data processing tools have been developed to speed and enhance the accuracy of the process of project definition, Work Breakdown Structure (WBS) determination, and cost estimation by task, labor category, overhead category, subcontractor, materials, travel and computer requirements. The PACE (Pricing and Cost Estimating) computer system is the primary tool used by the Cost Analysis Office in cost estimates to significantly reduce computation time, eliminate computational errors, and reduce typing and reproduction time for estimators and pricers.

To meet additional requirements and add new capability to the PACE system, a new system of programs has been developed. This system, called PRRA (Project Resource Reallocation Algorithm), provides the estimator with the capability, once a base estimate has been completed using PACE, to redistribute the resources* according to some new project schedule. This system eliminates the effort previously required for manual computation of the new schedule resource distribution by all members of the cost estimate team and allows the estimator to rapidly evaluate the effect of a schedule shift on the total cost of a project and its distribution over time.

The PRRA programs are written in FORTRAN programming language for execution on a UNIVAC 1100/82 computer under the EXEC 8 operating system. The minimum hardware configuration required for running the PRRA system is one central processor, one card reader, one card punch, and an on-line printer.

This report has been prepared to facilitate the use of the PRRA system. Very little effort was made to explain the PACE system or the methodology of estimating used by the PACE system. For more information in these areas, refer to NASA TM-78121 and TMX-64966, respectively.

* Resources, as used in this report, refers to the direct labor manhours and direct dollars required to perform a task.

II. PURPOSE OF THE PRRA COMPUTER SYSTEM

To provide clarity and more understanding as to the purpose of the PRRA system, a brief description of the process to be followed in producing a cost estimate is helpful.

The request for the grounds-up cost estimate is initiated in the Project Office. A team of Science and Engineering personnel is assembled to support the estimator. This team is composed of technical people with expertise in one or more given areas of the project. Each team member is asked to provide an estimate of the resource requirements in his area of expertise at the lowest WBS level. These data are collected by the estimator, reviewed for overlaps and omissions, formatted according to PACE requirements, and fed into PACE to produce the cost estimate. The estimate is then put together in the correct report form to be submitted to the Project Office. Although this is a very simplified description of the process, it does provide a general overview.

The estimate produced by this process is based on a given schedule of program milestones and completion dates. The distribution of the resources in the estimate is valid only for the schedule assumptions under which the estimate was prepared. If the schedule for the project changes, the resource distribution will change. The cost of a project is a function of the amount of resources required as well as the time frame over which these resources are distributed. If the distribution of the resources changes, the project cost will most likely change, too.

The purpose of the PRRA system is to offer one solution to the problem of reallocation project resources according to some new schedule once a base estimate has been generated. PRRA can be used to redistribute resources when the schedule changes in the following ways:

a. The project schedule is expanded (total length increased).

b. The project schedule is compressed (total length decreased).

c. The project start date is delayed or moved up and the end date is delayed or moved up.

d. A combination of c. and a. or c. and b.

The PRRA system reads the resource data cards from the PACE input deck which generated the baseline cost estimate (BASE DATA, TYPE 50 CARDS FROM PACE RUN), reallocates the resources proportionally based on the new schedule, and punches a new set of resource data cards. This new set of resource cards is re-input into PACE and a new cost estimate is generated.

Thus, the PRRA system eliminates the effort required to compute manually the new resource distribution and keypunch a new set of resource data cards corresponding to the new distribution.

III. THE ALGORITHM

A. Basic Assumptions

(1) The schedule change can be expressed as an integral number of months.

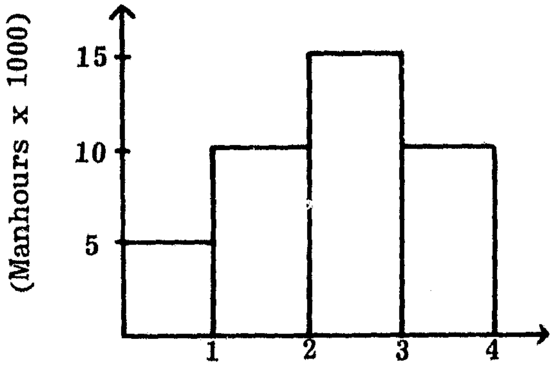
(2) The fiscal year inputs received by the estimators from the S&E team can be distributed uniformly over the months in the fiscal years that coincide with the project schedule. For example, if a project begins in May 1980, the fiscal year inputs received for 1980 are divided by five to obtain a uniform monthly distribution for fiscal year 1980. (May is the 8th month of the fiscal year which begins October 1; thus, there are 5 months remaining in FY80).

(3) The total manhours required to perform the task is not affected by the schedule change. This says that if under the baseline schedule, the total engineering manhours required for the project is 100,000, then the total engineering manhours required for the project under the new schedule is also 100,000. The cost of those 100,000 hours would change, however, if the new distribution resulted in a different yearly spread of the engineering manhours, because the engineering labor rate increases with time. Thus, if the new distribution results in a larger quantity of manhours in the second year of the project than the baseline distribution, the cost of the engineering manhours will be higher in the second year of the new distribution. This assumption was also made in the reallocation of the direct dollar resources. However, PRRA does evaluate the time-value of money when reallocating the direct dollars. This process is explained in detail in Section V, Part B, of this report.

(4) The work scheduled for any particular year cannot begin until the work of the previous year has been completed.

B. Methodology

PRRA directly proportions resources according to the ratio of the duration of the baseline schedule to the duration of the new schedule. For example, suppose a 4-year schedule has manhours distributed as shown in Figure 1. If the schedule is expanded to 5 years, the algorithm will assign 4/5 (ratio of old duration to new duration) of the manhours in the first year of the original schedule as the manhours for the first year of the new schedule (4/5 x 5,000 = 4,000 in this example). For the manhours in the second year of the new schedule, the algorithm will use the remaining 1/5 of the manhours for the first year of the baseline schedule plus 3/5 of the manhours in the second year of the original schedule. (1/5 x 5,000 + 3/5 x 10,000 = 7,000 manhours in this example.) The algorithm continues likewise until the manhours for each of the 5 years are determined.



In algebraic terms, if Xi denotes the manhours allocated in year i of the baseline schedule and Yi denotes the manhours to be allocated in year i of the new schedule, then the following equations result for this example:

$$Y1 = 4/5\ X1 = 4/5\ (5{,}000) = 4{,}000$$

$$Y2 = 1/5\ X1 + 3/5\ X2 = 1/5\ (5{,}000) + 3/5\ (10{,}000) = 7{,}000$$

$$Y3 = 2/5\ X2 + 2/5\ X3 = 2/5\ (10{,}000) + 2/5\ (15{,}000) = 10{,}000$$

$$Y4 = 3/5\ X3 + 1/5\ X4 = 3/5\ (15{,}000) + 1/5\ (10{,}000) = 11{,}000$$

$$Y5 = 4/5\ X4 = 4/5\ (10{,}000) = 8{,}000$$

The graph illustrated in Figure 2 shows the final result of the algorithm for this example:

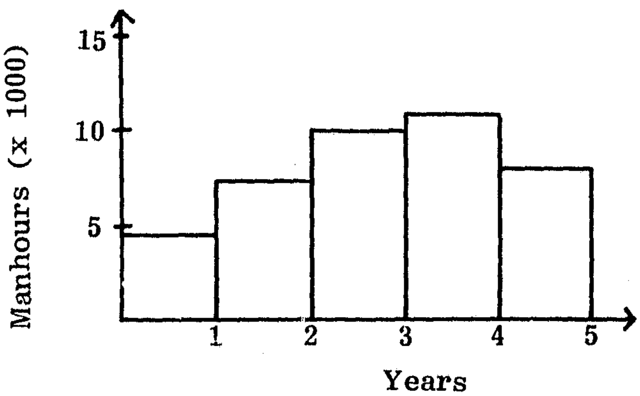


Figure 2

Dollar resource inputs in base year dollars are treated exactly the same as the manhours; however, real year dollar inputs are manipulated differently. Real year dollars are first de-escalated to a base year, spread as outlined above, and then re-escalated to real year dollars. For a more detailed discussion of the process, refer to Section IV, Part B, of this report.

