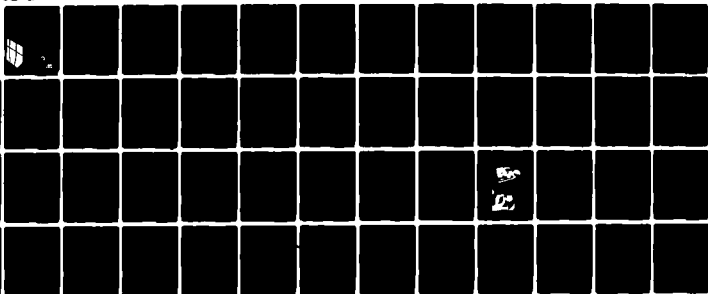AD-A113 737   CONSTRUCTION ENGINEERING RESEARCH LAB (ARMY) CHAMPAIGN IL   F/G 13/2
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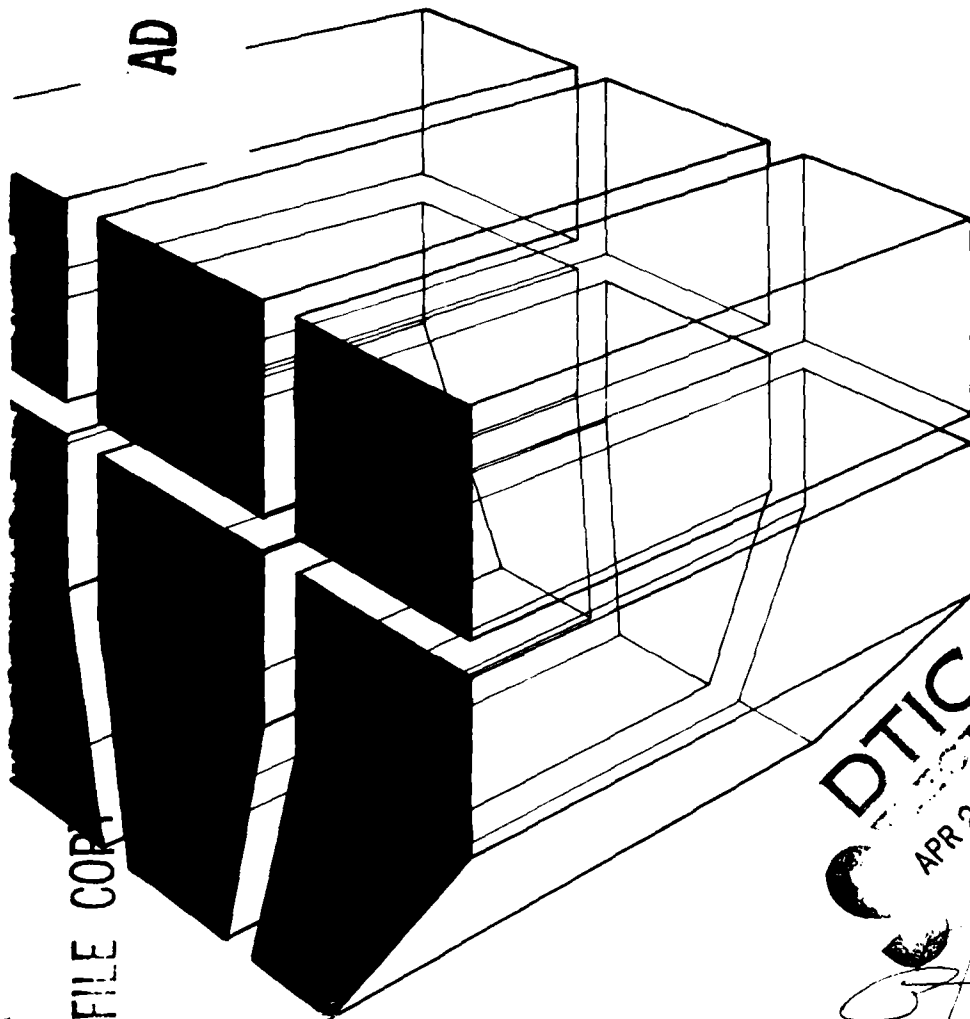
TECHNICAL REPORT P-124
April 1982
Quantification of MCA/Facilities Readiness

FACILITIES READINESS QUANTIFICATION MODEL
USERS MANUAL

by
John M. Deponai III
Laure Thomas
Craig Kukielski
Joe Sheffield

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This report describes how to use the Facilities Readiness Quantification Model developed by the U.S. Army Construction Engineering Research Laboratory. This model can be used by Army managers to determine the relative readiness merits of selected projects in the Military Construction, Army (MCA) program. The algorithms required for this model can be prepared manually, or on a programmable calculator.
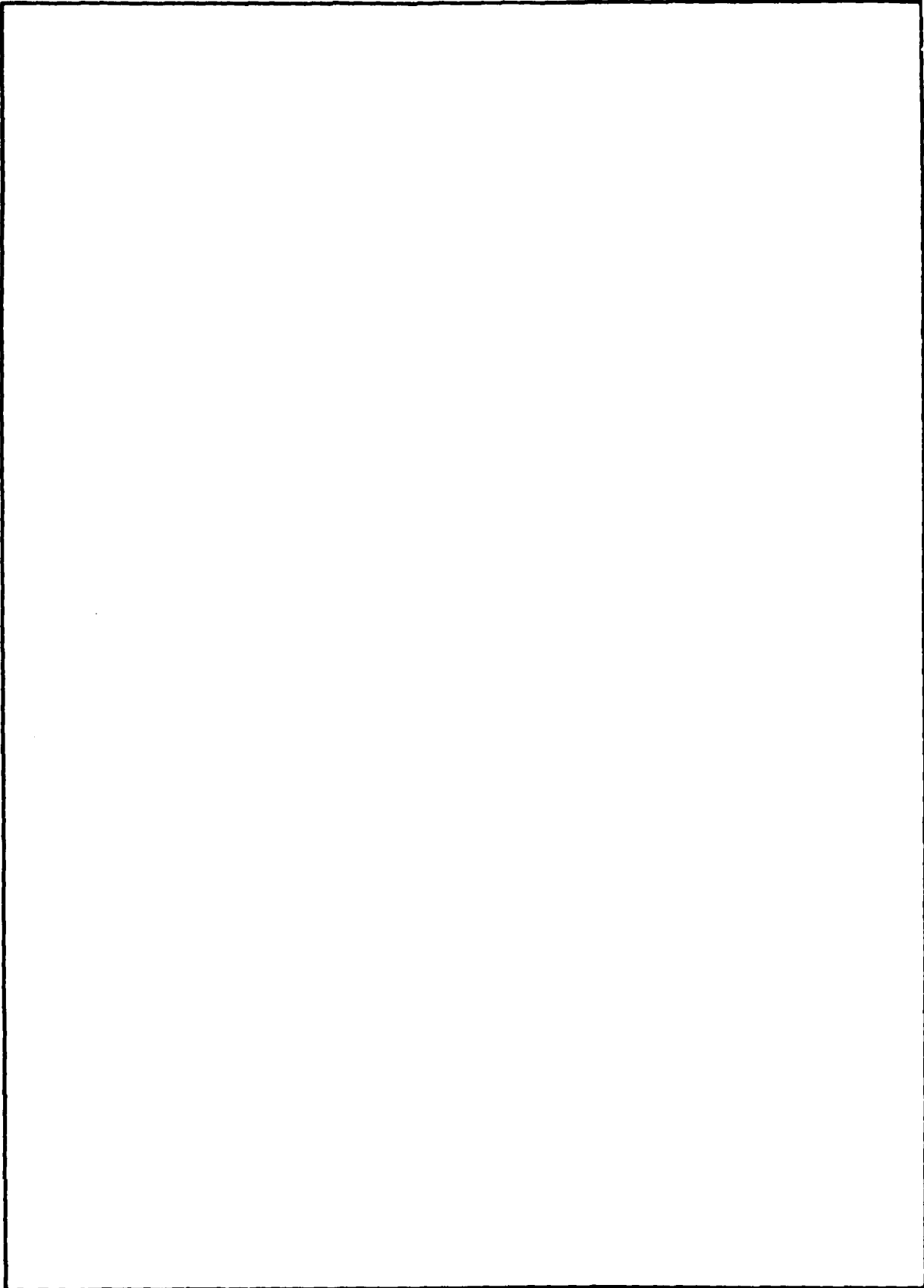
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FACILITIES READINESS QUANTIFICATION MODEL USERS MANUAL

1 INTRODUCTION

Background

In July 1978, the U.S. Army Construction Engineering Research Laboratory (CERL) was tasked by the Directorate of Military Programs, Office of the Chief of Engineers, to develop a model to relate military construction to force readiness. By November 1980, a pilot model had been developed, tested, and evaluated. In December 1980, it was decided not to develop a computerized system to fully implement the concept. However, OCE directed that CERL develop a noncomputerized version of the model. This version would be used at the option of the Construction Requirements Review Committee (CRRC) to determine the relative readiness merits of a few marginal projects in the Military Construction, Army (MCA) program. CERL used the data obtained during development and testing of the pilot model to devise a noncomputerized model for the CRRC; the algorithms required for this model can be performed manually or on a programmable calculator (see Appendix A).

Purpose

The objective of this study was to develop a model that quantifies the relative impact of all MCA projects on the readiness state of the Army. The objective of this report is to provide user instructions for a model that quantifies the relative impact of *selected* MCA projects on Army readiness.

Approach

1. A comprehensive pilot Facilities Readiness Quantification Model was developed, tested, and evaluated.

2. Data obtained during Step 1 above were used to devise a noncomputerized Facilities Readiness Quantification Model.

a. Algorithms were developed for the noncomputerized model.

b. Programs were created for implementing the model's algorithms on a programmable calculator.

Outline of Report

Chapter 2 of this report gives instructions for CRRC members who will actually rate MCA facility projects using the model. Chapter 3 gives instructions for CRRC support personnel who will process model data. Processing aids, in the form of programs for a Texas Instruments (TI)-59 programmable calcualtor system, are described in Appendices A through D. Blank forms for reproduction are provided in Appendix E.

Mode of Technology Transfer

This report is the technology transfer medium for the results of this study.

2 INSTRUCTIONS TO RATERS

This chapter describes how the CRRC can use a noncomputerized Facilities Readiness Quantification Model to define the relative readiness worth of selected MCA projects. Figure 1 shows the seven-step procedure for implementing the model. To illustrate this procedure, five example MCA projects are compared in this chapter. Some basic information on the example projects is given in Table 1. Example ratings are assigned to *each* project for *each* variable and for *each* rater.* These example ratings will serve as the basis for the data processing examples in Chapter 3.

The following assumptions were made concerning rating authorities:

1. All 10 CRRC voting members would participate in determining mission weights.

2. The special staff members of the CRRC who represent the Assistant Chief of Engineers (COE), the Comptroller of the Army (COA), The Adjutant General (TAG), and The Surgeon General (TSG) would rate only those projects for which they are the proponent.

