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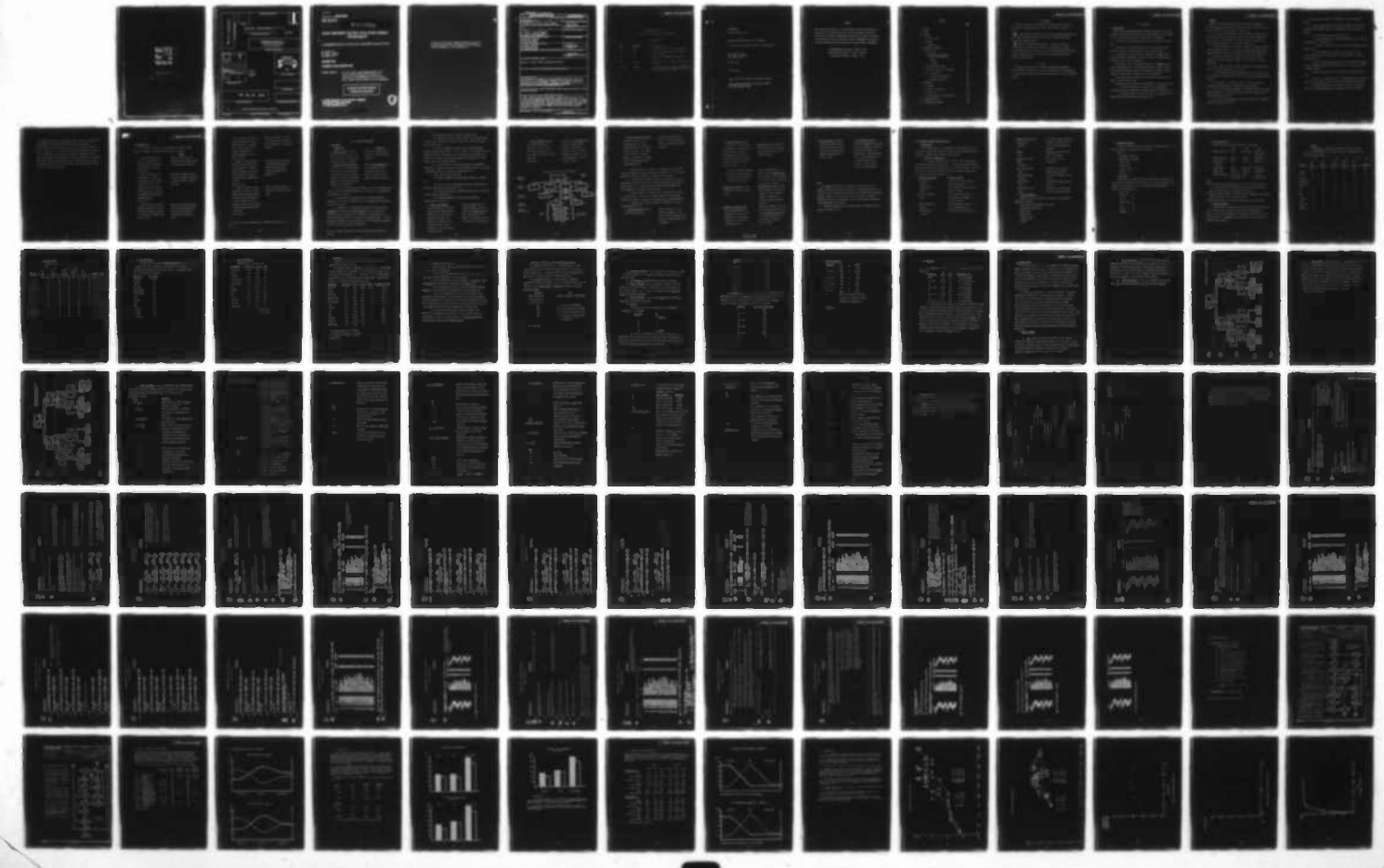

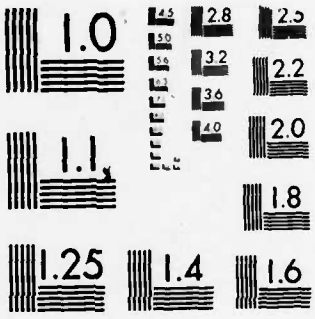

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COST BENEFIT RATIO ANALYSIS (CBRA) TECHNIQUE

A Simplified System Evaluation Trade-Off Analysis Tool

Mrs. Judith N. Fite
Mr. William A. Oxendale
Mr. Samuel R. Hart

DECEMBER 1980

USER'S HANDBOOK

US ARMY RESEARCH & DEVELOPMENT COMMAND
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CBRA Technique was originated as an Army Suggestion (#127-79A), adopted and implemented by the Advanced Scout Helicopter Project Manager's Office and approved by the Cdr, USAAVRADCOM. Implementation assistance was provided by Plans & Anal Dir, and Dir for Advanced Systems, USAAVRADCOM.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Cost-benefit analysis, Trade-off analysis, System evaluation, Decision analysis, Systems acquisition.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A simple, general-purpose, quick-reaction, computer-assisted tool for use in evaluating and substantiating the relative merits of given course(s) of action, on an elective (nonmandatory) basis, for application to a wide range of systems acquisition/evaluation tasks. Automated portion was developed on an IBM 360/65 and provides hardcopy output on most printer/typewriter/graphic terminals. It was written in IBM Fortran IV language, and copy of the source program is appended to the Report.

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Cost Benefit-Ratio Analysis (CBRA) Technique

ERRATA SHEET

Page	Paragraph	Correction
20	f (2)	"delectability" should be "detectability".
29	7a	CW for last column (Schedule) should be (.15) vs. (.10)
30	7b	Same - CW for Schedule column should be (.15).
97	d, Sys A	MEP Acqn Cost (last column) should be 655.8 vs. 655.9.
104-105	Comment:	Since these charts are purely for illustration, no effort was made to portray the colors referred to in the chart legend.

USAAVRADCOM

Technical Report TR 81-

COST BENEFIT RATIO ANALYSIS (CBRA) TECHNIQUE

A Simplified System Evaluation/Trade Off Analysis Tool

Mrs. Judith H. Fite
Mr. William A. Oxandale
Mr. Samuel R. Hurt

December 1980

USER's GUIDE

Approved for Public Release; Distribution Unlimited

US Army Aviation Research and Development Command
4300 Goodfellow Boulevard
St. Louis, Missouri 63120

PREFACE

CBRA Technique was originated as an Army Suggestion (#127-79A), adopted and implemented by the Advanced Scout Helicopter Project Manager's Office and approved by the Commander, USAAVRADCOM; implementation assistance (automation) was provided by the Plans & Analysis Directorate, USAAVRADCOM; and technical application assistance by the Directorate for Advanced Systems, USAAVRADCOM.