IV. THE PRRA COMPUTER SYSTEM

A. Input Definition

There are three types of user-supplied inputs to the PRRA system. They are: (1) Project Schedule Data, (2) Dollar Escalation Data, and (3) Project Resource Data.

1. Project Schedule Data

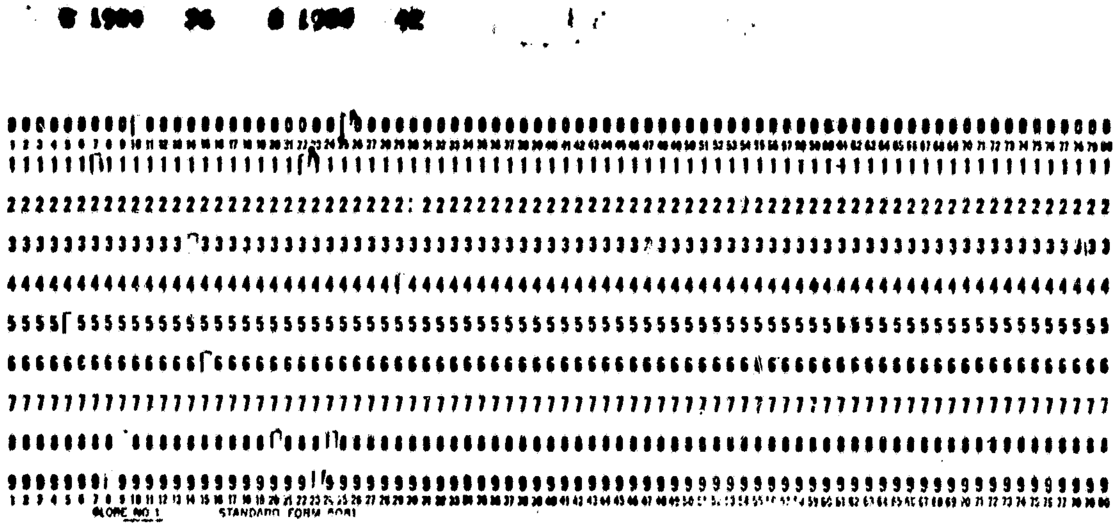
This input type consists of the information necessary to define the time frames of both the baseline schedule and the new schedule. The required inputs are the start data and duration of both the baseline schedule and the new schedule. The start dates are entered as calendar month and year. For example, if the baseline schedule had a start date of May 1980, and the new schedule had a start date of August 1980, then these values would be input as 5,1980, and 8,1980, respectively. The duration of each schedule must be expressed in an integral number of months. If the baseline schedule had a duration of 3 years, and the new schedule had a duration of 3 1/2 years, these values would be input as 36 months and 42 months, respectively. In the PRRA input stream, all values of this data type are input on card 1. The data must be input on the card in the following form:

Card 1

Value #	Description	Columns	Example Value
1	Beginning month of its original schedule	1-5	5
2	Beginning year of the original schedule	6-10	1980
3	Duration of the original schedule	11-15	36
4	Beginning month of the new schedule	16-20	8
5	Beginning year of the new schedule	21-25	1980
6	Duration of the new schedule	26-30	42

All values are integers and must be right justified in their respective fields. This implies that the first input value should appear in the last column of its field, column 5 in this case, because it is a single digit integer. The second input value should begin in the second column of its input field, column 7 in this case, because it is a four-digit integer, and so on, until all six values have been input. Thus, for this example, card 1 appears as follows:

Card 1 - (Project Schedule Data)



2. Dollar Escalation Rate

This input type consists of the factors used to (1) de-escalate real year dollars to some base year prior to reallocation, and (2) re-escalate the base year dollars to real year dollars after the reallocation has been completed.

Cards 2, 3, and 4 contain the factors required to de-escalate material dollars, travel dollars, and other direct dollars, respectively. There should be one factor for each year of the baseline schedule. Using the example of the project which originally began in May 1980 and was 36 months long, there should be four de-escalation factors per card. Looking at card 2, the material dollars de-escalation card, the first factor would de-escalate the FY 80 real year dollars to the given base year; the second factor would de-escalate the FY 81 dollars, the third factor would de-escalate the FY 82, and the fourth factor would de-escalate the FY 83 dollars. If the base year was selected to be FY 79, then the de-escalation factors required to go from the respective real year dollars to FY 79 dollars would be 1.115, 1.252, 1.390, and 1.523 (from the NASA escalation index for new start programs, June 1980). The data should be input as follows:

Card 2 - (Material De-escalation)

Value #	Description	Columns	Example Value
1	FY 80 to FY 79 Factor	1-6	1.115
2	FY 81 to FY 79 Factor	7-12	1.252
3	FY 82 to FY 79 Factor	13-18	1.390
4	FY 83 to FY 79 Facotr	19-24	1.523

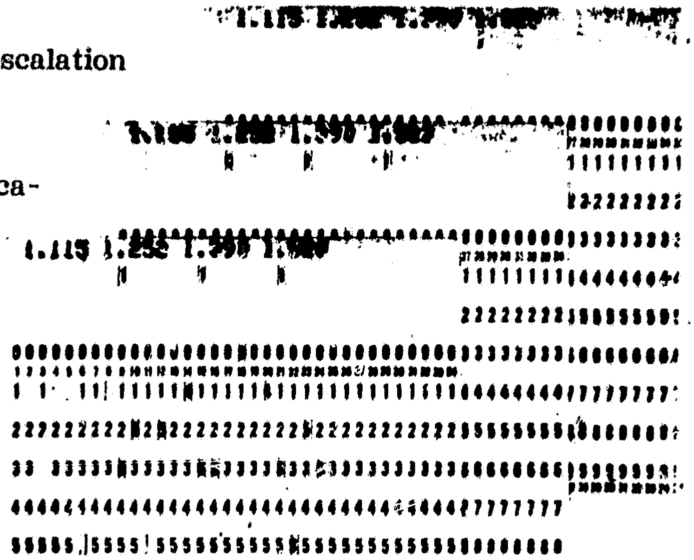
Assuming material, travel, and other direct dollars are all in real year dollars, cards 3 and 4 are the same as card 2. Thus, for this example, cards 2, 3, and 4 would appear as follows:

Cards 2, 3, and 4 - (Dollar Escalation Data)

Card 2, Material $ De-escalation

Card 3, Travel $ De-escalation

Card 4, Other Direct $ De-escalation



If the dollars in any category are already in base year dollars, then no de-escalation values should be input for the category. However, the blank card for that category must appear in the run stream. If any of the cards 2, 3 or 4 is blank then no de-escalation is performed on the category corresponding to the blank card. On the other hand, if the base year selected is the same as the first year of the project, then the de-escalation factor input for the first year must be 1.0, not 0.0. If PRRA encounters a 0.0 factor for the first year, no de-escalation is performed for any year of that category.

Cards 5, 6, and 7 are defined just like cards 2, 3, and 4, respectively, except that instead of de-escalating the real year dollars to some base year, the factors on these cards are used to escalate from the base year dollars to the appropriate real year dollars. Card 5 corresponds to material dollars, card 6 to travel dollars, and card 7 corresponds to other direct dollars. The first factor on any of these three cards must be that factor required to escalate the dollars from the given base year to the first year of the new schedule. This is very important.