3. Other CRRC members would rate all projects.

4. At least six or seven raters would participate each time the model was used.

---

*These ratings are arbitrary and do not represent the actual views of any member of the CRRC.

1 USE THE JULY 80 FIELD TEST DEFINITION OF FORCE READINESS (FR):

FR ••• TRAINING, ETC

NOT FR ••• AESTHETICS, ETC
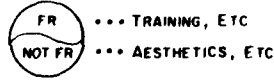
2 WEIGHT EXISTING 6-NODE MISSION HIERARCHY:

BE READY TO WIN...

WHERE...

HOW LONG

a_1 a_2 a_3 a_4 a_5 a_6 $\sum_1^6 a_i = 100$
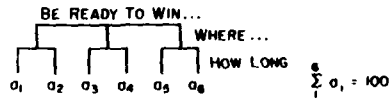
3 DECIDE EACH PROJECT'S RELEVANCE TO FR AND TO FR SUBOBJECTIVES:

PROJECT NO. 1 2 . . . j

(A FEW PROJECTS!)

n_j — NOT FR

r_j — FR

$r_j + n_j = 1$

$r_j = (C_R/C_T)_j$

b_1 b_2 b_3 b_4 b_5 b_6 $\left(\sum_1^6 b_i\right)_j = 1$

BE READY TO WIN...
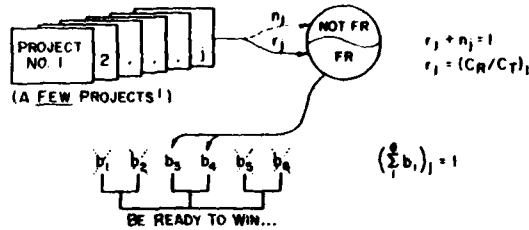
4 DEFINE ONE MAX CONTRIBUTION PROJECT FOR EACH OF THE 6 MISSION AREAS:

100   100   100
STD 1   STD 2   ...   STD 6

5 COMPARE PROJECT WORTHS TO APPROPRIATE STANDARDS:

100   100
$(W_3)_j$ $(W_4)_j$
STD 3   STD 4
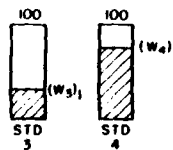
6 COMPUTE THE FINAL B_R/C_T:

$$\left(\sum_{i=1}^6 a_i b_i w_i\right)_j \times r_j = (B_R/C_T)_j = (B_R/\$PA)_j$$

7 REVIEW AND DISCUSS RESULTS:

RANK	B/C
1	15
2	12
3	8
.	.
.	.
.	.
j	2

Figure 1. General procedure for using the noncomputerized Force Readiness Quantification Concept.

Table 1
Example Projects—Basic Information

Location	Project Number	Project Description	Proponent	MACOM	Program Amount ($K)
Germany	414	Igloo Storage (various)	DCSLOG	USAREUR	1,700
Korea	690	Tactical equip shop (Taegu)	DCSLOG	EUSA	1.000
Fort Benning	342	Tactical equip shops	DCSLOG	TRADOC	4,150
Turkey	203	Administration building (DET 67/168)	DCSPER	USAREUR	1.300
Germany	784	Banking facility (Frankfurt)	TAG	USAREUR	480

Step 1—Define Force Readiness

Table 2 gives a working definition developed by the CRRC of force readiness with respect to MCA facilities. For this report, force readiness is defined as the degree to which a force is capable of accomplishing the requirements of the specific missions or contingency plans for which it is responsible. Since a force is essentially an assemblage of resources, force capability can be viewed as a function of the level of fulfillment of those resources needed to accomplish the missions.

Table 2
Working Definition of Force Readiness

Force Readiness Includes:
- Training
- Maintenance
- Command, Control, Communication (C^3)
- Security
- Manning the Force
- Making Military Operations More Efficient

Force Readiness Does Not Include:
- Asthetics
- Occupational Health and Safety Act (OHSA) Compliance
- Pollution Abatement
- Energy Conservation
- Environment Enhancement
- Convenience of Operations

Step 2—Weight Mission Hierarchy

Using the mission subobjective definitions given in Table 3, each member of the CRRC decides the relative significance of five mission comparisons by entering a ratio on the appropriate line of Form A (Figure 2). This ratio represents the rater's opinion of the relative importance of being ready to win in Europe vs being ready to win in the United States, etc. To assign this ratio, the rater must make a subjective assessment of the relative consequences of losing in one mission area vs another, and of the probability that a conflict would actually occur that would involve the mission areas being considered.

Table 3
Readiness Mission Subobjective Definitions

	Where	Response Phase
Be Ready To Win In ...	E: Europe (incl Turkey)	EI: Initial (first 30 days)
		ES: Sustaining (after 30 days)
	U: USA (50 States only)	UI: Initial (first day)
		US: Sustaining (after first day)
	O: All Other (anywhere else)	OI: Initial (first 30 days)
		OS: Sustaining (after 30 days)

Raters should assign ratio values independently and should not compare their values directly with those of any other rater. Seven hypothetical ratings for the missions described in Table 2 are shown in Figure 3. Note that ratios in the form of 4/1, 3/1, 5/1, etc. can also be expressed as the whole numbers 4, 3, 5, etc.

The ratios assigned by each rater are processed as described in Chapter 3 to obtain the low quartile, median, and high quartile feedback values for each of the five ratios. The median feedback values then are used to distribute an arbitrary 100 "readiness utiles" across the six mission subobjectives.

A sample of a Form A listing feedback results for the ratios assigned in Figure 3 is shown in Figure 4. After receiving these results, the raters meet to discuss the pros and cons of the issues. Those members who wish to change their ratings enter revised ratings on the feedback sheet. These revised ratings are combined with the original ratings of members who elect not to change their ratings. Then, a new round of feedback results is computed using the most current values

Rater's Office: (check one)

☐ ACE (1)   ☐ DCSLOG (6)

☐ COA (2)   ☐ DCSOPS (7)

☐ TAG (3)   ☐ DCSPER (8)

☐ TSG (4)   ☐ DCSRDA (9)

☐ ACSI (5) ☐ ACSAC (0)

Rater's Initials: _____

Date: _____
        (Day/mo/yr)

PRIOR RATIOS ASSIGNED

(as of:)

Low Q	Median	High Q
----------	----------	----------
----------	----------	----------
----------	----------	----------
----------	----------	----------
----------	----------	----------

RELATIVE IMPORTANCE OF READINESS SUB-OBJECTIVES

Mission Sub-Objectives Being Compared	Relative Significance (Ratio)
European Theater / USA	_____
All Other Theaters / USA	_____
Europe: Initial / Sustained	_____
USA: Initial / Sustained	_____
Other: Initial / Sustained	_____

ARMY READINESS TO ACCOMPLISH MISSIONS

IN EUROPEAN THEATRE   IN USA   IN ALL OTHER THEATERS

DURING INITIAL BATTLES	DURING SUSTAINED CONFLICT	DURING INITIAL BATTLES	DURING SUSTAINED CONFLICT	DURING INITIAL BATTLES	DURING SUSTAINED CONFLICT
$a_1 = $_____	$a_2 = $_____	$a_3 = $_____	$a_4 = $_____	$a_5 = $_____	$a_6 = $_____

(BOX RESERVED FOR FEEDBACK INFORMATION)

Form A (Proposed)

Figure 2. Form A.

Figure 3. Hypothetical mission weights assigned by CRRC raters.

Rater's Initials: _____

Date: _____
(Day/mo/yr)

PRIOR RATIOS ASSIGNED

(as of: *22/9/81*)

Low Q	Median	High Q
2	3	4
1	2	2
2	2.67	6
0.5	1.25	2
1	3	4

RELATIVE IMPORTANCE OF READINESS SUB-OBJECTIVES

Mission Sub-Objectives Being Compared	Relative Significance (Ratio)
European Theater / USA	____
All Other Theaters / USA	____
Europe: Initial / Sustained	____
USA: Initial / Sustained	____
Other: Initial / Sustained	____

ARMY READINESS TO ACCOMPLISH MISSIONS

IN EUROPEAN THEATRE

IN USA

IN ALL OTHER THEATERS

DURING INITIAL BATTLES

DURING SUSTAINED CONFLICT

DURING INITIAL BATTLES

DURING SUSTAINED CONFLICT

DURING INITIAL BATTLES

DURING SUSTAINED CONFLICT

$a_1 = 36.39$ $a_2 = 13.62$ $a_3 = 9.26$ $a_4 = 7.41$ $a_5 = 25.00$ $a_6 = 8.33$
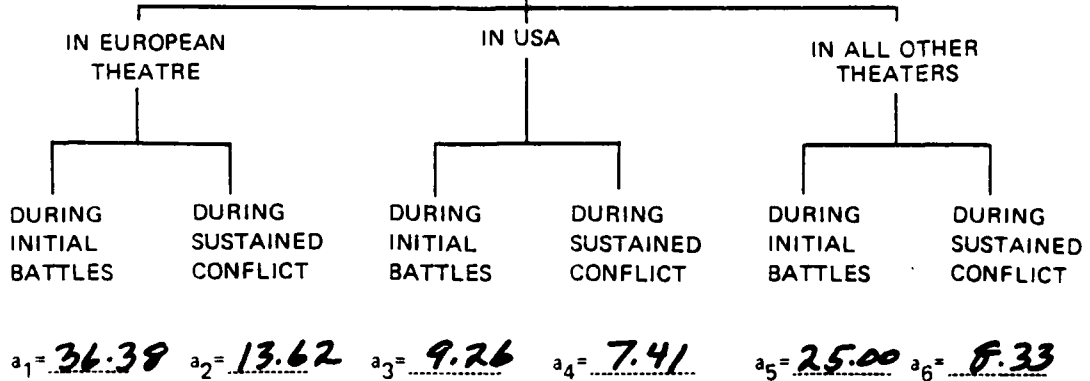
(BOX RESERVED FOR FEEDBACK INFORMATION)

Form A (Proposed)

Figure 4. Processed data results for the ratios assigned in Figure 3 – sample.

Table 4
Summary of Final B/C Ratios for the Five Sample Projects in Table 1

Location	Project Number	Project Description	SPA ($K)	B_R/SPA
Germany	414	Igloo storage (various)	1,700	27.7
Korea	690	Tactical equipment shop (Taegu)	1,000	19.8
Fort Benning	342	Tactical equipment shops	4,150	15.2
Turkey	203	Administration building (Det 67/168)	1,300	7.6
Germany	784	Banking facility (Frankfurt)	480	0.3

from each of the 10 raters. This can be done at any time and as many times as desired.* However, any change in the median mission weights will change each project's final benefit/cost (B/C) ratio. Thus, every time the median values of the mission weights change, the final B/C ratios for *all* projects must be recomputed. These computations are discussed in Chapter 3.