Author/Suggestion Originator - Judith H. Fite

Systems Analyst/Programmer - William A. Oxandale

Applications Consultant - Samuel R. Hurt

CONTENTS

I - PURPOSE

To provide a simple, general purpose, quick-reaction tool for use in evaluating and substantiating the relative merits of given course(s) of action:

- To help bridge the gap between purely subjective/emotional analysis and full-blown quantitative analysis, in a variety of systems evaluation or cost-benefit assessment needs.
- Intended to supplement (NOT supplant or circumvent!) existing requirements or processes in the areas of cost analysis (CA), economic analysis (EA), risk analysis (RA), cost and operational/training effectiveness analysis (COEA/CTEA), source selection/evaluation planning, and related systems acquisition matters.

II - SCOPE

This Guide is the product of an adopted and implemented suggestion (AR 672-20) and is offered as an elective, nonmandatory tool for application to a wide range of systems acquisition/evaluation tasks, by any U.S. Government element.

III - OVERVIEW

A. BASIS OF NEED.

Despite the many CA/EA/RA/COEA/CTEA governing regulations and resulting multitude of sophisticated decision-analytic computer models, a gap continues to exist in terms of tools to meet everyday needs. For instance:

1. When there is not enough data available to fully exercise a "canned" model.

2. When there is not enough time and/or lack of available operations research or computer assistance personnel to meet suspense dates.

3. When there is need to deal with a combination of tangible (more or less quantifiable) and intangible (primarily subjective) considerations in evaluating a given option or alternative.

4. When there is need for systematic evaluation of a single course of action, by comparison with a known, accepted standard or product. (Most existing models accommodate comparison of multiple alternatives, but do not provide for evaluating the relative merits of a single option).

5. When there is need to compare very dissimilar items in terms of relative worth for similar roles.

6. When there is need for preliminary screening of alternatives, either --

   a. To reduce a large number of options to a more manageable number/range on which full-blown, more formal analysis can be conducted; or --

   b. To identify which facets are most critical to the evaluation and which therefore warrant further, in-depth analysis.

B. CONCEPT.

The core of the CBRA technique is drawn from ordinary principles of decision analysis/source selection evalution, in terms of problem definition and identification and exploration of alternatives.

1. The chief advantage of CBRA is that it assimilates these "universal" evaluation methods into a simple but highly adaptable tool to improve the depth, quality, and documentation of analyses that would otherwise rely on totally subjective processes -- or not be attempted at all.

a. Permits assessment of a wide range of factors in evaluation processes by correlating both tangible and intangible aspects and expressing them in quantifiable terms conducive to both objective and subjective evaluation.

b. Designed for individual or group use, large or small number of variables -- no special training required for either manual or automated application.

c. With computer assistance, permits accommodation of a large volume of data in a practical visible manner; featuring --

(1) Self-contained, English-language program in ready-to-use status on any terminal with S&E computer access; no prior training or special skills required.

(2) Responsive, see-as-you-go results. Can be used either in "building block" increments, or completed at a single sitting.

(3) Allows real-time participation from multiple locations via remote access terminals; and in most cases, permits hard copy of input/output and other documentation if desired.

(4) Source program (Appendix D) is easily adaptable to non-IBM/S&E computers if desired (see IV.E.2).

2. Once the problem (task) has been defined, the following generally applies:

a. Identify principal characteristics which define the benefits and drawbacks of the candidate item(s) or alternative(s) against the overall objective.

b. Obtain assessment from key participants as to:

(1) Relationship of the critical parameters to each other (within the framework of the overall task).

(2) Weight or ranking of the critical parameters (against a total weight of 100).

(3) Estimated worth or rating of each candidate, for each critical characteristic above, expressed as a numeric rating on a decimal scale such as 1-10.

c. Compute candidate ratings against critical characteristic weights to derive candidate weighted score, which yields a projected "unit worth" in quantifiable terms.

d. Obtain cost estimates for each candidate and express in common terms.

e. Divide each candidate cost by the corresponding candidate weighted score, to yield a numeric cost per "benefit", or Cost-Benefit Ratio (CBR).

f. Expanded discussion of the technique, tailored to a variety of uses, plus case studies/examples, are presented in Section IV following.

3. A comment about other principles, techniques, terms, or tools within the broad category of decision theory/analysis: While such topics as Multi-Attribute Utility Theory, Utility Curves, use of Ratio vs. Absolute Scale -- endless etc. -- lie outside the purview of this Guide, there are no known incompatiblities or barriers to using CBRA in conjunction with such tools. Quite simply, CBRA is designed to assist in task layout, scorekeeping and feedback during the analysis; and if Utlity Curves (etc.) are desired, they simply become the basis of the scoring standard ("yardstick") selected for use in the evaluation process.

C. SUGGESTED USES.

1. To illustrate potential use of CBRA against the kinds of needs previously discussed, the following sample tasks are outlined:

	Remarks
a. Assess projected benefit vs cost of a proposed ECP or PIP; only skeletal information is available at this point. (Ref. III.A.1)	Analysis results will help determine whether formal review and staffing will be pursued.
b. "What If" question; one-day reaction time: What is the estimated impact in terms of "bang for bucks" if you augment the currently planned payload capability of System X to accommodate expanded mission equipment package? (Ref. III.A.2)	Outcome will influence decision on whether to submit request for a program increment, FY XX-XX POM cycle.
c. Compare alternative mission equipment packages, in terms of projected performance capability vs. human factors considerations. (Ref. III.A.3)	Results will influence scenario outline and task selection for Mission Profile Operational Test/Evaluation Plan (part of COEA).

d. Determine whether it is cost effective (additional bang for additional bucks) to modernize older, fielded assets to new system configuration, to achieve "homogeneous" fleet. (Ref. III.A.4)	Outcome, if positive, will be incorporated in justification of agency proposal for a conversion program.
e. Explore relative merits of ground vs. aerial vehicles for laser designation of targets, in various support roles; e.g., field artillery, air cavalry, attack helicopter, command and control. (Ref. III.A.5)	Results will be fed into Trade Off Analyses/Determinations (TOA/TOD) during Concept Formulation Package (CFP) preparation.
f. Screen a dozen-plus initial options and narrow down to those which reflect greatest potential for and/or greatest differences in type of approach to task solution; isolate critical aspects on which further analysis should be focused. (Ref. III.A.6)	Results will help frame the structure and scope of subsequent COEA.