Card 5 - (Material Escalation)

Travel #	Description	Columns	Example Value
1	FY 79 to FY 80	1-6	1.115
2	FY 79 to FY 81	7-12	1.252
3	FY 79 to FY 82	13-18	1.390
4	FY 79 to FY 83	19-24	1.523
5	FY 79 to FY 84	25-30	1.660

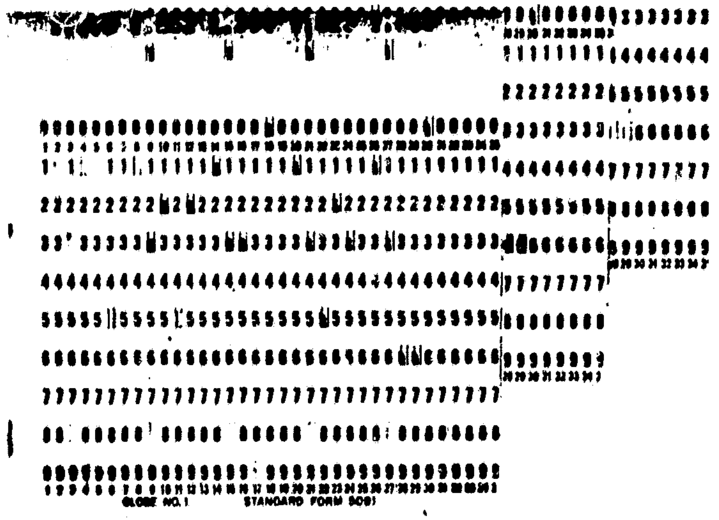
In this example, cards 6 and 7 are the same as card 5 with card 6 corresponding to travel dollars, and card 7 to other direct dollars. Thus, cards 5, 6, and 7 would appear as follows:

Cards 5, 6, and 7 - (Dollar Escalation Data)

Card 5, Material & De-escalation

Card 6, Travel Escalation

Card 7, Other Direct
$ Escalation



Again, it is not mandatory that the base year dollars be escalated to real year dollars. If escalation is not desired for any of the direct dollar categories, a blank card should be input in the run stream for the appropriate category.

By providing the ability to de-escalate independently of any escalation used, and vice-versa, PRRA offers the user some additional capability. The advantages of this system are explained in Section V of this manual.

PROJECT RESOURCE DATA

WBS NUMBER:	COMPUTER INPUT AND WORKSHEET (Base Data) PACE II SYSTEM (Pricing and Cost Estimating)	DATE
WBS TITLE:	PROJECT NAME:	PREPARED BY

TYPE CODE		WORK BREAKDOWN STRUCTURE CODE	FY	MANPOWER						DOLLARS		
				ENGINEERING	MANUFACTURING	TOOLING	QUAL. & REL. ASSURANCE	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											
5	0											

MSFC - Form 514 (Rev. February 1977)

Figure 3

3. <u>Project Resource Data</u>

Each card of this input type represents one element or block at the lowest levels of the WBS for a particular fiscal year and contains the estimated amount of labor in manhours per labor category and dollar expenses (Material, travel, and other direct) for that fiscal year WBS element combination. This input type consists of the "type 50" cards from the PACE input deck used to make the baseline estimate. A sample PACE input sheet for the type 50 cards appears in Figure 3. For a more detailed explanation of the input type refer to NASA TM 78121, pages 4-13.

These cards must be grouped by WBS element. This means that all cards pertaining to a single WBS element must appear back-to-back in the run stream. Furthermore, the cards must be arranged in ascending time order within each WBS element. For example, if the input data for WBS element 1.2.1 covered the 3 fiscal years FY 80 to FY 82, then the card containing the data for FY 80 must appear before the FY 81 data card, which must appear before the FY 82 data card in the run stream.

B. Logic Flow

This part of section IV presents an overview of the logic flow of the PRRA computer system. It is intended to describe verbally the sequence of operations carried out by PRRA.

PRRA begins by defining the old and new project schedule time frames. The necessary information is contained on card 1 of the input stream. The schedules are defined with respect to fiscal year dates. For example, calendar date November 1980 is the second month of the government fiscal year 1981. PRRA performs all calculations in the fiscal year time frame.

In defining the old and new schedule time frames, PRRA also defines the ratio which will be used to reallocate the resources. (Refer to Section III, Part b).

The dollar escalation data cards (cards 2 through 7) are read in next. This information is stored for use when working with the direct dollar categories (material dollars, travel dollars, and other direct dollars) of the project resource data.

PRRA then begins reading the project resource data cards. These cards must be ordered as defined in part A of this section. PRRA operates on one WBS element at a time. Once all cards pertaining to a single WBS element have been read, PRRA begins the spreading loop. This loop is completed nine times per WBS element, one time for each of the nine resource categories. It is within this loop that the reallocation of the resources is computed.

PRRA must compute a monthly resource allocation from the fiscal year resource inputs which were used to generate new baseline estimate. This is done by dividing the fiscal year inputs by the number of months in that fiscal year which coincide with the baseline project schedule. These are the next computations performed when working with the manpower categories of the project resource data (the first six resource categories on a base data card). But, when working with the dollar categories of the project resource data (the last three resource categories on a base data card), PRRA must determine if the dollar inputs are in base year dollars or real year dollars. This determination is accomplished by referring to the first three dollar excalation data cards. As described in the input definitions, if one de-escalation factor for a particular category is blank, or if the first value on the card is 0.0, then PRRA assumes that the resource dollar inputs for that dollar category are in base year dollars and proceeds in computing a monthly allocation. Otherwise, the resource dollar inputs for that dollar category are assumed to be in real year dollars. In this case, the real year dollars must first be de-escalated to a common base year before computing a monthly spread. This is done by dividing each value in this category by the appropriate de-escalation factor. If a monthly allocation was computed using the real year dollars, then the time value of money ffect would not be reflected in the new distribution. Once the real year dollars are in some base year reference, then a monthly allocation is computed.

Next, this monthly allocation of the baseline resources is processed by the spreading algorithm and a new monthly allocation is computed which corresponds to the new schedule.

Now PRRA cumulates the monthly resource allocation into fiscal year totals. The manpower resources are now ready to be punched out in the new projects resource data cards, but PRRA must determine if the new dollar resource values are to be left in base year dollars or escalated to real year dollars. This determination is made by referencing the second set of three dollar escalation data cards. If the card for a particular dollar category is blank or has an 0.0 for the first value, then no escalation will be performed on that particular dollar category. The values in this category will be punched in base year dollars. Otherwise, each value in this category will be escalated by the appropriate escalation factor.

The last operation performed by PRRA is to punch out a new deck of project resource data cards. PRRA also prints out the input data (as it appears on the cards), the monthly allocation of the resources for both the old schedule and the new schedule, and finally the new resource data (as it appears on the cards).

C. Output Description

PRRA generates two basic outputs: (1) a new set of resource data cards, and (2) line printer output.

The new set of resource data cards is used to generate a PACE cost estimate based on the new resource distribution. This set of cards replaces the baseline resource data cards (type 50) in the PACE run-stream.

The line printer output is used to check and verify the program run. It consists of three basic parts: (1) PRRA Input Data, (2) monthly resource spread by WBS element for both the baseline distribution and the new distribution, and (3) new resource data card images.

The first section, PRRA Input Data, is a listing of the data in card image form, which the user input to PRRA. With this information, the user is able to review the data and verify its accuracy.

The second section presents the monthly distribution of the resource for both the baseline schedule and the new schedule. The data appears by month and is grouped by fiscal year. (Refer to the second assumption under Part a, Section III, Page 3). The material dollar, travel dollar, and other direct dollar categories appear as base year dollars, not real year dollars, regardless of how these values were input.

The third section consists of a listing, in card image form, of the resource data cards corresponding to the new project schedule. This allows the user to review the new resource distribution without having to shuffle through the cards.

D. Setting up the New PACE Deck

Some changes in the PACE run stream may be required in addition to replacing the old TYPE 50 cards with the new TYPE 50 cards. Exactly what changes are required are determined by the project schedule change. For instance, if the new schedule extends into a year which was not covered in the baseline schedule, then the user would have to add a labor rate factor for this new year on each of the labor rate cards (TYPE 20 cards from PACE deck). Also, an escalation factor for the new year for each of the dollar categories may be required if the dollar categories are in base year dollars.