Steps 3 through 6—Determine Project Values

Each rater uses Form B to record the set of weights assigned to each project (Figure 5). Figure 6 shows how each of six raters might have scored Project Number 414 (from Table 1) as to what percentage (r) of its cost is credited to the procurement of readiness benefits (Step 3 in Figure 1); as to what percentage (b_i) of the total project benefit is attritutable to each readiness subobjective (Step 3 in Figure 1); and as to what the relative worth (w_i) of each benefit is compared to some arbitrary maximum contribution facility (Step 4 in Figure 1) for each readiness subobjective (Step 5 in Figure 1). Again, to ensure the integrity of the data, all raters must assign these values independently, *without* comparing values directly with any other raters.

After all Forms B are completed, they are processed (Step 6 in Figure 1) as described in Chapter 3 to obtain low quartile, median, and high quartile feedback values for each of the variables r, b_i, and w_i. The final project B/C ratio also is computed at this time. All this information is recorded on a blank Form B along with the location, project number, and description of the project to which the feedback applies. Figure 7 shows feedback results for the values assigned in Figure 6.

Hypothetical ratings for Project Numbers 690, 342, 203, and 784 from Table 1 are shown in Figures 8, 10,

---

*Obviously, no single rating will remain stable over a long period of time; during periods of high international tension, a rating may change significantly in a short period of time.

12, and 14, respectively. The corresponding feedback data are shown in Figures 9, 11, 13, and 15. Note that if the computations are based on the median value, the effect of unusually high or unusually low scores is eliminated. If *mean* values are used, extreme ratings could have a dramatic effect on the outcome; however, using median values ensures that no one rater can dominate the outcome.

Step 7—Review Results

Table 4 summarizes the final B/C ratios for all five projects listed in Table 1. After final B/C ratios are computed, raters should meet to (1) review these data, (2) identify and resolve any glaring discrepancies, (3) argue the merits and demerits of the various projects in light of the final B/C ratios, and (4) determine whether any rater wishes to change a rating. Assuming at least one member does change a rating - whether mission weight or any project variable - the data would have to be reprocessed. If a median value of any *mission weight* changes, the B/C must be recomputed for *all* projects. However, if only the median *project values* change, only those projects whose median values are affected need to have their B/C ratios recomputed.

3 DATA PROCESSING INSTRUCTIONS

Form A Data

This section desc. bes how to process the data entered by the raters on the right side of the Form A data sheets. Before processing these data, make sure that there is one Form A data sheet for each rater. Although it is not necessary that a full set of 10 be used, at least six are needed to ensure the model will deliver reliable results. The seven Form A rating sheets shown in Figure 3 are used below as an example of how to process Form A data.

1. Convert the ratios to decimal format.

Rater's Initials: _____

Date: _____
Day/mo/yr

PROJECT IDENTIFICATION AND PROJECT RATINGS

LOCATION   PN   DESCRIPTION

PRIOR RATING RESULTS

(as of   )

r VALUES

Low Q	Median	High Q
....	....	....

b VALUES

Low Q	Median	High Q
....	....	....

w VALUES

Low Q	Median	High Q
....	....	....
....	....	....

Note. Feedback values for each r,b, and w are independent of all other r,b,and w values. Median values of b will be normalized before use in later computations. Median values of r and w will be used directly.

Project Relevance to Readiness (%)

$r =$ _____

Relative Contribution of Project to each Sub-Objective (%)

Mission Sub Objective	
Europe-Initial	$b_1 =$ _____
Europe-Sustained	$b_2 =$ _____
USA Initial	$b_3 =$ _____
USA-Sustained	$b_4 =$ _____
Other-Initial	$b_5 =$ _____
Other-Sustained	$b_6 =$ _____

(Total 100%)

Mission Sub-Objective	Project Worth*
Europe-Initial	$w_1 =$ _____
Europe-Sustained	$w_2 =$ _____
USA-Initial	$w_3 =$ _____
USA-Sustained	$w_4 =$ _____
Other-Initial	$w_5 =$ _____
Other-Sustained	$w_6 =$ _____

*(On a scale of 1 to 100, compare project to some "Maximum Contribution" Project.)

$B_c/\$PA =$ ....

(BOX RESERVED FOR FEEDBACK INFORMATION)

Form B (Proposed)

Figure 5. Form B.

14

Figure 6. Hypothetical values assigned to Project Number 414 from Table 1.

Rater's Initials: _____

Date: _____
Day/mo/yr

PROJECT IDENTIFICATION AND PROJECT RATINGS

LOCATION	PN	DESCRIPTION
GERMANY	414	IGLOO STORAGE-VARIOUS

PRIOR RATING RESULTS

(as of 22/9/81)

r VALUES

Low Q	Median	High Q
97.5	100	100

b VALUES

Low Q	Median	High Q
52.5	70	86.25
13.75	30	45
—	—	—
—	—	—
—	—	—
—	—	—

w VALUES

Low Q	Median	High Q
86.25	100	100
37.25	55	100
—	—	—
—	—	—
—	—	—
—	—	—

Note: Feedback values for each r,b, and w are independent of all other r,b,and w values. Median values of b will be normalized before use in later computations. Median values of r and w will be used directly.

Project Relevance to Readiness (%)

$r = $ _____

Relative Contribution of Project to each Sub-Objective (%)

Mission Sub-Objective	
Europe-Initial	$b_1 = $ _____
Europe-Sustained	$b_2 = $ _____
USA-Initial	$b_3 = $ _____
USA-Sustained	$b_4 = $ _____
Other Initial	$b_5 = $ _____
Other-Sustained	$b_8 = $ _____

(Total = 100%)

Project Worth*

Mission Sub- Objective	
Europe-Initial	$w_1 = $ _____
Europe-Sustained	$w_2 = $ _____
USA-Initial	$w_3 = $ _____
USA-Sustained	$w_4 = $ _____
Other-Initial	$w_5 = $ _____
Other-Sustained	$w_6 = $ _____

*(On a scale of 1 to 100, compare project to some "Maximum Contribution" Project.)

$B_c/SPA = $ 27.72 _____

(BOX RESERVED FOR FEEDBACK INFORMATION)

Form 8 (Proposed)

Figure 7. Processed data results for the values assigned in Figure 6.

16

Figure 8. Hypothetical ratings for Project Number 690 from Table 1.

17

Rater's Initials: _____

Date: _____
Day/mo/yr

Rater's Office: (check one)

☐ ACE (1)   ☐ DCSLOG (6)
☐ COA (2)   ☐ DCSOPS (7)
☐ TAG (3)   ☐ DCSPER (8)
☐ TSG (4)   ☐ OCSRDA (9)
☐ ACSI (5) ☐ ACSAC (0)

PROJECT IDENTIFICATION AND PROJECT RATINGS

LOCATION	PN	DESCRIPTION
KOREA	690	TACTICAL EQUIPMENT SHOP-TAEGU

PRIOR RATING RESULTS

(as of $22/9/81$)

r VALUES

Low Q	Median	High Q
90	100	100

b VALUES

Low Q	Median	High Q
—	—	—
—	—	—
—	—	—
—	—	—
47.5	72.5	92.5
7.5	27.5	52.5

w VALUES

Low Q	Median	High Q
—	—	—
—	—	—
—	—	—
—	—	—
90	97.5	100
60	85	100

Note: Feedback values for each r,b, and w are independent of all other r,b,and w values. Median values of b will be normalized before use in later computations. Median values of r and w will be used directly.

Project Relevance to Readiness (%)

r= _____

Mission Sub-Objective	Relative Contribution of Project to each Sub-Objective (%)
Europe-Initial	b_1= _____
Europe-Sustained	b_2= _____
USA-Initial	b_3= _____
USA-Sustained	b_4= _____
Other-Initial	b_5= _____
Other-Sustained	b_6= _____

(Total =100%)

Mission Sub-Objective	Project Worth*
Europe-Initial	w_1= _____
Europe-Sustained	w_2= _____
USA-Initial	w_3= _____
USA-Sustained	w_4= _____
Other-Initial	w_5= _____
Other-Sustained	w_6= _____

*(On a scale of 1 to 100, compare project to some "Maximum Contribution" Project.)

B_c/SPA= _19.77_

(BOX RESERVED FOR FEEDBACK INFORMATION)

Form 3 Proposed!

Figure 9. Feedback results for the values in Figure 8.

18

Figure 10. Hypothetical ratings for Project Number 342 from Table 1.

Rater's Office: (check one)

☐ ACE	(1)	☐ DCSLOG	(6)
☐ COA	(2)	☐ DCSOPS	(7)
☐ TAG	(3)	☐ DCSPER	(8)
☐ TSG	(4)	☐ DCSRDA	(9)
☐ ACSI	(5)	☐ ACSAC	(0)

Rater's Initials: _____

Date: _____
  Day/mo/yr

PROJECT IDENTIFICATION AND PROJECT RATINGS

LOCATION	PN	DESCRIPTION
FT. BENNING	342	TACTICAL EQUIPMENT SHOPS

PRIOR RATING RESULTS

(as of *22/4/81*)

r VALUES

Low Q	Median	High Q
87.5	*90*	*100*

b VALUES

Low Q	Median	High Q	Mission Sub-Objective	Relative Contribution of Project to each Sub-Objective (%)
17.5	*27.5*	*52.5*	Europe-Initial	$b_1 =$ _____
13.75	*20*	*35*	Europe-Sustained	$b_2 =$ _____
0	*5*	*16.25*	USA-Initial	$b_3 =$ _____
0	*10*	*31.25*	USA-Sustained	$b_4 =$ _____
0	*7.5*	*20*	Other-Initial	$b_5 =$ _____
0	*12.5*	*20*	Other-Sustained	$b_6 =$ _____

(Total = 100%)

w VALUES

Low Q	Median	High Q	Mission Sub-Objective	Project Worth*
80	*90*	*100*	Europe-Initial	$w_1 =$ _____
80	*90*	*92.5*	Europe-Sustained	$w_2 =$ _____
0	*32.5*	*77.5*	USA-Initial	$w_3 =$ _____
0	*10*	*26.25*	USA-Sustained	$w_4 =$ _____
0	*85*	*92.5*	Other-Initial	$w_5 =$ _____
0	*75*	*92.5*	Other-Sustained	$w_6 =$ _____

Project Relevance to Readiness (%)

r = _____

*(On a scale of 1 to 100, compare project to some "Maximum Contribution" Project.)

Note: Feedback values for each r,b, and w are independent of all other r,b,and w values. Median values of b will be normalized before use in later computations. Median values of r and w will be used directly.

B_c/SPA= *15.17*

(BOX RESERVED FOR FEEDBACK INFORMATION)

Form B (Proposed)

Figure 11. Feedback results for the values in Figure 10.

Figure 12. Hypothetical ratings for Project Number 203 from Table 1.