2. Specific instructions and examples of CBRA application are included in IV.B.

IV - OPERATING INSTRUCTIONS

A. THE PROCESS

Basic Steps*	Discussion
1. Define the task. No matter what the nature of the exercise, the first step is to establish the objective (define the problem).	This forms the summary level (top piece) of the evaluation framework.
2. Identify Critical Parameters. The next step is to determine what key elements or principal characteristics will "make or break" a solution to the problem; evaluation "musts". When selecting critical parameters, try to assure:	These critical parameters (CP) form the backbone of the evaluation structure, and every CP occupies a "cell" within the overall structure.

a. Focus on aspects which are important in terms of contribution (pro and con) to the final purpose/objective of the task; i.e., the things which should influence a decision.

b. Completeness of coverage--so that the primary benefits and drawbacks of the potential candidate item(s) or approach(es) are included in the scope of evaluation.

c. Recognition of interdependence among factors (such as target recognition as a function of target detection); but at the same time, avoidance of direct redundancy (e.g., evaluation of airspeed both as a technical characteristic and as an indicator of maneuverability). To avoid this kind of redundancy, tailor the parameters to the function or capability desired, rather than the means of attaining it.

*Be sure to document assumptions, sources, and rationale throughout the process.

d. When comparing alternative candidates, assure that:

(1) Emphasis is given to aspects in which the candidates differ; inclusion of too much similarity tends to "muddy" the outcome rather than enhance discrimination.

(2) There is basis for meaningful comparison between/among candidates against each parameter selected. However, if the candidates are so dissimilar that their characteristics or features cannot be compared, then reorient the evaluation to assess their respective contribution to the end purpose, rather than "hardware" aspects.

e. If a single option is to be evaluated against an established "yardstick", it can be done either in terms of comparable aspects, or in terms of added/delta capability or benefits for added/delta cost.

f. Some typical critical parameters:

(1) Mission capability--including speed, endurance, firepower, etc.

(2) Survivability--encompassing delectability, crashworthiness, ballistic protection, EW countermeasures, etc.

(3) Operational suitability--addressing human factors, handling qualities, mission analysis, etc.

(4) Logistics/Management--including RAM, availability, provisioning, "-ilities", etc.

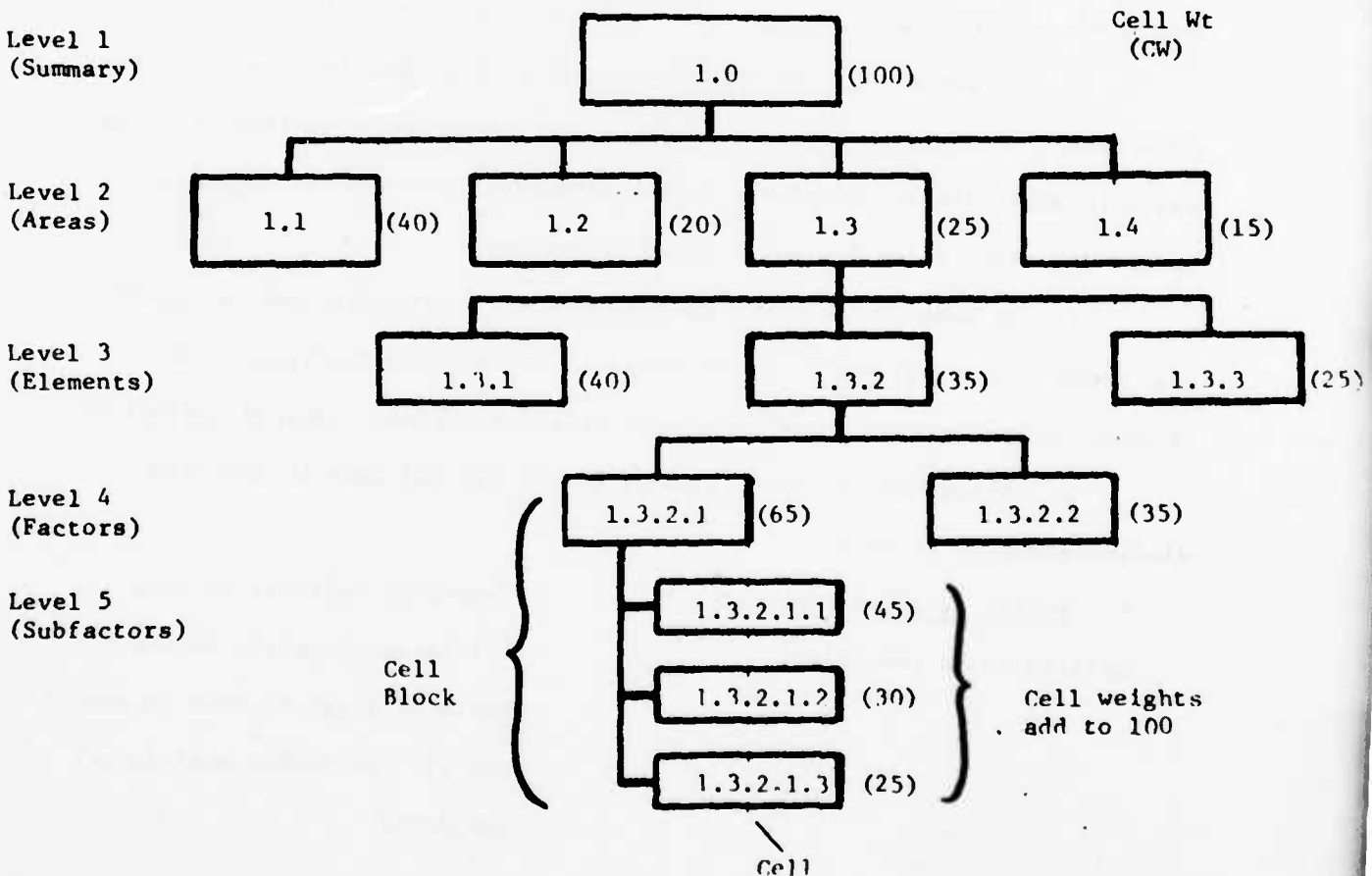
3. Lay out the framework. Variously referred to as a blueprint, pyramid, wiring diagram, decision tree, hierarchy, etc.--regardless of "label", the object is to establish the relationship of the critical parameters to each other within the overall task. This rough diagram depicting critical parameter relationships becomes the evaluation structure (ES). May range from very simple to very complex, depending on the nature of the task itself.

4. Allocate weights reflecting the relative importance or "preference" of the critical parameters; total weight for the cells within a given block should equal 100%.

Illustration:

Referred to as cell weight (CW). In a multi-level evaluation structure, each group of subordinate cells with their immediately superior cell form a cell block (CB). Every cell receives a weight.