V. OTHER USES

PRRA may be applied to problems other than a schedule change. For instance, PRRA may be used to escalate base year dollars to real year dollars for the three dollar categories on the base data cards. PRRA simplifies the process by eliminating the effort required to repunch manually each of the base data cards and eliminating the effort required to compute the real year values for each WBS element.

PRRA can be used to de-escalate the dollar categories by one set of factors and re-escalate them by another set of factors. This may be the case in the event that the Comptroller's Office issues new escalation tables, replacing the old tables; thus invalidating the base year to real year escalation by the old table. Again, PRRA eliminates the effort required to repunch manually each of the base data cards, as well as the effort required to recompute the appropriate real year dollar value.

PRRA may also be used to duplicate the base data cards if the need should arise.

VI. LIMITATIONS

Although PRRA is a very useful system, it should not be used indiscriminately. There are many costs incurred by a project which are directly related to the duration of the project. PRRA does not consider the change in the project costs which results from these time-dependent costs. These considerations are left up to the user's discretion. Each problem should be worked independently, taking into account its unique characteristics. PRRA may be an invaluable tool when used correctly, but the potential exists for abuse.

VII. FUTURE IMPROVEMENTS

Realizing the desire to expand both the PACE and PRRA system in the future, the PRRA programs are written to be compatible with the PDP 11/70 computer system. The PDP system is designed to allow interactive operation from a CRT terminal by the user. Work has begun to develop a PRRA system which will execute real time interactively from a CRT on the PDP computer. This will allow the PRRA system to keep pace with the general trend of moving from batch program execution to real time interactive execution.

APPENDIX A

TO

PROJECT RESOURCE REALLOCATION ALGORITHM

EXAMPLE OF THE ALGORITHM

EXAMPLE OF ALGORITHM

The original schedule called for the project to begin in May 1980 and run for 20 months.

The new schedule calls for the project to begin in August 1980 and run for 26 months.

The PACE input sheet contains the input data. All dollars are in real year dollars. The de-escalation rates are:

FY 1980 to Base Year - 10%
FY 1981 to Base Year - 20%
FY 1982 to Base Year - 30%

The escalation rates used to escalate the dollars after reallocation are:

Base Year to FY 1980 - 20%
Base Year to FY 1981 - 30%
Base Year to FY 1982 - 40%

The real year dollar inputs will be de-escalated by the de-escalation rates, spread by the algorithm, and escalated by the escalation rates.

This example encompasses all the major options of the PRRA system.

a. The schedule is expanded.

b. A new start date is selected.

c. Real year dollars are de-escalated by one set of rates, redistributed, and then escalated by another set of rates.

To minimize the hand-written computations, only the engineering hours labor category and the material dollar category of WBS #1.1.1 are expanded in this example. All other labor hour categories are computed like the engineering hours labor category, and all other dollar categories are computed like the materials dollars category.

COMPUTER INPUT AND WORKSHEET (Base Data)
PACE II SYSTEM (Pricing and Cost Estimating)

WBS NUMBER:

WBS TITLE: PRRA EXAMPLE DATA

PROJECT NAME:

DATE:

PREPARED BY: J. MYERS

PAGE 1 OF 1

TYPE CODE	WORK BREAKDOWN STRUCTURE CODE	FY	MANPOWER: ENGINEERING	MANPOWER: MANUFACTURING	MANPOWER: TOOLING	MANPOWER: QUAL. & REL. ASSURANCE	MANPOWER: TESTING	MANPOWER: OTHER	DOLLARS: MATERIAL $	DOLLARS: TRAVEL $	DOLLARS: OTHER DIRECT $
50	1.1.1	80	4000	1500							
50	1.1.1	81	6000	3000	300				1000	1500	300
50	1.1.1	82	3000	1000					2000	3000	1500
50									3000	4500	200
50	1.1.2	80		1500							
50	1.1.2	81	8000	1500							
50											
50	1.1.3	80		800							
50	1.1.3	81		3000	800						
50	1.1.3	82		1500							
50											
50	1.1.4	81	3000								
50	1.1.4	82	4000							100	3000
50											
50	1.1.5	80	1000	4000							
50	1.1.5	81	2000	8000	1000						
50	1.1.5	82	3000	3000							
50											
50	1.1.6	82	3000	1000							
50									300	800	1000
50											

MSFC - Form 514 (Rev. February 1977)

MATERIAL DOLLARS SPREAD

When working with the dollar resource data, PRRA must first determine if the dollars are in real year dollars or some base year dollars. In the example, the dollars are in some real year dollars, and PRRA must first de-escalate them before the reallocation can begin. (If the dollars had been in some base year, no de-escalation would occur and PRRA would compute the new spread immediately.)

The FY 80 material dollars are divided by 1.0 plus the first de-escalation rate, or 1.0 + .1 which equals 1.1. Thus, the de-escalate FY 80 materials dollars value is computed at $1,000 ÷ 1.1 = 909.1. This value is then divided by 5 (the number of months remaining in FY 80) to yield 181.8 dollars per month for each of the 5 months in FY 80.

The FY 81 material dollars are de-escalated by a factor of 1.2 and then spread uniformly over FY 81. This computation looks like this.

$2,000 ÷ 1.2 = $1,666.7
in the base year dollars

$1,666.7 ÷ 12 = $138.9
per month for each month in FY 81

The FY 82 material dollars are de-escalated by a factor of 1.3 and then spread uniformly over the remaining project months in FY 82. This computation looks like this:

$3,000 ÷ 1.2 = $2,307.7
in the base year dollars

$2,307.7 ÷ 3 = $769.2
per month for the 3 months in
FY 81 that the project spare

In algebraic terms, with reference to the engineering labor hours category calculations, we have

X_1 thru X_5 = $181.8

X_6 thru X_{17} = $138.9

and X_{18} thru X_{20} = $769.2

The calculations of Y_1 thru Y_{26} are exactly the same as in the engineering labor category calculations. They yield:

Y_1 and Y_6 = $140, Y_7 = $123,

Y_8 thru Y_{22} = $107,

Y_{23} = $543 and

Y_{24} thru Y_{26} = $592

Accumulating by fiscal year gives the following fiscal year material dollars before escalation:

FY 80 = \$280

FY 81 = \$1431

FY 82 = \$3173

Now PRRA determines if the user wishes to leave the material dollars in some base year dollars or escalate them to real year dollars. In this example, the user does wish to escalate the material dollars to real year dollars. Using the escalation rates given in the beginning of this Appendix, we have

Base Year to FY 80 = \$280 x 1.2 = \$336

Base Year to FY 81 = \$1,431 x 1.3 = \$1,860

Base Year to FY 82 = \$3,173 x 1.4 = \$4,442

ENGINEERING HOUR SPREAD

The old schedule called for a 20-month program beginning in May 1980. This means there are 5 months left in FY 1980 (May, June, July, August and September). PRRA takes the engineering labor hours for 1980 and divides them by the number of months remaining in this fiscal year. In this example this is 4000 engineering labor hours divided by 5 months which yield a uniform monthly distribution of 800 hours per month for the 5 months remaining in FY 80.

For FY 81, PRRA takes the 6000 engineering labor hours and divides them by 12 months to obtain a uniform monthly distribution of 500 engineering hours per month for the 12 months of FY 81.

Since 17 months of the program were completed in FY 80 and FY 81, that leaves only 3 months of effort for FY 82. PRRA takes the 3000 engineering labor hours in FY 82, divides them by 3, and obtains a uniform monthly distribution of 1000 hours per month for each of the 3 months of FY 82.

The following table summarizes how PRRA distributes the labor hours of the old schedule, then calculates the new distribution for the new schedule based on the ratio of the old duration to the new durations. In this example the ratio is $\frac{20}{26}$.