Rater's Initials: _____

Date: _____
Day/mo/yr

☐ ACE (1)   ☐ DCSLOG (6)
☐ COA (2)   ☐ DCSOPS (7)
☐ TAG (3)   ☐ DCSPER (8)
☐ TSG (4)   ☐ DCSRDA (9)
☐ ACSI (5)   ☐ ACSAC (0)

PROJECT IDENTIFICATION AND PROJECT RATINGS

LOCATION	PN	DESCRIPTION
TURKEY	203	ADMIN BLDG-DET 67/168

PRIOR RATING RESULTS

(as of $22/9/81$)

r VALUES

Low Q	Median	High Q
67.5	70	77.5

b VALUES

Low Q	Median	High Q
37.5	45	60
—	—	—
25	40	50
—	—	—
5	10	30
—	—	—

w VALUES

Low Q	Median	High Q
33.75	40	62.5
—	—	—
79.75	92.5	100
—	—	—
10	15	62.5
—	—	—

Note: Feedback values for each r,b, and w are independent of all other r,b,and w values. Median values of b will be normalized before use in later computations. Median values of r and w will be used directly.

Project Relevance to Readiness (%)

r= _____

Relative Contribution of Project to each Sub-Objective (%)

Mission Sub-Objective	
Europe-Initial	$b_1=$ _____
Europe-Sustained	$b_2=$ _____
USA-Initial	$b_3=$ _____
USA-Sustained	$b_4=$ _____
Other-Initial	$b_5=$ _____
Other-Sustained	$b_6=$ _____

(Total = 100%)

Mission Sub-Objective	Project Worth*
Europe-Initial	$w_1=$ _____
Europe-Sustained	$w_2=$ _____
USA-Initial	$w_3=$ _____
USA-Sustained	$w_4=$ _____
Other-Initial	$w_5=$ _____
Other-Sustained	$w_6=$ _____

*(On a scale of 1 to 100, compare project to some "Maximum Contribution" Project.)

$B_c/\$PA=$ __7.60__

(BOX RESERVED FOR FEEDBACK INFORMATION)

Form B (Proposed)

Figure 13. Feedback results for the values in Figure 12.

Figure 14. Hypothetical ratings for Project Number 784 from Table 1.

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Rater's Office: (check one)

Rater's Initials: _____

Date: _____
Day/mo/yr

☐ ACE (1)   ☐ DCSLOG (6)
☐ COA (2)   ☐ DCSOPS (7)
☐ TAG (3)   ☐ DCSPER (8)
☐ TSG (4)   ☐ DCSRDA (9)
☐ ACSI (5)   ☐ ACSAC (0)

PROJECT IDENTIFICATION AND PROJECT RATINGS

LOCATION	PN	DESCRIPTION
GERMANY	784	BANKING FACILITY-FRANKFURT

PRIOR RATING RESULTS

(as of 22/9/81)

r VALUES

Low Q	Median	High Q
10	20	40

Project Relevance to Readiness (%)

r = _____

b VALUES

Low Q	Median	High Q	Mission Sub-Objective	Relative Contribution of Project to each Sub-Objective (%)
100	100	100	Europe-Initial	b_1 = _____
0	0	0	Europe-Sustained	b_2 = _____
0	0	0	USA-Initial	b_3 = _____
0	0	0	USA-Sustained	b_4 = _____
0	0	0	Other-Initial	b_5 = _____
0	0	0	Other-Sustained	b_6 = _____

(Total =100%)

w VALUES

Low Q	Median	High Q	Mission Sub-Objective	Project Worth*
1	4	10	Europe-Initial	w_1 = _____
—	—	—	Europe-Sustained	w_2 = _____
—	—	—	USA-Initial	w_3 = _____
—	—	—	USA-Sustained	w_4 = _____
—	—	—	Other-Initial	w_5 = _____
—	—	—	Other-Sustained	w_6 = _____

*(On a scale of 1 to 100, compare project to some "Maximum Contribution" Project.)

Note: Feedback values for each r,b, and w are independent of all other r,b,and w values. Median values of b will be normalized before use in later computations. Median values of r and w will be used directly.

B_c/SPA = 0.29

(BOX RESERVED FOR FEEDBACK INFORMATION)

Form 8 (Proposed)

Figure 15. Feedback results for the values in Figure 14.

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2. Enter the decimal equivalent of each ratio in the appropriate box of the STEP 1 TABLE on Form A1 (Figure 16). Carry fractions out to two decimal places.

3. If one or more of the raters do not submit ratings, *cross out* the appropriate column(s) of boxes in the STEP 1 TABLE of Form A1. (This is very important.)

4. Use the statistical analysis program described in Appendix B to compute the low quartile, median, and high quartile values for each row of the STEP 1 TABLE matrix.

5. Record these three values in the appropriate row of the STEP 2 TABLE on Form A1 and on a blank copy of Form A (as feedback information).

6. Use the m_i to a_j program in Appendix C to compute the values a_1 through a_6. The input to this program is the median column of values in the STEP 2 TABLE on Form A1.

7. Record the output (a_1 through a_6) of that program on Form A in the STEP 3 TABLE of Form A1 and on Form C for later use.

Figure 17 shows the STEP 1 TABLE results for the data in Figure 3. Figure 18 shows the a_1 through a_6 values from the STEP 3 TABLE of Form A1 entered onto Form C.

Form B Data

This section describes how to process the data entered by raters on the right side of the Form B data sheets. Each project will have six to 10 Form B rating sheets to be processed. The six example rating sheets for Project Number 414 shown in Figure 6 are used below as an example of how to process Form B data:

1. Transfer each value from each Form B to the appropriate box on the Form B1 worksheet (Figure 19).

2. If one or more of the raters does not submit ratings, *cross out* that column(s) on Form B1 for that rater(s). (This is very important.)

3. Use the statistical analysis program described in Appendix B to compute the low quartile, median, and upper quartile values for rows r, b_1 through b_6, and w_1 through w_6 on Form B1. If a box is *crossed off* do *not* include it in the set of numbers being processed for

that row. However, *blank* boxes are equivalent to *zero entries* for processing purposes.

4. Enter the results of processing the Form B1 data on Form B2 (Figure 20). Also enter the respective project number on Form B2.

5. Enter these results in the feedback section of Form B along with the project identification information for the respective project.

6. Enter the decimal form of the median r value, the normalized b' values, and the decimal form of the median w values in the correct boxes on Form C.

7. Enter the project number at the bottom of Form C.

Figure 21 is an example of a Form B1 filled in with values from Figure 6. Figure 22 shows the data from Figure 21 after being processed and recorded on Form B2.

Form C Instructions

For each project, certain data from Forms A1 and B2 are transferred to Form C:

1. Take the values a_1 through a_6 from the most recent mission weight evaluation that was done, i.e., from the STEP 3 TABLE of the most recent Form A1 data sheet. Each a_i should have a value between 0 and 100. If not, an error has been made.

2. Use the same a_1 through a_6 values for every project. The a_i values in Figure 18 were taken from Figure 17.

3. The b', w, and r values in Columns 2, 3, and 4 of Form C vary from project to project; therefore, enter the appropriate project number on *each* Form C.

4. Use the decimal form of the median r values (not the % form). Take this value from the STEP 1 TABLE of the most recent Form B2 computation for that project.

5. Take the values b_1' through b_6' from the STEP 3 TABLE of the most recently created Form B2; the values w_1 through w_6 are the decimal form of the median values from the STEP 4 TABLE. These r, b', and w variables can have values from 0 to 1. If they do not, an error has been made.

PROCESSING INSTRUCTIONS FOR FORM "A" INPUT DATA

Initials: _____ Date Processed: _____

STEP 1: Enter into the respective box below the decimal equivalent (to the nearest 0.01) of each ratio from basic input Form A.

STEP 1 TABLE

	ACE (1)	COA (2)	TAG (3)	TSG (4)	ACSI (5)	DCSLOG (6)	DCSOPS (7)	DCSPER (8)	DCSRDA (9)	ACSAC (0)
EUR/USA										
OTH/USA										
EUR: I/S										
USA: I/S										
OTH: I/S										

STEP 2: Using the program "Statistical Analysis," compute the Low Quartile, Median, and High Quartile values for each row of numbers above and record results in the Step 2 table below and on Form A (as feedback information.)

STEP 3: Using the program, "m_i to a_j," compute a_1 through a_6 (to the nearest 0.01) and record the six values on Form A (as feedback information), in Step 3 table below, and on Form C.

STEP 2 TABLE

ROW	OBJECTIVE	LOW Q	MEDIAN	HIGH Q
1	EUR/USA	l_1:	m_1:	h_1:
2	OTH/USA	l_2:	m_2:	h_2:
3	EUR:I/S	l_3:	m_3:	h_3:
4	USA:I/S	l_4:	m_4:	h_4:
5	OTH:I/S	l_5:	m_5:	h_5:

STEP 3 TABLE

MISSION WEIGHTS
a_1:
a_2:
a_3:
a_4:
a_5:
a_6:

Form A1 (Proposed)

Figure 16. Form AI.

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PROCESSING INSTRUCTIONS FOR FORM "A" INPUT DATA

Initials: _JP_ Date Processed: _22/9/81_

STEP 1: Enter into the respective box below the decimal equivalent (to the nearest 0.01) of each ratio from basic input Form A.

STEP 1 TABLE

	ACE (1)	COA (2)	TAG (3)	TSG (4)	ACSI (5)	DCSLOG (6)	DCSOPS (7)	DCSPER (8)	DCSRDA (9)	ACSAC (0)
EUR/USA	4		3	3	2	2	4		50	
OTH/USA	2		2	1	0.1	2	2		10	
EUR: I/S	2		2.67	7	2	4	6		2	
USA: I/S	0.5		2.25	1.25	0.5	0.33	2		1.25	
OTH: I/S	1.33		3	1	3	0.33	4		4	

STEP 2: Using the program "Statistical Analysis," compute the Low Quartile, Median, and High Quartile values for each row of numbers above and record results in the Step 2 table below and on Form A (as feedback information.)

STEP 3: Using the program, "m_i to a_j," compute a_1 through a_6 (to the nearest 0.01) and record the six values on Form A (as feedback information), in Step 3 table below, and on Form C.

STEP 2 TABLE

ROW	OBJECTIVE	LOW Q	MEDIAN	HIGH Q
1	EUR/USA	l_1: 2	m_1: 3	h_1: 4
2	OTH/USA	l_2: 1	m_2: 2	h_2: 2
3	EUR:I/S	l_3: 2	m_3: 2.67	h_3: 6
4	USA:I/S	l_4: 0.5	m_4: 1.25	h_4: 2
5	OTH:I/S	l_5: 1	m_5: 3	h_5: 4

STEP 3 TABLE

MISSION WEIGHTS
a_1: 36.38
a_2: 13.62
a_3: 9.26
a_4: 7.41
a_5: 25.00
a_6: 8.33

Form A1 (Proposed)

Figure 17. STEP 1 TABLE results for the data in Figure 3.

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PROJECT B/C COMPUTATION SHEET

Compute the Benefit Cost Ratios $(b/c)_1$ through $(b/c)_6$ by multiplying the values in the boxes. Blank boxes equal zero. Sum the six $(b/c)_i$ ratios to get $B_R/\$PA$.