EVALUATION STRUCTURE (ES) ILLUSTRATION



5. Formulate evaluation criteria. Evaluation is essentially a measurement process, using a yardstick tailored to the specific needs of the task. Even though critical parameters predispose what will be measured, it remains to be determined how to measure them systematically.

These scoring standards (SS) become a sort of "yardstick" to facilitate consistent, objective assessment.

a. Obviously, wherever possible, it is desirable to use specific requirements (from ROC, system specification, test plans, etc.) to establish benchmarks; including "required" and "desired" characteristics.

b. In the absence of specific tangible requirements as a basis for measurement, construct narrative criteria which describe as definitively as possible what will be considered good/acceptable, bad/unacceptable, and better/desirable in evaluating a given parameter.

c. In some instances, a different kind of yardstick may be needed; e.g., where detail criteria is not feasible but where a known, accepted product can be used as a standard, with proposed options compared against it.

d. Illustrations of various yardstick are included in the case studies/examples in IV.B.

6. Verify candidates or alternatives to be evaluated.

Frequently implicit in task definition; however, review should at least be made to assure that all reasonable options are considered.

7. Assign and Compute Scores.

a. Assess the estimated worth (or preference or ranking) of each candidate, for each critical parameter, against its scoring standard and express as a numeric value on a decimal scale such as 1-10 or 1-100.

Raw scores (RS) are applied only to the lowest level cells within each block (those which have no subordinate cells).

b. Compute candidate weighted scores, to yield an estimated "candidate worth" or "benefit rating" in numeric terms.

Raw score multiplied by cell weight yields the weighted score (WS), repeated for each ascending level (RS x CW = WS). This process is referred to as rollup.

8. Obtain cost estimates for each candidate and express in common terms.

Candidate cost (CC) may be drawn from any type of funds or any category of cost, as needed/available to compare the candidates in the areas being evaluated.

9. Compute cost-benefit ratio. May be computed/compared for individual cell blocks or for intermediate cell groupings ("modules"), as well as for task summary level.

Divide each candidate cost by the corresponding weighted score to yield cost-benefit ratio (CBR), which is an expression of relative "bang for bucks". (CC ÷ WS = CBR).

10. Analyze results, performing sensitivity analyses wherever indicated by those results, to help solidify conclusion and support recommendations for further action.	The cost-benefit ratio with supporting analysis (CBRA) assists in decision making by isolating issues and clarifying their impacts under varying conditions; but does not predispose a one-only best answer or final solution. It is a decision tool--not a decision maker.

NOTES:

a. Throughout this Guide, the assumption is made that cost is an important consideration in most any evaluation or justification task, and for this reason cost considerations are inherent in the instruction and discussion material. However, if for any reason it is not pertinent or possible to address cost issues, the technique may still be used by simply omitting the cost-related steps in the process.

b. Practical examples of the technique, tailored to different types of tasks, are included in IV.B.

B. WALK-THROUGH INSTRUCTIONS/CASE STUDIES

1. Manual Usage.

For obvious reasons, it is impractical to utilize CBRA manually on very large or complex tasks; therefore, instructions for manual applications are geared to fairly simple, straight forward examples.

a. System X "Shopping List".

(1) Task: Screen the list of potential items against System X modernization objectives and constraints, to eliminate any obvious drop-outs and highlight marginal items/issues which warrant further analysis. Thrust of modernization is on improved capability without extensive new development, with early fielding and at moderate cost.

Candidate Improvements	Benefits/Drawbacks
Crew station (modify)	Human factors, growth potential; reduced commonality.
De-icing system (add)	Adverse weather operations; weight and power penalty.
Auxiliary generator (add)	Safety backup, power source for test/maintenance equipment; space and weight penalty.
Uprated transmission (modify)	Mission performance benefits; MTBF fuel consumption impacts.
Teflon bearings (replace)	Improved RAM; loss of commonality.

Integrated communications package (ICP) (replace)	Saves weight, space & reduces crew workload; not compatible with older, fielded communications equipment.
Doppler (add)	Navigation aid; requires ICP above to accommodate.
Automatic direction finder (replace)	More accurate; loss of commonality.
Night vision system (add)	Round-the-clock operations; weight and space penalty.
Infrared suppressor (replace)	Survivability; weight and power penalty.
Infrared jammer (add)	Survivability; weight and power penalty.
Laser warning device (add)	Survivability; space/location and electro-mangetic problems.

2. Critical Parameters.

Based on the task objective and the candidate characteristics, following are selected:

Mission cpability/performance improvement

Weight/power requirements

Human factors

Survivability

Logistic support

Schedule

3. Evaluation Structure

To keep it simple (bearing in mind this is a screening exercise, not a "final selection"), a vertical structure is used:

System X

- Performance capability
- Weight/power requirements
- Human factors
- Survivability
- Logistic support
- Schedule

4. Cell Weight

Widely different viewpoints may exist concerning the importance of these parameters; therefore, even though only one version is employed in this example, it is advisable to run 2 or 3 variations in actual practice, to reflect anticipated extremes.

System X (100)

Perf Cap	35
Wt/Pwr	15
Human Factors	10
Surv	15
Log Spt	10
Schedule	15

5. Scoring Standards. [1/]

On a scale of 1-10, following yardstick is established:

	1-4	5-7	8-10
Perf Cap (benefit)	Minor	Significant	Highly sig./ Multiple [2/]
Wt/Power (impact)	Major	Moderate	None/improves
Human Factors (benefit)	Minor	Moderate	Substantial
Survivability	Minor	Significant	Major/new [3/]
Logistic Spt	Significant	Moderate	None/improved
Schedule (target)	Pacing item & high risk	Moderate risk	Low risk & nonpacing item

NOTES:

[1/] If warranted, scoring standards can be broken down more specifically; i.e., translating "major" & "moderate" weight penalties into numbers of pounds, schedule variances into numbers of months, etc.

[2/] "Multiple" benefit example = ICP, which permits accommodation of navigation items in addition to its own (direct) benefits.

[3/] "New" means protection not previously provided even in lesser forms.

6. Verify Candidates.

In this example, candidates are already identified via the "shopping list". However, in other cases, candidates are not predetermined and need to be solidified here after critical parameter identification and trial weight allocation, but before actual scoring--to maximize thoroughness and objectivity of evaluation.

7. Scoring:

(a) Raw scores. Using best data available, assign raw scores for each candidate against each critical parameter, in accordance with the pertinent scoring standard.