ENGINEERING LABOR CATEGORY

WBS # 1.1.1

	i	Xi						Yi		
FY 80	May 1	800		$Y_1 = \frac{20}{26} X_1$	=	$\frac{20}{26}$ (800)	=	615.4	Aug	FY 80
	Jun 2	800		$Y_2 = \frac{6}{26} X_1 + \frac{14}{26} X_2$	=	$\frac{6}{26}$ (800) + $\frac{14}{26}$ (800)	=	615.4	Sept	1,231,
	Jul 3	800	4,000 FY 80	$Y_3 = \frac{12}{26} X_2 + \frac{8}{26} X_3$	=		=	615.4	Oct	FY 81
	Aug 4	800		$Y_4 = \frac{18}{26} X_3 + \frac{2}{26} X_4$	=		=	615.4	Nov	
	Sept 5	800		$Y_5 = \frac{20}{26} X_4$	=		=	615.4	Dec	
FY 81	Oct 6	500		$Y_6 = \frac{4}{26} X_4 + \frac{16}{26} X_5$	=		=	615.4	Jan	
	Nov 7	500		$Y_7 = \frac{10}{26} X_5 + \frac{10}{26} X_6$	=	$\frac{10}{26}$ (800) + $\frac{10}{26}$ (500)	=	500.0	Feb	
	Dec 8	500		$Y_8 = \frac{16}{26} X_6 + \frac{4}{26} X_7$	=		=	384.6	Mar	5,654
	Jan 9	500		$Y_9 = \frac{20}{26} X_7$	=		=	384.6	Apr	FY 81
	Feb 10	500		$Y_{10} = \frac{2}{26} X_7 + \frac{18}{26} X_8$	=		=	384.6	May	
	Mar 11	500	6,000	$Y_{11} = \frac{8}{26} X_8 + \frac{12}{26} X_9$	=		=	384.6	June	
	Apr 12	500	FY 81	$Y_{12} = \frac{14}{26} X_9 + \frac{6}{26} X_{10}$	=		=	384.6	July	
	May 13	500		$Y_{13} = \frac{20}{26} X_{10}$	=		=	384.6	Aug	
	Jun 14	500		$Y_{14} = \frac{20}{26} X_{11}$	=		=	384.6	Sept	
	Jul 15	500		$Y_{15} = \frac{6}{26} X_{11} + \frac{14}{26} X_{12}$	=		=	384.6	Oct	FY 82
	Aug 16	500		$Y_{16} = \frac{12}{26} X_{12} + \frac{8}{26} X_{13}$	=		=	384.6	Nov	
	Sept 17	500		$Y_{17} = \frac{18}{26} X_{13} + \frac{2}{26} X_{14}$	=		=	384.6	Dec	
FY 82	Oct 18	1,000		$Y_{18} = \frac{20}{26} X_{14}$	=		=	384.6	Jan	
	Nov 19	1,000		$Y_{19} = \frac{4}{26} X_{14} + \frac{16}{26} X_{15}$	=		=	384.6	Feb	

ENGINEERING LABOR CATEGORY (Cont'd)

WBS 1.1.1

		i	Xi					Yi		
FY 82	Dec	20	1,000	$Y_{20} = \frac{10}{26} X_{15} + \frac{10}{26} X_{16}$	=		=	384.6	Mar	6,115
		21	-0-	$Y_{21} = \frac{16}{26} X_{16} + \frac{4}{26} X_{17}$	=		=	384.6	Apr	FY 82
		22	-0-	$Y_{22} = \frac{20}{26} X_{17}$	=		=	384.6	May	
		23	-0-	$Y_{23} = \frac{2}{26} X_{17} + \frac{18}{26} X_{18}$	=	$\frac{2}{26}(500) + \frac{18}{26}(1,000)$	=	730.8	June	
		24	-0-	$Y_{24} = \frac{8}{26} X_{18} + \frac{12}{26} X_{19}$	=		=	769.2	July	
		25	-0-	$Y_{25} = \frac{14}{26} X_{19} + \frac{6}{26} X_{20}$	=		=	769.2	Aug	
		26	-0-	$Y_{26} = \frac{20}{26} X_{20}$	=		=	769.2	Sept	

APPENDIX B

TO

PROJECT RESOURCE REALLOCATION ALGORITHM

DECK SETUP

Card 1   Green Run Card

@ Run_Myers, 1HEL02D3007L, JMyers Bin 207, 30,1000/500

On the green card you should mark "YES" on the punch line and "NO" on the PLOTS LINE. Core Size is 32K, bin number is 207, and input tape number is 18705.

Card 2

@ SRG, SJ

Card 3

Myers*PRDA, 18705

Card 4

@XQT_Myers*PRDA.ABS

Card 5

Project schedule data card.

Card 6

Material $ de-escalation card.

Card 7

Travel $ de-escalation card

Card 8

Other direct $ de-escalation card

Card 9

Material $ escalation card

Card 10

Travel $ escalation card

Card 11

Other direct $ escalation card

Card 12

Begin PACE data cards (Type 50)

Last Card

@ FIN

APPENDIX C

TO

PROJECT RESOURCE REALLOCATION ALGORITHM

PROGRAM RUN AND OUTPUT

```
****************************************************      SECTION 1      ******************************************************
                                                         PRRA INPUT DATA

   5 1980   20    8 1980   26
 1.100 1.200 1.300 0.000 0.000 0.000 0.000 0.000 0.000 0.000
 1.100 1.200 1.300 0.000 0.000 0.000 0.000 0.000 0.000 0.000
 1.100 1.200 1.300 0.000 0.000 0.000 0.000 0.000 0.000 0.000
 1.200 1.300 1.400 1.500 0.000 0.000 0.000 0.000 0.000 0.000
 1.200 1.300 1.400 1.500 0.000 0.000 0.000 0.000 0.000 0.000
 1.200 1.300 1.400 1.500 0.000 0.000 0.000 0.000 0.000 0.000

501.1.1           80   4000   1500                           1000  1500   300
501.1.1           81   6000   3000   300                     2000  3000  1500
501.1.1           82   3000   1000                           3000  4500   200

501.1.2           80          1500
501.1.2           81   8000   1500

501.1.3           80           800
501.1.3           81          3000   800
501.1.3           82          1500

501.1.4           81   3000                                         100  3000
501.1.4           82   4000

501.1.5           80   1000   4000
501.1.5           81   2000   8000  1000
501.1.5           82   3000   3000

501.1.6           82   3000   1000                            300   800  1000
```

SECTION 2

MONTHLY SPREAD BY WBS ELEMENT

OLD SCHEDULE

1.1.1

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	800	300	0	0	0	0	182	273	55
	800	300	0	0	0	0	182	273	55
	800	300	0	0	0	0	182	273	55
	800	300	0	0	0	0	182	273	55
	800	300	0	0	0	0	182	273	55
81	500	250	25	0	0	0	139	208	104
	500	250	25	0	0	0	139	208	104
	500	250	25	0	0	0	139	208	104
	500	250	25	0	0	0	139	208	104
	500	250	25	0	0	0	139	208	104
	500	250	25	0	0	0	139	208	104
	500	250	25	0	0	0	139	208	104
	500	250	25	0	0	0	139	208	104
	500	250	25	0	0	0	139	208	104
	500	250	25	0	0	0	139	208	104
	500	250	25	0	0	0	139	208	104
	500	250	25	0	0	0	139	208	104
82	1000	333	0	0	0	0	769	1154	51
	1000	333	0	0	0	0	769	1154	51
	1000	333	0	0	0	0	769	1154	51

NEW SCHEDULE

1.1.1

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	615	231	0	0	0	0	140	210	42
	615	231	0	0	0	0	140	210	42
81	615	231	0	0	0	0	140	210	42
	615	231	0	0	0	0	140	210	42
	615	231	0	0	0	0	140	210	42
	615	231	0	0	0	0	140	210	42
	500	212	10	0	0	0	123	185	61
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
82	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	385	192	19	0	0	0	107	160	80
	731	250	2	0	0	0	543	815	44
	769	256	0	0	0	0	592	888	39
	769	256	0	0	0	0	592	888	39
	769	256	0	0	0	0	592	688	39