RELATIVE IMPORTANCE (a_i) OF MISSION SUB OBJECTIVE

RELATIVE CONTRIBUTION (b_i) TO MISSION SUB OBJECTIVE (Normalized)

RELATIVE PROJECT WORTH (w_i) WITHIN SUB-OBJECTIVE

PROJECT RELEVANCE (r) TO FORCE READINESS

Initials. _____

Date Processed: 22/9/81

26.39 ×	0.7 ×	1.0 ×	1.0 =	25.47
(a_1)	(b'_1)	(w_1)	(r)	$(b/c)_1$
13.62 ×	0.3 ×	0.55 ×	1.0 =	2.25
(a_2)	(b'_2)	(w_2)	(r)	$(b/c)_2$
9.26 ×	0 ×	0 ×	1.0 =	0
(a_3)	(b'_3)	(w_3)	(r)	$(b/c)_3$
7.41 ×	0 ×	0 ×	1.0 =	0
(a_4)	(b'_4)	(w_4)	(r)	$(b/c)_4$
25.0 ×	0 ×	0 ×	1.0 =	0
(a_5)	(b'_5)	(w_5)	(r)	$(b/c)_5$
9.33 ×	0 ×	0 ×	1.0 =	0
(a_6)	(b'_6)	(w_6)	(r)	$(b/c)_6$

(SUM TO GET $B_R/\$PA$)

PN: 414

SUM= 27.72 = $B_R/\$PA$
(Enter on Form B)

Form C (Proposed)

Figure 18. Form C filled in with values from Forms A1 and B1.

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PROCESSING INSTRUCTIONS FOR FORM "B" INPUT DATA

PN: _____   Initials: _____   Date Processed: _____

	ACE	COA	TAG	TSG	ACSI	DCSLOG	DCSOPS	DCSPER	DCSRDA	ACSAC
r:										

b_1:										
b_2:										
b_3:										
b_4:										
b_5:										
b_6:										

w_1:										
w_2:										
w_3:										
w_4:										
w_5:										
w_6:										

Transfer the individual ratings from Forms B to the respective boxes above. Cross out (x) any columns for which no ratings were made. Continue processing on Form B2.

Form B1 (Proposed)

Figure 19. Form B1.

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PROCESSING INSTRUCTIONS FOR FORM "B-1" DATA

PN:_____ Initials:_____ Date Processed:_____

STEP 1: Using program "Statistical Analysis," compute the Low Quartile, Median, and High Quartile values for the "r" values on Form B-1. Enter results here and on Form "B" (as feedback information.)

r: Low Q. _____(%) Median_____(%) High Q._____(%)

Enter the decimal form of the Median Value of "r" on Form C in six places.

STEP 2: Using the program "Statistical Analysis," compute the Low Quartile, Median, and High Quartile values for rows b_1 through b_6 on Form B-1 and enter results in the Step 2 table below and on Form B (as feedback information.)

STEP 3: Using the program "Normalize b_i," compute the decimal form of the normalized values of b_i and enter them in the Step 3 table below and on the B/C Computation sheet, Form C.

<div style="display:flex">

STEP 2 TABLE

	Low Q (%)	Median (%)	High Q (%)
b_1:			
b_2:			
b_3:			
b_4:			
b_5:			
b_6:			

STEP 3 TABLE

	Normalized Median
b'_1	
b'_2	
b'_3	
b'_4	
b'_5	
b'_6	

</div>

STEP 4: Using program "Statistical Analysis" compute the Low Quartile, Median, and High Quartile values for rows w_1 through w_6 of Form B-1. Enter results in the Step 4 table below and on Form "B" (as feedback information.) Enter the decimal form of the Median w_i values on the B/C Computation sheet, Form C.

STEP 4 TABLE

	Low Q (%)	Median (%)	High Q (%)
w_1:			
w_2:			
w_3:			
w_4:			
w_5:			
w_6:			

Form B2 (Proposed)

Figure 20. Form B2.

PN: **414**   Initials: **J P**   Date Processed: **22/9/81**

	ACE	COA	TAG	TSG	ACSI	DCSLOG	DCSOPS	DCSPER	DCSRDA	ACSAC
r:	✕	✕	✕	✕	100	100	90	100	100	100

					ACSI	DCSLOG	DCSOPS	DCSPER	DCSRDA	ACSAC
b₁:					60	70	70	85	90	30
b₂:					40	30	30	15	10	60
b₃:										
b₄:										
b₅:										
b₆:										

					ACSI	DCSLOG	DCSOPS	DCSPER	DCSRDA	ACSAC
w₁:					90	100	100	100	100	75
w₂:					50	100	60	40	30	100
w₃:										
w₄:										
w₅:										
w₆:										

Transfer the individual ratings from Forms B to the respective boxes above. Cross out (x) any columns for which no ratings were made. Continue processing on Form B2.

Form B1 (Proposed)

Figure 21. Form B1 filled in with values from Figure 6.

PROCESSING INSTRUCTIONS FOR FORM "B-1" DATA

PN __414__   Initials: __JO__   Date Processed: __22/9/81__

STEP 1 Using program "Statistical Analysis," compute the Low Quartile, Median, and High Quartile values for the "r" values on Form B-1. Enter results here and on Form "B" (as feedback information.)

r: Low Q __97.5__ (%)   Median __100__ (%)   High Q __100__ (%)

Enter the decimal form of the Median Value of "r" on Form C in six places.

STEP 2 Using the program "Statistical Analysis," compute the Low Quartile, Median, and High Quartile values for rows b_1 through b_6 on Form B-1 and enter results in the Step 2 table below and on Form B (as feedback information.)

STEP 3 Using the program "Normalize b_i," compute the decimal form of the normalized values of b_i and enter them in the Step 3 table below and on the B/C Computation sheet, Form C.

STEP 2 TABLE

	Low Q (%)	Median (%)	High Q (%)
b_1	52.5	70	86.25
b_2	13.75	30	45
b_3	—	—	—
b_4	—	—	—
b_5	—	—	—
b_6	—	—	—

STEP 3 TABLE

	Normalized Median
b_1'	0.70
b_2'	0.30
b_3'	—
b_4'	—
b_5'	—
b_6'	—

STEP 4: Using program "Statistical Analysis" compute the Low Quartile, Median, and High Quartile values for rows w_1 through w_6 of Form B-1. Enter results in the Step 4 table below and on Form "B" (as feedback information.) Enter the decimal form of the Median w_i values on the B/C Computation sheet, Form C.

STEP 4 TABLE

	Low Q (%)	Median (%)	High Q (%)
w_1	86.25	100	100
w_2	37.5	55	100
w_3	—	—	—
w_4	—	—	—
w_5	—	—	—
w_6	—	—	—

Form B2 (Proposed)

Figure 22. Data from Figure 21 transferred to Form B2.

6. After all values are entered, compute the values $(b/c)_1$ through $(b/c)_6$ as the simple product of the numbers in the boxes in each row. Record these values on Form C to the nearest hundredth (0.00).

7. Sum the values $(b/c)_1$ through $(b/c)_6$ to get $B_R/C = B_R/\$PA$. Enter this sum at the bottom of Form C and at the bottom of Form B. The b', w, and r data from Figure 22 were processed in this manner; the results are shown in Figure 18 and in Figure 7.

Data Processing Exercise

The reader is encouraged to process the data from Figures 8, 10, 12, and 14. The correct $B_R/\$PA$ ratios for these data are shown in Figures 9, 11, 13, and 15, respectively.

4 CONCLUSION

The Facilities Readiness Quantification Model can be used to determine the relative readiness merits of selected MCA programs. If the model is to provide accurate results, at least six raters must participate. Rater data can be processed either manually, or by using the model algorithms on a programmable calculator.

GLOSSARY

a_i:	mission weight of the ith mission.
B_R:	benefits to readiness.
B/C:	benefit/cost.
b_i:	the fractional portion of a project's benefits that are assigned to the ith mission (expressed as a decimal).
C_R:	that part of the cost of a funding entity attributable to readiness.

C_T:	the estimated total cost of a funding entity.
CERL:	U.S. Army Construction Engineering Research Laboratory.
COA:	Controller of the Army.
COE:	Chief of Engineers.
CRRC:	Construction Requirements Review Committee.
DCSLOG:	Deputy Chief of Staff, Logistics.
DCSPER:	Deputy Chief of Staff, Personnel.
EUSA:	Eighth U.S. Army.
FR:	force readiness.
m_j	the fractional part of the cost of the jth funding entity that does not buy readiness benefits. Note: m_j also can be described as the "complement of r_j."
MCA:	Military Construction, Army (appropriation)
r_j:	the fractional part of the cost of the jth funding entity that does buy readiness benefits.
STD:	standard (maximum contribution standard).
TAG:	The Adjutant General.
TI:	Texas Instruments Corporation.
TRADOC:	Training and Doctrine Command.
TSG:	The Surgeon General.
USAREUR:	U.S. Army, Europe.
$(w_i)_j$:	the relative worth of the jth funding entity when compared to the maximum contribution standard for the ith mission area.
$\$PA$:	dollars, programmed amount.

APPENDIX A:
GENERAL INFORMATION ON THE TI-59 CALCULATOR*

Placing the TI-59 Calculator into Operation

The instructions in this appendix and Appendices B through D assume the user has access to a Texas Instruments (TI)-59 programmable calculator, a TI PC-100C print cradle, a TI Math Module, TI-59 magnetic cards, and the TI manuals listed below. (The system is shown in Figure A1.)

Personal Programming - A Complete Owner's Manual for TI Programmable 58/59 (Texas Instruments Corporation, 1977).

Math/Utilities - Using the Power of Your Solid State Software Module (Texas Instruments Corporation, 1978).

Texas Instruments - Print/Security Cradle PC-100 C (Texas Instruments Corporation, 1978).

First ensure that a TI math module is installed in the TI-59 calculator. Next, store the dust cover for the PC-100 calculator mounting bracket in the right side of the storage compartment on the PC-100 printer. Remove the battery pack from the calculator and put

*The instructions given in this appendix and Appendices B through D assume the user implements the program on a Texas Instruments (TI)-59 calculator. However, the algorithms described in this report can be adapted to programs for similar programmable calculators.

it into the left side of the storage compartment. The battery pack fits only one way. The flat side should face up and the slot should be to the left.

Put the key in the PC-100 lock and turn it fully counterclockwise. Then put the TI-59 on the mounting bracket and press down and toward the back of the PC-100. Hold the calculator in this position and turn the key a half turn clockwise to lock the calculator in place. If the calculator is correctly positioned, the key should turn easily (see Figure A1). Connect the printer to a standard 115-V outlet. Slide the switch on the right side of the printer to the rear to turn the printer on. Then turn the calculator itself on by putting the on/off switch in the "on" position. Both instruments must be "on" for the system to work. The programs listed in Appendices B, C, and D will not work without the printer attached to the calculator.