CW	(.35)	(.15)	(.10)	(.15)	(.10)	(.10)
Candidate	Perf Cap (RS)	Wt/ Power (RS)	Human Factors (RS)	Safety/ Surv- (RS)	Log Spt (RS)	Schedule (RS)
Crew sta.	1	8	9	4	5	6
De-ice	6	6	1	1	5	7
Aug. gen	9	3	2	7	4	8
Uprated Xmn	9	8	5	3	4	6
Teflon brgs	3	6	5	5	8	2
ICP	8	8	9	4	3	5
ADG	6	4	7	2	5	6
NVS	7	2	3	7	5	3
IR supp.	4	4	5	8	5	8
IR jam.	5	3	5	9	3	4
Laser warn.	5	5	5	7	4	6
Doppler	7	4	6	7	6	7

(b) Weighted Scores.

Computed below: (CW x RS = WS)

CW	(.35)		(.15)		(.10)		(.15)		(.10)		(.10)		
Candidate	Perf Cap		Wt/ Power		Human Factors		Safety/ Surv-		Log Spt		Schedule		Total
	(RS)	(WS)	(RS)	(WS)	(RS)	(WS)	(RS)	(WS)	(RS)	(WS)	(RS)	(WS)	(WS)
Crew sta	1	.35	8	1.20	9	.90	4	.60	5	.50	6	.90	4.45
De-ice	6	2.10	6	.90	1	.10	1	.15	5	.50	7	1.05	4.80
Aug. gen	9	3.15	3	.45	2	.20	7	1.05	4	.40	8	1.20	6.45
Uprated Xmn	9	3.15	8	1.20	5	.50	3	.45	4	.40	6	.90	6.60
Teflon brgs	3	1.05	6	.90	5	.50	5	.75	8	.80	2	.30	4.30
ICP	8	2.80	8	1.20	9	.90	4	.60	3	.30	5	.75	6.55
ADG	6	2.10	4	.60	7	.70	2	.30	5	.50	6	.90	5.10
NVS	7	2.45	2	.30	3	.30	7	1.05	5	.50	3	.45	5.05
IR supp.	4	1.40	4	.60	5	.50	8	1.20	5	.50	8	1.20	5.40
IR jam.	5	1.75	3	.45	5	.50	9	1.35	3	.30	4	.60	4.95
Laser warn.	5	1.75	5	.75	5	.50	7	1.05	4	.40	6	.90	4.95
Doppler	7	2.45	4	.60	6	.60	7	1.05	6	.60	7	1.05	6.35

8. Candidate Cost.

For this example, estimated unit acquisition cost is used (development plus procurement cost, divided by the planned number of systems to be modernized), expressed in constant year dollars. If available, other costs (such as O&S) could be included.

Candidate	Cost ($=K)
Crew sta	5.6
De-ice	3.5
Aux. gen	2.9
Uprated Xmn	13.4
Teflon brgs	5.8
ICP	8.1
Doppler	7.4
ADF	5.4
NVS	15.2
IR supp.	5.8
IR jam.	7.6
Laser warn	3.7

9. Cost-Benefit Ratio.

Computed below: (CC - WS = CBR)

Candidate	CC ($=K)	÷	WS	=	CBR
Crew sta.	5.6		4.45		1.26
De-ice	3.5		4.80		.73
Aug. gen	2.9		6.45		.45
Uprated Xmn	13.4		6.60		2.03
Teflon brgs	5.8		4.30		1.35
ICP	8.1		6.55		1.24
Doppler	7.4		6.35		1.17
ADF	5.4		5.10		1.06
NVS	15.2		5.05		3.01
IR supp.	5.8		5.40		1.07
IR jam.	7.6		4.95		1.54
Laser warn.	3.7		4.95		.75

Average CBR = 1.31

(Use as SS)

10. Analysis.

Review of this first-cut CBR "output" leads to several areas of question/need for further analysis.

(a) Since no specific standard CBR is available, and the candidates are widely spread, the average CBR of 1.3 can be used as a standard. Thus, candidates with CBR of approx. 1.3 or less appear to offer promising "bang for bucks", while those with CBR substantially greater than 1.3 deserve further scrutiny. See comparative CBR annotations below:

Candidate	CC ($=K) ÷	WS =	CBR ÷	SS =	Comparative CBR	
Crew sta.	5.6	4.45	1.26	(1.31)	.96	F
De-ice	3.5	4.80	.73	"	.56	F
Aug. gen	2.9	6.45	.45	"	.34	F
Uprated Xmn	13.4	6.60	2.03	"	1.55	U
Teflon brgs	5.8	4.30	1.35	"	1.03	M
ICP	8.1	6.55	1.24	"	.95	F
Doppler	7.4	6.35	1.17	"	.89	F
ADF	5.4	5.10	1.06	"	.81	F
NVS	15.2	5.05	3.01	"	2.30	U
IR supp.	5.8	5.40	1.07	"	.82	F
IR jam.	7.6	4.95	1.54	"	1.18	M
Laser warn.	3.7	4.95	.75	"	.57	F

F = favorable comparison to standard

U = unfavorable comparison to standard

M = marginal

(b) Suggested directions to pursue:

* Have the right critical parameters been selected for the task? Are there omissions/redundancies?

* Do the individual scoring standards reflect proper means of measurement for their respective critical parameters?

* Are there imbalances in the cell weights? For example, do one or two parameters drive the whole outcome--and if so, should they?

* Do the assigned scores properly reflect the candidate benefits/drawbacks? (This is where clear documentation of rationale pays off.)

* Are there interdependencies that were not reflected in the weighting or scoring process? A good cross-check is to group the candidate items into packages--e.g., evaluate items which impact weight/power with those which provide it; those which save space with those which require it--and see if a favorable CBR results from the combinations of related items.

* Are there aspects which would logically be added to the evaluation if information were available? If so, do a quick test with "assumed data" to see how it affects outcome. This may point the way to essential fact finding before proceeding further.

b. "Go-No Go" for Homogeneous Fleet Modernization Request.

(1) Task: Determine whether it is cost-beneficial to update fielded System X assets (in varying configurations) to the fully moderized System X configuration. Outcome (if positive) will be incorporated in justification of proposed conversion program submission.

(2) Critical Parameters. In this instance, the separate configurations themselves become the critical parameters, because the central question is one of delta benefit vs. delta cost to update to the fully moderized standard.

Quantity*	CP
(Was 1000; all have been converted to X1, X2, X3 or X4)	System X = original configuration
300	X1 = X plus weapon subsystem
200	X2 = X1 plus performance package
100	X3 = X2 plus survivability mode
400	X4 = X3 plus fire control & comm/nav package

*For info only.

(3) Evaluation Structure. Layered structure is not pertinent, since each critical parameter is to be compared independently against the fully moderized standard.

(4) Cell Weights. Not applicable--same reason as (3) above.