OLD SCHEDULE

1.1.2

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	0	300	0	0	0	0	0	0	0
	0	300	0	0	0	0	0	0	0
	0	300	0	0	0	0	0	0	0
	0	300	0	0	0	0	0	0	0
	0	300	0	0	0	0	0	0	0
81	667	125	0	0	0	0	0	0	0
	667	125	0	0	0	0	0	0	0
	667	125	0	0	0	0	0	0	0
	667	125	0	0	0	0	0	0	0
	667	125	0	0	0	0	0	0	0
	667	125	0	0	0	0	0	0	0
	667	125	0	0	0	0	0	0	0
	667	125	0	0	0	0	0	0	0
	667	125	0	0	0	0	0	0	0
	667	125	0	0	0	0	0	0	0
	667	125	0	0	0	0	0	0	0
	667	125	0	0	0	0	0	0	0
82	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0

NEW SCHEDULE

1.1.2

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	0	231	0	0	0	0	0	0	0
	0	231	0	0	0	0	0	0	0
81	0	231	0	0	0	0	0	0	0
	0	231	0	0	0	0	0	0	0
	0	231	0	0	0	0	0	0	0
	0	231	0	0	0	0	0	0	0
	256	163	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
82	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	513	96	0	0	0	0	0	0	0
	51	10	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0

OLD SCHEDULE

1.1.3

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	0	160	0	0	0	0	0	0	0
	0	160	0	0	0	0	0	0	0
	0	160	0	0	0	0	0	0	0
	0	160	0	0	0	0	0	0	0
	0	160	0	0	0	0	0	0	0
81	0	250	67	0	0	0	0	0	0
	0	250	67	0	0	0	0	0	0
	0	250	67	0	0	0	0	0	0
	0	250	67	0	0	0	0	0	0
	0	250	67	0	0	0	0	0	0
	0	250	67	0	0	0	0	0	0
	0	250	67	0	0	0	0	0	0
	0	250	67	0	0	0	0	0	0
	0	250	67	0	0	0	0	0	0
	0	250	67	0	0	0	0	0	0
	0	250	67	0	0	0	0	0	0
	0	250	67	0	0	0	0	0	0
82	0	500	0	0	0	0	0	0	0
	0	500	0	0	0	0	0	0	0
	0	500	0	0	0	0	0	0	0

NEW SCHEDULE

1.1.3

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	0	123	0	0	0	0	0	0	0
	0	123	0	0	0	0	0	0	0
81	0	123	0	0	0	0	0	0	0
	0	123	0	0	0	0	0	0	0
	0	123	0	0	0	0	0	0	0
	0	123	0	0	0	0	0	0	0
	0	158	26	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
82	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	192	51	0	0	0	0	0	0
	0	365	5	0	0	0	0	0	0
	0	385	0	0	0	0	0	0	0
	0	385	0	0	0	0	0	0	0
	0	385	0	0	0	0	0	[illegible]	0

OLD SCHEDULE

1.1.4

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
81	250	0	0	0	0	0	0	7	208
	250	0	0	0	0	0	0	7	208
	250	0	0	0	0	0	0	7	208
	250	0	0	0	0	0	0	7	208
	250	0	0	0	0	0	0	7	208
	250	0	0	0	0	0	0	7	208
	250	0	0	0	0	0	0	7	208
	250	0	0	0	0	0	0	7	208
	250	0	0	0	0	0	0	7	208
	250	0	0	0	0	0	0	7	208
	250	0	0	0	0	0	0	7	208
	250	0	0	0	0	0	0	7	208
82	1333	0	0	0	0	0	0	0	0
	1333	0	0	0	0	0	0	0	0
	1333	0	0	0	0	0	[illegible]	0	0

NEW SCHEDULE

1.1.4

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
81	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	96	0	0	0	0	0	0	3	80
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
82	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	192	0	0	0	0	0	0	5	160
	942	0	0	0	0	0	0	1	16
	1026	0	0	0	0	0	0	0	0
	1026	0	0	0	0	0	0	0	0
	1026	0	0	0	0	0	0	0	0

OLD SCHEDULE

1.1.5

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	200	800	0	0	0	0	0	0	0
	200	800	0	0	0	0	0	0	0
	200	800	0	0	0	0	0	0	0
	200	800	0	0	0	0	0	0	0
	200	800	0	0	0	0	0	0	0
81	167	667	83	0	0	0	0	0	0
	167	667	83	0	0	0	0	0	0
	167	667	83	0	0	0	0	0	0
	167	667	83	0	0	0	0	0	0
	167	667	83	0	0	0	0	0	0
	167	667	83	0	0	0	0	0	0
	167	667	83	0	0	0	0	0	0
	167	667	83	0	0	0	0	0	0
	167	667	83	0	0	0	0	0	0
	167	667	83	0	0	0	0	0	0
	167	667	83	0	0	0	0	0	0
	167	667	83	0	0	0	0	0	0
82	1000	1000	0	0	0	0	0	0	0
	1000	1000	0	0	0	0	0	0	0
	1000	1000	0	0	0	0	0	0	0

NEW SCHEDULE

1.1.5

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	154	615	0	0	0	0	0	0	0
	154	615	0	0	0	0	0	0	0
81	154	615	0	0	0	0	0	0	0
	154	615	0	0	0	0	0	0	0
	154	615	0	0	0	0	0	0	0
	154	615	0	0	0	0	0	0	0
	141	564	32	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
82	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	128	513	64	0	0	0	0	0	0
	705	744	6	0	0	0	0	0	0
	769	769	0	0	0	0	0	0	0
	769	769	0	0	0	0	0	0	0
	769	769	0	0	0	0	0	0	0

OLD SCHEDULE

1.1.6

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
81	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
82	1000	333	0	0	0	0	77	205	256
	1000	333	0	0	0	0	77	205	256
	1000	333	0	0	0	0	77	205	256

NEW SCHEDULE

1.1.6

FY	ENGINEERING	MANUFACTURING	TOOLING	QUAL.& REL.	TESTING	OTHER	MATERIAL $	TRAVEL $	OTHER DIRECT $
80	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
81	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
82	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0
	692	231	0	0	0	0	53	142	178
	769	256	0	0	0	0	59	158	197
	769	256	0	0	0	0	59	158	197
	769	256	0	0	0	0	59	158	197

** SECTION 3 **

NEW RESOURCE DATA CARD IMAGES

501.1.1	80	1231	462	0	0	0	0	336	503	101
501.1.1	81	5654	2481	144	0	0	0	1860	2790	1027
501.1.1	82	6115	2558	156	0	0	0	4442	6663	1124
501.1.2	80	0	462	0	0	0	0	0	0	0
501.1.2	81	3846	1760	0	0	0	0	0	0	0
501.1.2	82	4154	779	0	0	0	0	0	0	0
501.1.3	80	0	246	0	0	0	0	0	0	0
501.1.3	81	0	1996	385	0	0	0	0	0	0
501.1.3	82	0	3058	415	0	0	0	0	0	0
501.1.4	81	1442	0	0	0	0	0	0	52	1562
501.1.4	82	5558	0	0	0	0	0	0	61	1817
501.1.5	80	308	1231	0	0	0	0	0	0	0
501.1.5	81	1654	6615	481	0	0	0	0	0	0
501.1.5	82	4038	7154	519	0	0	0	0	0	0
501.1.6	82	3000	1000	0	0	0	0	323	862	1077