Recording a Program

Once the calculator is operational, any of the programs listed in Appendices B, C, and D of this report can be keyed-in. Only *one* of these programs should be stored at a time in the calculator, because all three programs use some of the same label keys. Certain *program data* also must be entered for the statistical analysis program described in Appendix B.

It is advisable to record all programs on magnetic cards so they will not have to be keyed-in each time they are needed.

Figure Al. TI-59 system.

APPENDIX B:
STATISTICAL ANALYSIS PROGRAM

Using the Program

This appendix describes how to use the statistical analysis program after the program steps and program data have been entered into the calculator (as described in Appendix A). Figure B1 shows how to use the program to process the first line of data in Figure 17. The resulting printout is keyed to each step of the process. Figure B2 shows how the first line of data in Figure 21 would be processed. The program actually can be used to find the quartile value of a sequence of up to 32 input values. If more than 32 values are input, however, some of the program data in registers 33 and beyond will be erased. This will adversely affect the printout messages. On the other hand, at least *three* values must be input for the program to work correctly. Each row of data in Figures 17 and 21 would be processed separately, following steps 1 through 3 of Figures B1 or B2 for each row of data.

Program Steps/Data Required

Before using the statistical analysis program, the TI-59 steps in Figure B3 must be entered into cal-

culator memory, and the data in Figure B4 must be entered into data storage registers 33 to 59. Note: this program also requires that the math module be in the calculator at the time the program is executed.

Algorithms Used

This section describes the algorithm for determining the low quartile values (V_l), the median value (V_m), and the high quartile value (V_h) for a sequence of numbers. First, the N input values (V_i) are sorted into low to high sequence $(V_1$ to $V_n)$. Then, $l = (n+1)/4$ is assigned as the low quartile index number; $m = (n+1)/2$ is assigned as the median index number; and $h = (n+1)(3/4)$ is assigned as the high quartile index number. These three index numbers—l, m, and h—are *all* integers *only* when $N = 3, 7, 11, 15, 19, 23, \ldots$ etc. For all other values of N, some of the index numbers will have a fractional component. For these cases, the index numbers (l, m, or h) are separated into two parts—an integer part (i) and a decimal part (0.d). The quartile *value* being computed is the value of the ith number plus the quantity $(0.d)$ $(V_{i+1} - V_i)$. The manual use of this algorithm is demonstrated in Figures B5 and B6.

Problem Statement: Compute the low quartile value (V_l), the median value (V_m), and the high quartile value (V_h) for the first row of data in Figure 17, i.e., for input values of 4, 3, 3, 2, 2, 4, and 50.

STEP	PROCEDURE	ENTER	PRESS	TI-59 DISPLAY	PC-100 PRINTER
1	Initialize the program		RST		ENTER VALUE, PRESS A
			E	0.	(FOR EACH VALUE) ...
					THEN PRESS B TO COM-
2	Enter each input	4	A	4.	PUTE... DO THIS NOW!
	value and press	3	A	3.	4.
	A in turn for	3	A	3.	3.
	each value entered	2	A	2.	3.
		2	A	2.	2.
		4	A	4.	2.
		50	A	50.	4.
					50.
3	Compute/output answers		B		COMPUTING... WAIT!
					LOW Q VALUE=
					2.
					MEDIAN VALUE=
					3.
					TOP Q VALUE =
				4.	4.

Figure B1. Example problem no. 1 for the statistical analysis program.

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Problem Statement: Compute the low quartile value (V_l), the median value (V_m), and the high quartile value (V_h) for the first row of data in Figure 21, i.e., for input values of 100, 100, 90, 100, 100, and 100.

STEP	PROCEDURE	ENTER	PRESS	TI-59 DISPLAY	PC-100 PRINTER
1	Initialize the program		RST		ENTER VALUE, PRESS A
			E	0.	(FOR EACH VALUE) . . .
					THEN PRESS B TO COM-
2	Enter each input	100	A	100.	PUTE. . . DO THIS NOW!
	value and press	100	A	100.	100.
	A in turn for	90	A	90.	100.
	each value entered	100	A	100.	90.
		100	A	100.	100.
		100	A	100.	100.
					100.
3	Compute/output answers		B		COMPUTING. . . WAIT!
					LOW Q VALUE=
					97.5
					MEDIAN VALUE=
					100.
					TOP Q VALUE=
				100.	100.

Figure B2. Example problem no. 2 for the statistical analysis program.

```
000  76 LBL          078  38  38       154  03   3        230  59 INT
001  11  A           079  69 OP        155  54   )        231  67  EQ
002  99 PRT          080  01  01       156  42 STO        232  17  B'
003  36 PGM          081  43 RCL       157  24  24        233  43 RCL
004  06  06          082  39  39       158  69 OP         234  25  25
005  11  A           083  69 OP        159  00  00        235  59 INT
006  91 R/S          084  02  02       160  43 RCL        236  42 STO
007  76 LBL          085  43 RCL       161  51  51        237  29  29
008  13  C           086  40  40       162  69 OP         238  85  +
009  36 PGM          087  69 OP        163  01  01        239  01  1
010  06  06          088  03  03       164  43 RCL        240  54  )
011  13  C           089  43 RCL       165  52  52        241  42 STO
012  25 CLR          090  41  41       166  69 OP         242  30  30
013  91 R/S          091  69 OP        167  02  02        243  73 RC*
014  76 LBL          092  04  04       168  43 RCL        244  29  29
015  15  E           093  69 OP        169  48  48        245  85  +
016  03   3          094  05  05       170  69 OP         246  73 RC*
017  69 OP           095  69 OP        171  03  03        247  30  30
018  17  17          096  00  00       172  43 RCL        248  54  )
019  47 CMS          097  43 RCL       173  49  49        249  55  ÷
020  06   6          098  42  42       174  69 OP         250  02   2
021  69 OP           099  69 OP        175  04  04        251  54  )
022  17  17          100  01  01       176  69 OP         252  42 STO
023  00   0          101  43 RCL       177  05  05        253  30  30
024  42 STO          102  43  43       178  36 PGM        254  76 LBL
025  30  30          103  69 OP        179  06  06        255  10  E'
026  42 STO          104  02  02       180  12  B         256  43 RCL
027  31  31          105  43 RCL       181  76 LBL        257  24  24
028  42 STO          106  44  44       182  14  D         258  22 INV
029  32  32          107  69 OP        183  29 CP         259  59 INT
030  68 NOP          108  03  03       184  25 CLR        260  67  EQ
031  68 NOP          109  43 RCL       185  43 RCL        261  18  C'
032  68 NOP          110  50  50       186  26  26        262  43 RCL
033  25 CLR          111  69 OP        187  22 INV        263  24  24
034  29 CP           112  04  04       188  59 INT        264  59 INT
035  69 OP           113  69 OP        189  67  EQ        265  42 STO
036  00  00          114  05  05       190  16  A'        266  31  31
037  43 RCL          115  25 CLR       191  43 RCL        267  85  +
038  45  45          116  91 R/S       192  26  26        268  01   1
039  69 OP           117  76 LBL       193  59 INT        269  54  )
040  01  01          118  12  B        194  42 STO        270  42 STO
041  43 RCL          119  03   3       195  27  27        271  32  32
042  46  46          120  32 X:T       196  85  +         272  73 RC*
043  69 OP           121  43 RCL       197  01  1         273  32  32
044  02  02          122  00  00       198  54  )         274  75  -
045  43 RCL          123  22 INV       199  42 STO        275  73 RC*
046  47  47          124  77  GE       200  28  28        276  31  31
047  69 OP           125  86 STF       201  73 RC*        277  42 STO
048  03  03          126  29 CP        202  28  28        278  31  31
049  43 RCL          127  43 RCL       203  75  -         279  54  )
050  33  33          128  00  00       204  73 RC*        280  42 STO
051  69 OP           129  42 STO       205  27  27        281  32  32
052  04  04          130  23  23       206  42 STO        282  43 RCL
053  69 OP           131  43 RCL       207  27  27        283  24  24
054  05  05          132  00  00       208  54  )         284  22 INV
055  69 OP           133  85  +        209  42 STO        285  59 INT
056  00  00          134  01  1        210  28  28        286  65  ×
057  43 RCL          135  54  )        211  43 RCL        287  43 RCL
058  34  34          136  55  ÷        212  26  26        288  32  32
059  69 OP           137  04  4        213  22 INV        289  85  +
060  01  01          138  54  )        214  59 INT        290  43 RCL
061  43 RCL          139  42 STO       215  65  ×         291  31  31
062  35  35          140  26  26       216  43 RCL        292  54  )
063  69 OP           141  43 RCL       217  28  28        293  42 STO
064  02  02          142  00  00       218  85  +         294  32  32
065  43 RCL          143  85  +        219  43 RCL        295  76 LBL
066  36  36          144  01  1        220  27  27        296  99 PRT
067  69 OP           145  54  )        221  54  )         297  98 ADV
068  01  01          146  55  ÷        222  42 STO        298  69 OP
069  43 RCL          147  02  2        223  28  28        299  00  00
070  37  37          148  54  )        224  76 LBL        300  43 RCL
071  69 OP           149  42 STO       225  19  D'        301  53  53
072  04  04          150  25  25       226  29 CP         302  69 OP
073  69 OP           151  43 RCL       227  43 RCL        303  01  01
074  05  05          152  26  26       228  25  25        304  43 RCL
075  69 OP           153  65  ×        229  22 INV        305  54  54
076  00  00                                               306  69 OP
077  43 RCL
```

Figure B.3. TI-59 steps required for the statistical analysis program.

38

```
307  02 02        356  69 DP        405  27 27
308  43 RCL       357  00 00        406  73 RC*
309  55 55        358  00 0         407  27 27
310  69 DP        359  00 0         408  42 STD
311  03 03        360  00 0         409  28 28
312  43 RCL       361  00 0         410  61 GTD
313  56 56        362  00 0         411  19 D'
314  69 DP        363  00 0         412  76 LBL
315  04 04        364  00 0         413  17 B'
316  69 DP        365  03 3         414  43 RCL
317  05 05        366  07 7         415  25 25
318  43 RCL       367  69 DP        416  59 INT
319  28 28        368  01 01        417  42 STD
320  99 PRT       369  03 3         418  29 29
321  98 ADV       370  03 3         419  73 RC*
322  69 DP        371  02 2         420  29 29
323  00 00        372  03 3         421  42 STD
324  43 RCL       373  03 3         422  30 30
325  57 57        374  00 0         423  61 GTD
326  69 DP        375  03 3         424  10 E'
327  01 01        376  03 3         425  76 LBL
328  43 RCL       377  04 4         426  18 C'
329  58 58        378  00 0         427  43 RCL
330  69 DP        379  00 0         428  24 24
331  02 02        380  69 DP        429  59 INT
332  43 RCL       381  02 02        430  42 STD
333  59 59        382  43 RCL       431  31 31
334  69 DP        383  55 55        432  73 RC*
335  03 03        384  69 DP        433  31 31
336  01 1         385  03 03        434  42 STD
337  07 7         386  43 RCL       435  32 32
338  06 6         387  56 56        436  61 GTD
339  04 4         388  69 DP        437  99 PRT
340  00 0         389  04 04        438  76 LBL
341  00 0         390  69 DP        439  68 NDP
342  00 0         391  05 05        440  36 PGM
343  00 0         392  43 RCL       441  02 02
344  00 0         393  32 32        442  10 E'
345  00 0         394  99 PRT       443  22 INV
346  69 DP        395  98 ADV       444  58 FIX
347  04 04        396  98 ADV       445  91 R/S
348  69 DP        397  98 ADV       446  76 LBL
349  05 05        398  91 R/S       447  86 STF
350  69 DP        399  76 LBL       448  36 PGM
351  00 00        400  16 A'        449  02 02
352  43 RCL       401  43 RCL       450  15 E
353  30 30        402  26 26        451  22 .NV
354  99 PRT       403  59 INT       452  58 FIX
355  98 ADV       404  42 STD       453  91 R/S
```

Figure B3. (Cont'd).