(5) Scoring Standards. Only one yardstick is needed; 1-10 scale is established by using the original (X) configuration as the "1" mark and the fully modernized (X4) as the "10" mark. X1, X2 and X3 will be measured by comparison against this standard.

(6) Verify Candidates. In this case, candidates are predetermined (synonymous with critical parameters).

(7) Scoring.

(a) Raw score is based on assessment of each candidate's "worth" in comparison to the standard.

Candidate	RS	
X	1	(given)
X1	3	
X2	6	
X3	7	
X4	10	(given)

(b) Since cell weights are not pertinent, weighted score is merely the raw score translated into added (delta) benefit to be derived if modernized to X4 standards. Also, the incremental steps to get from original X to X1, X2, X3 and X4 are shown (purely for reference).

Candidate	RS	WS
X	1	+9
(X to X1)		(+2)
X1	3	+7
(X1 to X2)		(+3)
X2	6	+4
(X2 to X3)		(+1)
X3	7	+3
(X3 to X4)		(+3)
X4	10	+Ø

(8) Candidate Cost. Since development cost is essentially "sunk" (accomplished prior to X4 configuration conversion), and quantities per candidate vary, unit procurement cost of modernization (FY 80 constant dollars) is selected as best available basis for comparison.

Candidate	Cost to Modernize ($=K)
X	1100
(X to X1)	(550)
X1	500
(X1 to X2)	(200)
X2	450
(X2 to X3)	(150)
X3	350
(X3 to X4)	(300)
X4	Ø

(9) Cost-Benefit Ratio.

Candidate	CC	WS	CBR
X	1100	9	122*
(X to X1)	(500)	(2)	(250)
X1	650	7	93
(X1 to X2)	(250)	(3)	(83)
X2	450	4	113
(X2 to X3)	(150)	(1)	(250)
X3	350	3	117
(X3 to X4)	(350)	(3)	(117)
X4	(Same as X, because X4 reflects conversion of original to fully modernized configuration).		

*Standard

(10) Analysis:

(a) Comparison of candidate CBR to the "standard" CBR reveals the following:

Candidate	CBR	Std	Comparative CBR
X/X4	122	122	1.00 "Yardstick"
(X to X1)	(250)	122	(2.05) (Unfavorable)
X1	93	122	.76 Favorable
(X1 to X2)	(83)	122	(.68) (Favorable)
X2	113	122	.93 Favorable
(X2 to X3)	(150)	122	(1.23) (Marginal)
X3	117	122	.96 Favorable
(X3 to X4)	(117)	122	(.96) (Favorable)

(b) Review indicates that some of the incremental configuration steps (shown for reference) were less "cost-beneficial" than the standard, but that all current candidates for modernization do compare favorably to the standard. While favorable/unfavorable comparisons do not necessarily equate to "good buy/bad buy", they do provide a basis for communicating the relative "good buy" to decision makers--by using the known and accepted X4 configuration as a baseline. Thus, having substantiated a rough cost-benefit relationship, additional factors (such as logistic support advantage of a homogeneous fleet) may be introduced to amplify the program request.

2. Automated Usage.

a. The basic process is the same for automated as for manual application; however, much greater scope and depth of evaluation can be accommodated with computer assistance. To this end, the CBRA computer model is designed to be as flexible as possible; a general-purpose tool which can be used in whole or in part for many different types of tasks. The examples presented here are representative only, and are intended to familiarize the user with the automated technique so that it can be readily adapted to "live" needs as they are encountered.

b. The operating instructions in this Guide are keyed to the specific IBM-Fortran IV computer source program provided at Appendix C. However, utilization is by no means limited to IBM/"main frame" type computers. In fact, this is actually a relatively cumbersome/inflexible program model--much greater flexibility/versatility can be obtained from smaller computers designed specifically for personal/interactive use. (One such, ideally suited, is the Apple II with Visi-Calc package; example of CBRA - Apple application is included with IV.E.2.) The sheer diversity and versatility of these computers renders it impractical to discuss specific instructions in this document; but the manuals furnished with each manufacturer's equipment make the "translation" largely self-explanatory once the basic technique is understood.

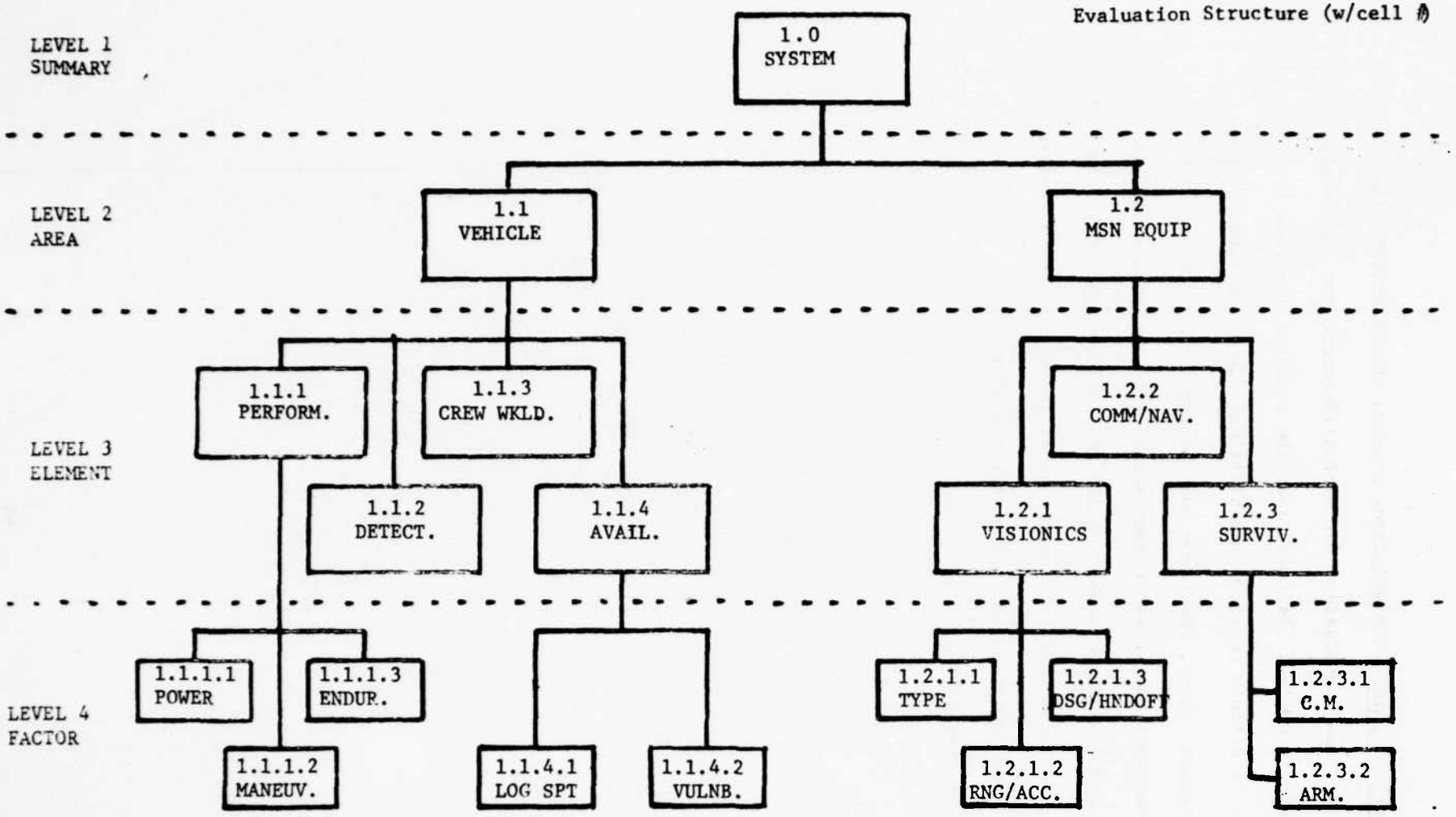
c. Sample Problems.