APPENDIX D

TO

PROJECT RESOURCE REALLOCATION ALGORITHM

PROGRAM LISTING

```
      DIMENSION NHOUR(20,9),HOUR(20,9),IY(20),HROLD(180),
     *HRNEW(180),IHOUR(100,9),NIHOUR(100,9),ESC(3,15),RNESC(3,15)
      CHARACTER*80 CARD,CARRAY(1000),NARRAY(1000)
      CHARACTER*16 WBS1,WBS2
      CHARACTER*4 BLANK
      DATA BLANK/'    '/
      JFLAG=0
      IFIVE=50
      KEEP=0
      JCOUNT=0
      WRITE(6,2050)
      WRITE(6,3000)
      READ(5,2000) MONTH,IYEAR,ISPAN,NMONTH,NYEAR,NSPAN
      WRITE(6,2060) MONTH,IYEAR,ISPAN,NMONTH,NYEAR,NSPAN
      READ(5,2030) (ESC(1,I),I=1,10)
      WRITE(6,2070) (ESC(1,I),I=1,10)
      READ(5,2030) (ESC(2,I),I=1,10)
      WRITE(6,2070) (ESC(2,I),I=1,10)
      READ(5,2030) (ESC(3,I),I=1,10)
      WRITE(6,2070) (ESC(3,I),I=1,10)
      READ(5,2030) (RNESC(1,I),I=1,10)
      WRITE(6,2070) (RNESC(1,I),I=1,10)
      READ(5,2030) (RNESC(2,I),I=1,10)
      WRITE(6,2070) (RNESC(2,I),I=1,10)
      READ(5,2030) (RNESC(3,I),I=1,10)
      WRITE(6,2070) (RNESC(3,I),I=1,10)
      MONTH=MONTH+3
      IF(MONTH.GT.12) THEN
          MONTH=MONTH-12
          IYEAR=IYEAR+1
          END IF
      IYEAR=IYEAR-1900
      NMONTH=NMONTH+3
      IF(NMONTH.GT.12) THEN
          NMONTH=NMONTH-12
          NYEAR=NYEAR+1
          END IF
      NYEAR=NYEAR-1900
C
C
C
      KCOUNT=0
      KYEAR=0
      NX1=0
      K1=MONTH
      K2=12
   45 DO 50 I=K1,K2
      KCOUNT=KCOUNT+1
      NX1=NX1+1
      IF(KCOUNT.GE.ISPAN) GO TO 55
   50 CONTINUE
      NX1=0
      K1=K2+1
      K2=K2+12
      KYEAR=KYEAR+1
      GO TO 45
   55 KYEAR=KYEAR+1
      LIYEAR=IYEAR+KYEAR-1
C
C
C
```

```
      KCOUNT=0
      NY=0
      NY1=0
      K1=NMONTH
      K2=12
   70 DO 60 I=K1,K2
      KCOUNT=KCOUNT+1
      NY1=NY1+1
      IF(KCOUNT.GE.NSPAN) GO TO 65
   60 CONTINUE
      NY1=0
      K1=K2+1
      K2=K2+12
      NY=NY+1
      GO TO 70
   65 NY=NY+1
      LNYEAR=NYEAR+NY-1
      DO 75 I=1,1000
   75 CARRAY(I)(1:4)=BLANK
C
C           READ DATA BASE INPUT CARDS
C
      J=0
      DO 80 I=1,1000
      J=J+1
      READ(5,2010,END=85) CARRAY(J)
      IF(CARRAY(I)(1:4) .NE. '501.') J=J-1
   80 CONTINUE
C
C           END DATA BASE INPUT CARDS, NIC = # OF INPUT CARDS READ
C
   85 NIC=J-1
      I=0
C
C           PRINTING OUT DATA BASE INPUT CARDS
C
      I=I+1
      IF(I.GT.NIC) GO TO 95
      DECODE(18,1030,CARRAY(I)) WBS1
      WRITE(6,2080) CARRAY(I)
   90 I=I+1
      IF(I.GT.NIC) GO TO 95
      DECODE(18,1030,CARRAY(I)) WBS2
      IF(WBS1.EQ.WBS2) THEN
          WRITE(6,2090) CARRAY(I)
          GO TO 90
           ELSE
            WRITE(6,2080) CARRAY(I)
            WBS1=WBS2
            GO TO 90
             END IF
   95 CONTINUE
      WRITE(6,2050)
C
C           END PRINTOUT OF INPUT DATA
C
C           BEGINNING CARD LOOP
C
      WRITE(6,3010)
  100 JCOUNT=JCOUNT+1
      IF(JCOUNT.GT.NIC) GO TO 125
```

```
    110 DECODE(18,1030,CARRAY(JCOUNT)) WBS1
        DO 120 I=1,20
        DECODE(80,1040,CARRAY(JCOUNT)) IY(I),(HOUR(I,J),J=1,9)
        JCOUNT=JCOUNT+1
        IF(JCOUNT.GT.NIC) GO TO 125
        DECODE(18,1030,CARRAY(JCOUNT)) WBS2
        IF(WBS2.EQ.WBS1) THEN
          GO TO 120
            ELSE
              GO TO 140
                END IF
    120 CONTINUE
        GO TO 140
    125 JFLAG=1
C
C            BEGINNING SPREAD LOOP
C
    140 K=I
C
C       **************************************************
C       **************************************************
C
        DO 150 I=1,9
        IF(I.LE.6) GO TO 305
        IF(I.EQ.7.AND.ESC(1,1).EQ.0.0) GO TO 305
        IF(I.EQ.8.AND.ESC(2,1).EQ.0.0) GO TO 305
        IF(I.EQ.9.AND.ESC(3,1).EQ.0.0) GO TO 305
        NUM=I-6
        DO 410 JC=1,K
        KC=IY(JC)-IYEAR+1
        HOUR(JC,I)=HOUR(JC,I)/ESC(NUM,KC)
    410 CONTINUE
    305 L=MONTH
        LL=13-MONTH
        N=1
        LLL=LL
C             DOES THIS BLOCK'S EFFORT BEGIN CONCURRENTLY WITH
C                 THE PROJECT START DATE
        IF(IY(1).EQ.IYEAR) GO TO 145
C             WBS BLOCK EFFORT BEGINS IN A YEAR OTHER THAN PROJECT
C                 BEGINNING YEAR
        ISP=IY(1)-IYEAR
        N1=1
        N2=LL
        DO 300 J11=1,ISP
        DO 310 J12=N1,N2
    310 HROLD(J12)=0.0
        N1=N2+1
    300 N2=J11*12+LL
C                  LOAD OLD DATA ARRAY BY MONTHS
        N1=(ISP-1)*12+LL+1
        N2=N1+11
        DO 320 J=1,K
        SPR=HOUR(J,I)/12.
        IF(IY(J).EQ.LIYEAR) SPR=HOUR(J,I)/FLOAT(NX1)
        DO 330 KK=N1,N2
    330 HROLD(KK)=SPR
        N1=N2+1
    320 N2=N2+12
        GO TO 400
C               WBS BLOCK EFFORT BEGINS IN THE SAME YEAR AS
```

```
C                 THE PROJECT. LOAD OLD DATA ARRAY BY MONTHS
  145 DO 160 J=1,K
      SPR=HOUR(J,I)/12.0
      IF(IY(J).EQ.IYEAR) SPR=HOUR(J,I)/FLOAT(LL)
      IF(IY(J).EQ.LIYEAR) SPR=HOUR(J,I)/FLOAT(NX1)
      DO 165 KK=N,LLL
 165  HROLD(KK)=SPR
      N=LLL+1
      LLL=J*12+LL
  160 CONTINUE
C
C          CALL TO SPREAD ROUTINE
C
  400 CALL SPREAD(NSPAN,ISPAN,HROLD,HRNEW)
C
C       LOADING OUTPUT ARRAYS
C
      DO 600 NN=1,ISPAN
  600 IHOUR(NN,I)=HROLD(NN)+.4999
      DO 610 NN=1,NSPAN