Figure B4. Data required in data storage registers 33 to 59 for the statistical analysis program.

Problem: Determine the low quartile value (V_l), the median value (V_m), and the high quartile value (V_h) for the following numbers: 0, 22, 16, 16, 1, 5, and 0.

Step 1: Arrange numbers low to high.

i	1	2	3	4	5	6	7 (N = 7)
V_i	0	0	1	5	16	16	22

Step 2: Compute l, m, and h.

$$l = \frac{N+1}{4} = \frac{8}{4} = 2; m = \frac{N+1}{2} = 4; h = (N+1)(3/4) = 6$$

Step 3: Compute V_l, V_m, and V_h.

$$V_l = V_2 = 0, \text{ i.e., the 2nd value in the chart;}$$

$$V_m = V_4 = 5, \text{ i.e., the 4th value in the chart;}$$

$$V_h = V_6 = 16, \text{ i.e., the 6th value in the chart.}$$

Figure B5. Simple example of how quartile values are determined.

Problem: Determine the low quartile value (V_l), the median value (V_m), and the high quartile value (V_h) for the following numbers: 13.7, 12.1, 15.5, 11.5, 14.2, 8.1, 5.2, 21.3, and 15.5

Step 1: Arrange numbers low to high.

i	1	2	3	4	5	6	7	8	9 (N = 9)
V_i	5.2	8.1	11.5	12.1	13.7	14.2	15.5	15.5	21.3

Step 2: Compute l, m, and h.

$$l = \frac{N+1}{4} = 2\text{-}1/2; m = \frac{N+1}{2} = 5; h = (N+1)(3/4) = 7\text{-}1/2$$

Step 3: Compute V_l, V_m, and V_h.

$$V_l = V_{2.5} = V_2 + (0.5)(V_3 - V_2) = 8.1 + (.5)(11.5 - 8.1) = 9.8$$

$$V_m = V_5 = 13.7$$

$$V_h = V_{7.5} = V_7 + (0.5)(V_8 - V_7) = 15.5 + (0.5)(15.5 - 15.5) = 15.5$$

Figure B6. Complex example of how quartile values are determined.

APPENDIX C:
m_i TO a_j PROGRAM

Using the Program

This appendix describes how to use the m_i to a_j program after the program steps have been entered into the calculator. Figure C1 shows how to use the program to process the median ratio values in the STEP 2 TABLE of Figure 17. The resulting printout is keyed to each step of the process.

Program Steps Required

Before using the m_i to a_j program, the program steps in Figure C2 must be entered into the calculator memory.

Algorithm Used

The median ratio values, m_1 through m_5, in the STEP 2 TABLE of Form A1 (see Figure 17) are

converted to the mission weights, a_1 through a_6, in the STEP 3 TABLE (on the same form) according to the following algorithms:

$$a_1 = \frac{m_3}{m_3 + 1} \frac{m_1}{m_1 + m_2 + 1} \times 100 \quad [\text{Eq C1}]$$

$$a_2 = \frac{1}{m_3 + 1} \frac{m_1}{m_1 + m_2 + 1} \times 100 \quad [\text{Eq C2}]$$

$$a_3 = \frac{m_4}{m_4 + 1} \frac{1}{m_1 + m_2 + 1} \times 100 \quad [\text{Eq C3}]$$

$$a_4 = \frac{1}{m_4 + 1} \frac{1}{m_1 + m_2 + 1} \times 100 \quad [\text{Eq C4}]$$

$$a_5 = \frac{m_5}{m_5 + 1} \frac{m_2}{m_1 + m_2 + 1} \times 100 \quad [\text{Eq C5}]$$

$$a_6 = \frac{1}{m_5 + 1} \frac{m_2}{m_1 + m_2 + 1} \times 100 \quad [\text{Eq C6}]$$

Problem Statement: Compute the six values of a_j, given the five median values of m_i from the STEP 2 TABLE of Figure 17.

STEP	PROCEDURE	ENTER	PRESS	TI-59 DISPLAY	PC-100 PRINTER	
1	Initialize the Program		RST E'			
2	Input m_1	3	A	3.		
3	Input m_2	2	B	2.		
4	Input m_3	2.67	C	2.67		
5	Input m_4	1.25	D	1.25		
6	Input m_5	3	E	3.		
7	Compute and Output a_i		A'		'M TO A' PROGRAM IS COMPUTING..... WAIT	
					INPUT WAS :	
					3.00	M1
					2.00	M2
					2.67	M3
					1.25	M4
					3.00	M5
					OUTPUT IS :	
					36.38	A1
					13.62	A2
					9.26	A3
					7.41	A4
					25.00	A5
				999	8.33	A6

Figure C1. Example problem for the m_i to a_j program.

41
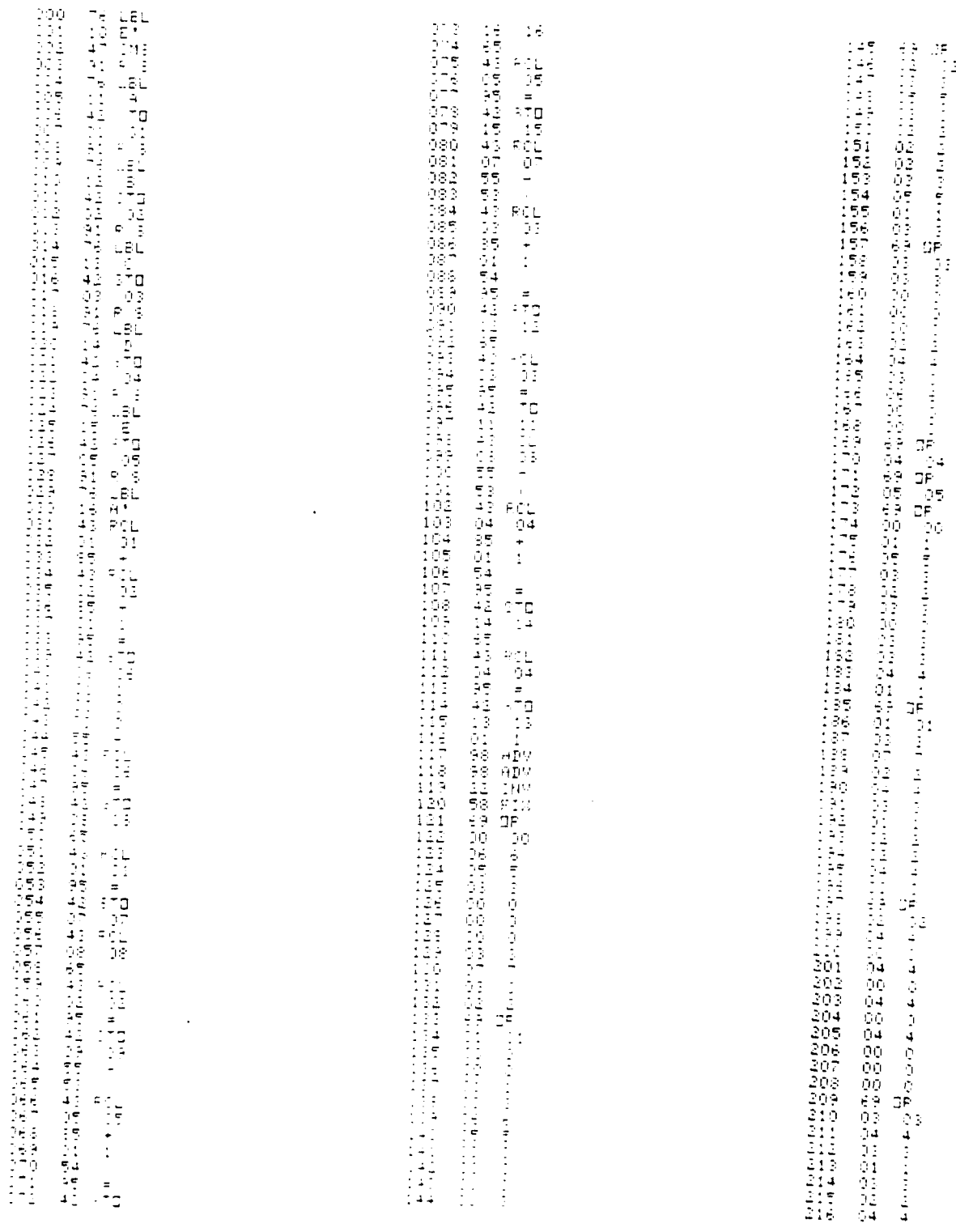
Figure C2. TI-59 steps required for the m_i to a_j program.

Figure C2. (Cont'd).

APPENDIX D:
NORMALIZE b PROGRAM

Using the Program

This appendix describes how to use the normalize b program after the program steps have been entered into the calculator. Figure D1 shows how to use the program to process the median b values in the STEP 2 TABLE of Figure 22. The resulting printout is keyed to each step of the process.

Program Steps Required

Before using the normalize b program, the program steps in Figure D2 must be entered into the calculator memory.

Algorithm Used

The median b values in the STEP 2 TABLE of Form B2 (see Figure 22) are in percentage form and do not always sum to 100 percent. The algorithm for this program is to sum the median b values in the STEP 2 TABLE of Form B2, to divide each median b value by this sum, and then to divide the results by 100 to convert to decimal form. The sum of the resulting six b' values is 1. The following equation applies:

$$b/(100 \sum_{i=1}^{6} b_i) = b' \qquad \text{[Eq D1]}$$

Problem Statement: Compute the normalized values b' for the median b_i values in the STEP 2 TABLE of Figure 22.