(1) Task. Assess the relative suitability of two classes of vehicles for performing a common support mission; e.g., serving as a target acquisition & designation medium for offensive weapon systems. Development of a new system specifically designed for the mission is precluded; therefore, adaptation of existing systems must be examined.

(2) Critical parameters. Performance of the target acquisition/designation mission entails required and desired capabilities in the areas of speed/power, endurance, maneuverability, detectability, supportability, velnerability, survivability/self defense, communications & navigation, crew workload, and, of course, the visionics package. These considerations form the critical parameters to be addressed in the evaluation.

(3) Evaluation structure. The critical parameters fall into two basic groups, with interrelationships as illustrated following page.

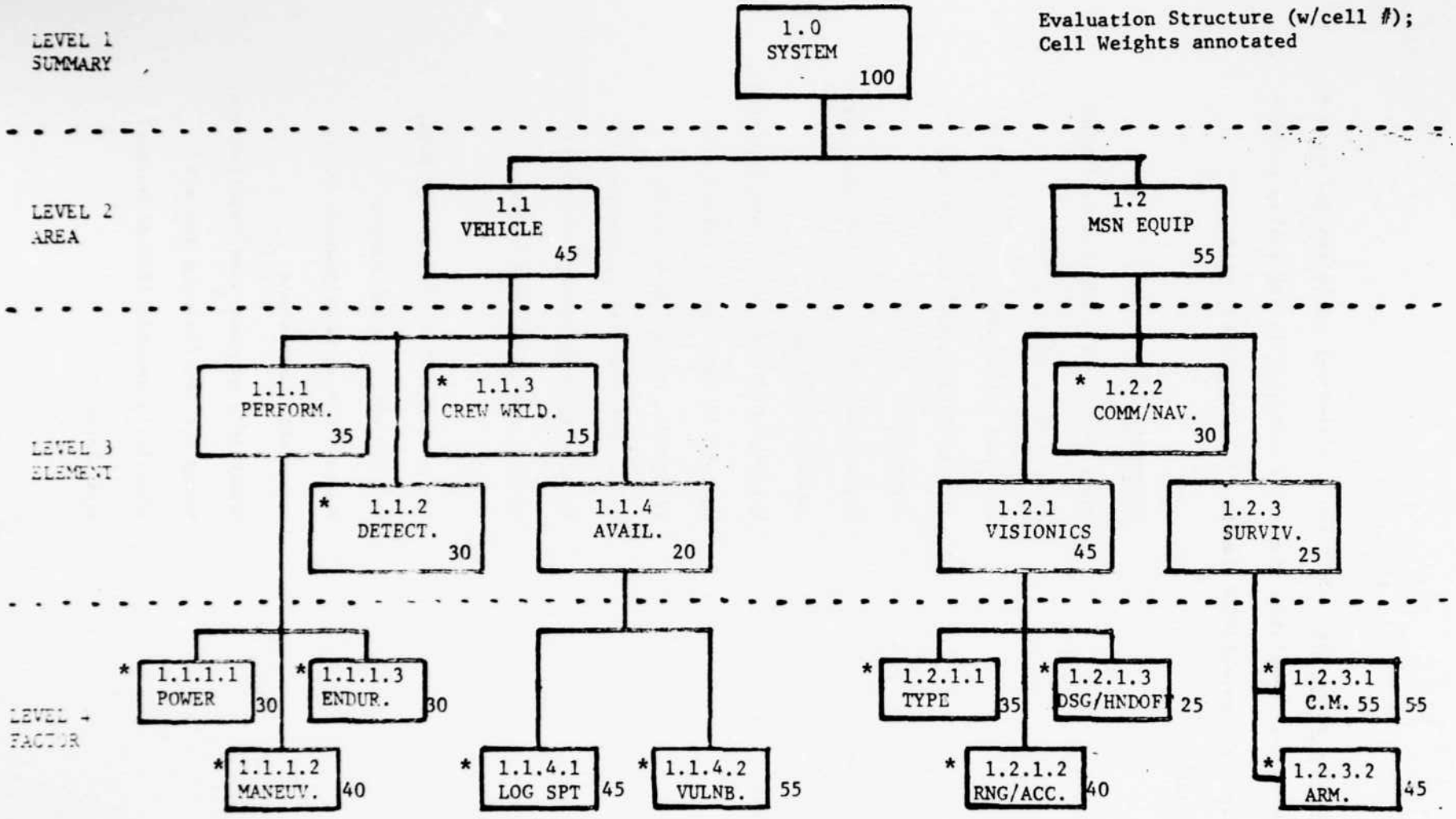
Evaluation Structure (w/cell #)



LEVEL 5
SUBFACTOR N/A

(4) Cell weights. The weighting process should address the areas of greatest contrast among candidates, for such differences are the reason that tradeoff analysis is needed. In this case, the contrast revolves around vehicle size as it affects required capabilities; i.e., the larger-class vehicles have greater power, endurance and "payload" capacity, and the smaller-class vehicles have greater maneuverability, better availability (in the specified method of employment) and are less detectable. Thus, the cell weights must reflect the relative importance of these aspects to isolate tradeoffs and areas requiring in-depth examination/testing.

Illustration following page.