  610 NIHOUR(NN,I)=HRNEW(NN)+.4999
C
C       REDISTRIBUTING MONTHLY UNITS INTO YEARLY UNITS
C
      DO 201 MNL=1,NY
  201 HOUR(MNL,I)=0.
      M1=1
      M2=LL
      IF(MONTH.NE.NMONTH) M2=13-NMONTH
      DO 210 J=1,NY
      DO 205 M=M1,M2
  205 HOUR(J,I)=HOUR(J,I)+HRNEW(M)
      M1=M2+1
      M2=M2+12
      IF(M2.GT.NSPAN) M2=NSPAN
  210 CONTINUE
      IF(I.LE.6) GO TO 250
      IF(I.EQ.7 .AND. RNESC(1,1).EQ.0.0) GO TO 250
      IF(I.EQ.8 .AND. RNESC(2,1).EQ.0.0) GO TO 250
      IF(I.EQ.9 .AND. RNESC(3,1).EQ.0.0) GO TO 250
      NUM=I-6
      DO 420 JC=1,NY
      HOUR(JC,I)=HOUR(JC,I)*RNESC(NUM,JC)
  420 CONTINUE
C
C          BEGIN OUTPUT LOOP
C
  250 DO 211 MNL=1,NY
  211 NHOUR(MNL,I)=HOUR(MNL,I)+.49999
      DO 850 KGB=1,180
      HROLD(KGB)=0.0
      HRNEW(KGB)=0.0
  850 CONTINUE
 150  CONTINUE
C
C          ******************************************************
C          ******************************************************
C
C
      CALL PRTOUT(WBS1,ISPAN,MONTH,IYEAR,IHOUR,NSPAN,NMONTH,NYEAP,
     *NIHOUR)
```

```
C
C
      DO 810 MM=1,9
      DO 800 NN=1,ISPAN
  800 IHOUR(NN,MM)=0
      DO 820 KB=1,NSPAN
  820 NIHOUR(KB,MM)=0
      DO 830 KBG=1,20
  830 HOUR(KBG,MM)=0.0
  810 CONTINUE
C
C
C
      DO 510 M=1,NY
      NYE=NYEAR+(M-1)
      DO 520 M15=1,9
  520 IF(NHOUR(M,M15).GT.0) GO TO 530
      GO TO 510
  530 KEEP=KEEP+1
      ENCODE(80,2020,NARRAY(KEEP)) IFIVE,WBS1,NYE,(NHOUR(M,M1),M1=1,9)
      PUNCH 2020, IFIVE,WBS1,NYE,(NHOUR(M,M1),M1=1,9)
  510 CONTINUE
      IF(JFLAG.EQ.1) GO TO 9999
      GO TO 110
C
C          >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
C          >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
C
 9999 WRITE(6,3020)
      J=1
  900 DECODE(18,1030,NARRAY(J)) WBS1
      WRITE(6,2080) NARRAY(J)
      J=J+1
      IF(J.GT.KEEP) GO TO 910
  920 DECODE(18,1030,NARRAY(J)) WBS2
      IF(WBS1.EQ.WBS2) THEN
          WRITE(6,2090) NARRAY(J)
          J=J+1
          IF(J.GT.KEEP) GO TO 910
          GO TO 920
            ELSE
              WRITE(6,2080) NARRAY(J)
              WBS1=WBS2
              J=J+1
              IF(J.GT.KEEP) GO TO 910
              GO TO 920

                END IF
  910 CONTINUE
C
C       **********FORMATS**********
C
 1030 FORMAT(2X,A16)
 1040 FORMAT(18X,I2,2F7.0,4F6.0,F8.0,F6.0,F7.0,1X)
 2000 FORMAT(6I5)
 2010 FORMAT(A80)
 2020 FORMAT(I2,A16,I2,2I7,4I6,I8,I6,I7,1X)
 2030 FORMAT(10F6.3)
 2040 FORMAT(1X,I2,A16,I2,2I7,4I6,I8,I6,I7,1X)
 2050 FORMAT(1H1)
 2060 FORMAT(1X,6I5)
```

```
 2070 FORMAT(1X,10F6.3)
 2080 FORMAT(/1X,A80)
 2090 FORMAT(1X,A80)
 3000 FORMAT(/55(1H*),5X,'SECTION 1',5X,56(1H*),//
     1  57X,'PRRA INPUT DATA',////)
 3010 FORMAT(/55(1H*),5X,'SECTION 2',5X,56(1H*),//
     1  50X,'MONTHLY SPREAD BY WBS ELEMENT',////)
 3020 FORMAT(/55(1H*),5X,'SECTION 3',5X,56(1H*),//
     1  50X,'NEW RESOURCE DATA CARD IMAGES',////)
      STOP
      END
```

```
      SUBROUTINE SPREAD(NSPAN,ISPAN,HROLD,HRNEW)
      DIMENSION HROLD(180),HRNEW(180)
      FF=1/(10.*FLOAT(NSPAN))
      DO 190 M=1,NSPAN
      HRNEW(M)=0.
      DO 180 M1=1,ISPAN
      T=FLOAT((M-1)*ISPAN)/FLOAT(NSPAN)+FLOAT(M1)/FLOAT(NSPAN)-FF
      DO 170 M2=1,ISPAN
  170 IF(T.LE.M2) GO TO 175
  175 IX=M2
  180 HRNEW(M)=HRNEW(M)+HROLD(IX)/FLOAT(NSPAN)
  190 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PRTOUT(WBS,ISPAN,ISTMO,ISTYR,IHOUR,NSPAN,NSTMO,NSTYR,
     *NHOUR)
      DIMENSION IHOUR(100,9),NHOUR(100,9)
      CHARACTER*16 WBS
      WRITE(6,1000)
      WRITE(6,2000)
      WRITE(6,3000)WBS
      K=0
      DO 10 I=1,ISPAN
      IF(I.EQ.1.OR.I.EQ.(12*K-ISTMO+2)) GO TO 100
      WRITE(6,4000)(IHOUR(I,J),J=1,9)
      GO TO 10
  100 IYR=ISTYR+K
      IF(K.EQ.0) GO TO 1
      WRITE(6,4500)
    1 K=K+1
      WRITE(6,5000)IYR,(IHOUR(I,J),J=1,9)
   10 CONTINUE
      WRITE(6,6000)
      WRITE(6,8000)
      WRITE(6,7000)
      WRITE(6,3000)WBS
      K=0
      DO 20 I=1,NSPAN
      IF(I.EQ.1.OR.I.EQ.(12*K-NSTMO+2))GO TO 200
      WRITE(6,4000)(NHOUR(I,J),J=1,9)
      GO TO 20
  200 IYR=NSTYR+K
      IF(K.EQ.0) GO TO 2
      WRITE(6,4500)
    2 K=K+1
      WRITE(6,5000)IYR,(NHOUR(I,J),J=1,9)
   20 CONTINUE
      WRITE(6,1000)
      WRITE(6,8000)
 1000 FORMAT(130(1H_))
 2000 FORMAT(//60X,'OLD SCHEDULE')
 3000 FORMAT(//2X,A16,1X,'FY',1X,'ENGINEERING',1X,'MANUFACTURING',2X,
     1'TOOLING',2X,'QUAL.& REL.',2X,'TESTING',5X,'OTHER',4X,'MATERIAL $'
     2,4X,'TRAVEL $',3X,'OTHER DIRECT $',/)
 4000 FORMAT(21X,I10,I13,4I11,3I13)
 4500 FORMAT(19X,110(1H-))
 5000 FORMAT(19X,I2,I10,I13,4I11,3I13)
 6000 FORMAT(//65(2H =))
 7000 FORMAT(60X,'NEW SCHEDULE')
 8000 FORMAT(1H1)
      RETURN
      END
```

APPROVAL

PROJECT RESOURCE REALLOCATION ALGORITHM

By J. E. Myers

The information in this report has been reviewed for technical content. Review of any information concerning Department of Defense or nuclear energy activities or programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

G. D. HOPSON
Director, Systems Analysis and
Integration Laboratory

☆ U.S. GOVERNMENT PRINTING OFFICE 1981—740-066/440 REGION NO. 4