STEP	PROCEDURE	ENTER	PRESS	TI-59 DISPLAY	PC-100 PRINTER
1	Initialize the program		RST E		
2	Input median b_1	70	A	70.	
3	Input median b_2	30	B	30.	
4	Input median b_3	0	C	0.	
5	Input median b_4	0	D	0.	
6	Input median b_5	0	A'	0.	
7	Input median b_6	0	B'	0.	
8	Compute and output b'		D'		'NORMALIZE B' PGM IS COMPUTING. . . . . WAIT.

```
INPUT WAS :
                         70.00      B1
                         30.00      B2
                          0.00      B3
                          0.00      B4
                          0.00      B5
                          0.00      B6
            NORMALIZED B VALUES=
                          0.70      B1
                          0.30      B2
                          0.00      B3
                          0.00      B4
                          0.00      B5
   999                    0.00      B6
```

Figure D1. Example problem for the normalize b program.

Figure D2. TI-59 steps required for the normalize b program.

Figure D2. (Cont'd).

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APPENDIX E:
BLANK FORMS

Rater's Initials: _____

Date: _____
(Day/mo/yr)

Rater's Office: (check one)

☐ ACE (1) ☐ DCSLOG (6)

☐ COA (2) ☐ DCSOPS (7)

☐ TAG (3) ☐ DCSPER (8)

☐ TSG (4) ☐ DCSRDA (9)

☐ ACSI (5) ☐ ACSAC (0)

PRIOR RATIOS ASSIGNED
(as of:)

Low Q	Median	High Q
----------	----------	----------
----------	----------	----------
----------	----------	----------
----------	----------	----------
----------	----------	----------

RELATIVE IMPORTANCE OF READINESS SUB-OBJECTIVES

Mission Sub-Objectives Being Compared	Relative Significance (Ratio)
European Theater / USA	_____
All Other Theaters / USA	_____
Europe: Initial / Sustained	_____
USA: Initial / Sustained	_____
Other: Initial / Sustained	_____

ARMY READINESS TO ACCOMPLISH MISSIONS

IN EUROPEAN THEATRE

IN USA

IN ALL OTHER THEATERS

DURING INITIAL BATTLES

DURING SUSTAINED CONFLICT

DURING INITIAL BATTLES

DURING SUSTAINED CONFLICT

DURING INITIAL BATTLES

DURING SUSTAINED CONFLICT

$a_1 =$ --------- $a_2 =$ --------- $a_3 =$ --------- $a_4 =$ --------- $a_5 =$ --------- $a_6 =$ ---------

(BOX RESERVED FOR FEEDBACK INFORMATION)

Form A (Proposed)

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PROCESSING INSTRUCTIONS FOR FORM "A" INPUT DATA

Initials:_____ Date Processed:_____

STEP 1: Enter into the respective box below the decimal equivalent (to the nearest 0.01) of each ratio from basic input Form A.

STEP 1 TABLE

	ACE (1)	COA (2)	TAG (3)	TSG (4)	ACSI (5)	DCSLOG (6)	DCSOPS (7)	DCSPER (8)	DCSRDA (9)	ACSAC (0)
EUR/USA										
OTH/USA										
EUR: I/S										
USA: I/S										
OTH: I/S										

STEP 2: Using the program "Statistical Analysis," compute the Low Quartile, Median, and High Quartile values for each row of numbers above and record results in the Step 2 table below and on Form A (as feedback information.)

STEP 3: Using the program, "m_i to a_j," compute a_1 through a_6 (to the nearest 0.01) and record the six values on Form A (as feedback information), in Step 3 table below, and on Form C.

STEP 2 TABLE

ROW	OBJECTIVE	LOW Q	MEDIAN	HIGH Q
1	EUR/USA	l_1:	m_1:	h_1:
2	OTH/USA	l_2:	m_2:	h_2:
3	EUR:I/S	l_3:	m_3:	h_3:
4	USA:I/S	l_4:	m_4:	h_4:
5	OTH:I/S	l_5:	m_5:	h_5:

STEP 3 TABLE

MISSION WEIGHTS
a_1:
a_2:
a_3:
a_4:
a_5:
a_6:

Form A1 (Proposed)

Rater's Office. (check one)

☐ ACE (1)	☐ DCSLOG (6)
☐ COA (2)	☐ DCSOPS (7)
☐ TAG (3)	☐ DCSPER (8)
☐ TSG (4)	☐ DCSRDA (9)
☐ ACSI (5)	☐ ACSAC (0)

Rater's Initials:_____

Date:_____
Day/mo/yr

PROJECT IDENTIFICATION AND PROJECT RATINGS

LOCATION   PN   DESCRIPTION

PRIOR RATING RESULTS

(as of _____)

r VALUES

Low Q	Median	High Q
----------	----------	----------

b VALUES

Low Q	Median	High Q
----------	----------	----------
----------	----------	----------
----------	----------	----------
----------	----------	----------
----------	----------	----------
----------	----------	----------

w VALUES

Low Q	Median	High Q
----------	----------	----------
----------	----------	----------
----------	----------	----------
----------	----------	----------
----------	----------	----------
----------	----------	----------

Note: Feedback values for each r,b, and w are independent of all other r,b,and w values. Median values of b will be normalized before use in later computations. Median values of r and w will be used directly.

Project Relevance to Readiness (%)

r= _____

Relative Contribution of Project to each Sub-Objective (%)

Mission Sub-Objective	Sub-Objective (%)
Europe-Initial	b_1= _____
Europe-Sustained	b_2= _____
USA-Initial	b_3= _____
USA-Sustained	b_4= _____
Other-Initial	b_5= _____
Other-Sustained	b_6= _____

(Total =100%)

Mission Sub-Objective	Project Worth*
Europe-Initial	w_1= _____
Europe-Sustained	w_2= _____
USA-Initial	w_3= _____
USA-Sustained	w_4= _____
Other-Initial	w_5= _____
Other-Sustained	w_6= _____

*(On a scale of 1 to 100, compare project to some "Maximum Contribution" Project.)

B_c/SPA= _____

(BOX RESERVED FOR FEEDBACK INFORMATION)

Form B (Proposed)

PROCESSING INSTRUCTIONS FOR FORM "B" INPUT DATA

PN: _____ Initials: _____ Date Processed: _____

	ACE	COA	TAG	TSG	ACSI	DCSLOG	DCSOPS	DCSPER	DCSRDA	ACSAC
r:										

	ACE	COA	TAG	TSG	ACSI	DCSLOG	DCSOPS	DCSPER	DCSRDA	ACSAC
b_1:										
b_2:										
b_3:										
b_4:										
b_5:										
b_6:										

	ACE	COA	TAG	TSG	ACSI	DCSLOG	DCSOPS	DCSPER	DCSRDA	ACSAC
w_1:										
w_2:										
w_3:										
w_4:										
w_5:										
w_6:										

Transfer the individual ratings from Forms B to the respective boxes above. Cross out (x) any columns for which no ratings were made. Continue processing on Form B2.

Form B1 (Proposed)

PROCESSING INSTRUCTIONS FOR FORM"B-1" DATA

PN: _____ Initials: _____ Date Processed: _____

STEP 1: Using program "Statistical Analysis," compute the Low Quartile, Median, and High Quartile values for the "r" values on Form B-1. Enter results here and on Form "B" (as feedback information.)

    r: Low Q. _____(%) Median_____(%) High Q._____(%)

        Enter the <u>decimal form</u> of the Median Value of "r" on Form C in six places.

STEP 2: Using the program "Statistical Analysis," compute the Low Quartile, Median, and High Quartile values for rows b_1 through b_6 on Form B-1 and enter results in the Step 2 table below and on Form B (as feedback information.)

STEP 3: Using the program "Normalize b_i," compute the <u>decimal form</u> of the normalized values of b_i and enter them in the Step 3 table below and on the B/C Computation sheet, Form C.

STEP 2 TABLE

	Low Q (%)	Median (%)	High Q (%)
b_1:			
b_2:			
b_3:			
b_4:			
b_5:			
b_6:			

STEP 3 TABLE

	Normalized Median
b_1'	
b_2'	
b_3'	
b_4'	
b_5'	
b_6'	

STEP 4: Using program "Statistical Analysis" compute the Low Quartile, Median, and High Quartile values for rows w_1 through w_6 of Form B-1. Enter results in the Step 4 table below and on Form "B" (as feedback information.) Enter the <u>decimal form</u> of the <u>Median</u> w_i values on the B/C Computation sheet, Form C.

STEP 4 TABLE

	Low Q (%)	Median (%)	High Q (%)
w_1:			
w_2:			
w_3:			
w_4:			
w_5:			
w_6:			

Form B2 (Proposed)

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PROJECT B/C COMPUTATION SHEET

Compute the Benefit Cost Ratios $(b/c)_1$ through $(b/c)_6$ by multiplying the values in the boxes. Blank boxes equal zero. Sum the six $(b/c)_i$ ratios to get B_R/SPA.

RELATIVE IMPORTANCE (a_i) OF MISSION SUB-OBJECTIVE

RELATIVE CONTRIBUTION (b_i) TO MISSION SUB-OBJECTIVE (Normalized)

RELATIVE PROJECT WORTH (w_i) WITHIN SUB-OBJECTIVE

PROJECT RELEVANCE (r) TO FORCE READINESS

Initials: _____

Date Processed: _____

$\square$ X $\square$ X $\square$ X $\square$ = $\overline{\qquad}$ $(b/c)_1$

(a_1) (b'_1) (w_1) (r)

$\square$ X $\square$ X $\square$ X $\square$ = $\overline{\qquad}$ $(b/c)_2$

(a_2) (b'_2) (w_2) (r)

$\square$ X $\square$ X $\square$ X $\square$ = $\overline{\qquad}$ $(b/c)_3$

(a_3) (b'_3) (w_3) (r)

$\square$ X $\square$ X $\square$ X $\square$ = $\overline{\qquad}$ $(b/c)_4$

(a_4) (b'_4) (w_4) (r)

$\square$ X $\square$ X $\square$ X $\square$ = $\overline{\qquad}$ $(b/c)_5$

(a_5) (b'_5) (w_5) (r)

$\square$ X $\square$ X $\square$ X $\square$ = $\overline{\qquad}$ $(b/c)_6$

(a_6) (b'_6) (w_6) (r)

(SUM TO GET B_R/SPA)

PN: _____

SUM= $\dfrac{\qquad\qquad}{\text{(Enter on Form B)}}$ = B_R/SPA

Form C (Proposed)

Chief of Engineers
ATTN: Tech Monitor
ATTN: DAEN-ASI-L (2)
ATTN: DAEN-CCP
ATTN: DAEN-CW
ATTN: DAEN-CWE
ATTN: DAEN-CWM-R
ATTN: DAEN-CWO
ATTN: DAEN-CWP
ATTN: DAEN-MP
ATTN: DAEN-MPC
ATTN: DAEN-MPE
ATTN: DAEN-MPO
ATTN: DAEN-MPR-A
ATTN: DAEN-RD
ATTN: DAEN-RDC
ATTN: DAEN-RDM
ATTN: DAEN-RM
ATTN: DAEN-ZC
ATTN: DAEN-ZCE
ATTN: DAEN-ZCI
ATTN: DAEN-ZCM

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