LEVEL 1
SUMMARY
LEVEL 2
AREA
LEVEL 3
ELEMENT
LEVEL 4
FACTOR
LEVEL 5
SUBFACTOR
N/A
Evaluation Structure (w/cell #);
Cell Weights annotated
1.0
SYSTEM
100
1.1
VEHICLE
45
1.2
MSN EQUIP
55
1.1.1
PERFORM.
35
* 1.1.3
CREW WKLD.
15
* 1.2.2
COMM/NAV.
30
* 1.1.2
DETECT.
30
1.1.4
AVAIL.
20
1.2.1
VISIONICS
45
1.2.3
SURVIV.
25
* 1.1.1.1
POWER
30
* 1.1.1.3
ENDUR.
30
* 1.2.1.1
TYPE
35
* 1.2.1.3
DSG/HNDOFF
25
* 1.2.3.1
C.M. 55
55
* 1.1.1.2
MANEUV.
40
* 1.1.4.1
LOG SPT
45
* 1.1.4.2
VULNB.
55
* 1.2.1.2
RNG/ACC.
40
* 1.2.3.2
ARM.
45

(5) Scoring standards. Only the lowest-level cells (marked with *) are assigned raw scores; remaining scores are computed in the rollup process. Following standards are established (scale of 1-10 points), with supporting rationale:

CELL	RATIONALE
1.0 System	Basic vehicle vs. mission equipment capability tradeoff.
1.1 Vehicle	Consider performance, detectability, crew operation, and availability aspects.
1.1.1 Performance	Key aspects are power, endurance and maneuverability.
*1.1.1.1 Power	Vehicle must have sufficient power to operate in anticipated battle environment, enough speed to be compatible with its companion (offensive weapon) systems with full mission equipment installed.

SS	
1-3	Comes within 2% of "required" power ratings and/or speed range.
4-5	Meets minimums requirements with reasonable confidence.
6-7	Moderately exceeds some requirements.
8-10	Meets all requirements and substantially exceeds (10% or better) some aspects.

*1.1.1.2 Maneuverability	Must be able to perform on/over/in the expected battle conditions (terrain, altitudes, temperatures, winds) safely and easily enough to preclude prolonged exposure to the enemy while keeping pace with companion weapon systems.
SS	
1-3	Performs most required maneuvers, but with significant payload/workload limitations/penalties.
4-5	Performs maneuvers but with little or no margin, either for vehicle or crew.
6-7	Performs responsively and with reasonable margin in one or more aspects.
8-10	Significantly exceeds minimums in several aspects.
*1.1.1.3 Endurance	Must be able to perform continuous mission operations without scheduled out-of-service time, for 3 hours; 5 desired.
SS	
1-3	Projected to meet 3 hr. requirement except with max. payload and/or in extreme environmental conditions.
4-5	Fully meets requirement.
6-7	Moderately exceeds requirement.
8-10	Significantly exceeds required/meets desired standards.

*1.1.2 Detectability		Vehicle must be able to "hide" well enough enroute & during battle so that exposure to enemy weapons does not permit them to fix location and fire while in kill range. Includes direct visual, radar, and IR means of detection.
	SS	
	1-3	Detectable for 3-5 seconds longer than specified min. guidelines in some modes/conditions.
	4-5	Meets established minimums, overall conditions.
	6-7	Meets all and moderately exceeds some minimums.
	8-10	Not detectable long enough to be successfully acquired at any point within kill range.

*1.1.3 Crew Workload	Overall system should be operable by crew of two, with adequate vehicle safety margin while performing mission maneuvers and employing mission equipment.
SS	
1-3	Unsatisfactory to marginal.
4-5	Adequate except during intense battle & adverse visibility conditions.
6-7	Potentially adequate with extensive training and/or additional skills.
8-10	Fully adequate with normal training & skills.
1.1.4 Availability	Consider impacts of logistic support and vulnerability upon overall readiness.
*1.1.4.1 Logistic Support	NORS/NOM/RAM standards equivalent to System X are desired; at minimum, characteristics of the existing Class A & B Systems should not be degraded by the planned modification/conversion.
SS	
1-3	Risk of minor degradation.
4-5	Equivalent to status-quo systems.
6-7	Improved over status quo but less than System X.
8-10	Roughly comparable to System X.

*1.1.4.2 Vulnerability	Consideration of expected damage/loss during normal mission operations, whether resulting from enemy fire, environmental conditions, handling problems, or other causes.
SS	
1-3	Significantly more vulnerable than System X.
4-5	More vulnerable than System X in some aspects/conditions.
6-7	Roughly equivalent to System X.
8-10	Less vulnerable than System X.
1.2 Mission Equipment	Consider the visionics, communications, navigation, and survivability equipment needs.
1.2.1. Visionics	Addresses type of acquisition subsystem range & accuracy, and designation capabilities.
*1.2.1.1 Type	Day/night/obscurants/all season capability is desired.
SS	
1-3	Day only.
4-5	Basic day/night.
6-7	Day/night plus certain obscurants.
8-10	Day/night/obscurant/all weather subsystem.

*1.2.1.3 Range & Accuracy — To achieve safe stand off ranges, following detection/recognition assessment pertains.

SS	Detect (meters)	Recognize
1-3	1800 day/1200 night	75-80%
4-5	2200 day/1800 night	80-85%
6-7	3000 day/2200 night	85-90%
8-10	4000 day/3000 night	90-95%

*1.2.1.3 Designation/Handoff — Ability to designate targets for sister weapon systems, throughout the above ranges, plus (desired) capability to automatically hand off acquired targets to other designation systems.

SS	
1-3	Designation with approx. 80% success/ accuracy; no auto handoff.
4-5	Approx. 85% designation capability; still no auto handoff.
6-7	Approx. 90% designation success; no auto handoff.
8-10	Designation 90% or better, auto handoff capability.

*1.2.2 Communications & Navigation	"Full suit" of third-generation equipment desired (compatible with System X).
SS	
1-3	Can accommodate only minimum essential items with existing space/weight/power allowance.
4-5	Can accommodate most of the desired items, but entails payload tradeoffs/ human factors penalties.
6-7	Can accommodate the full suit with moderate human factors impacts.
8-10	Full System X compatibility with reasonable crew workload.
1.2.3 Survivability	Considers ability to accommodate IR suppression/countermeasures equipment and also potential for self-defense armament.

*1.2.3.1 CM	Desired features include radar warning, IR suppression, IR jamming, laser warning indicator, NBC device.
SS	
1-3	Can accommodate only radar warning and IR suppression items.
4-5	Can accommodate above plus IR jammer.
6-7	Can accommodate all except NBC device, but with some performance/ payload impacts.
8-10	Can accommodate desired items with little to no impacts.
*1.2.3.2 Armament	Need existing space/weight/power allowance for first-generation self defense subsystem; growth potential for second generation (multiple-type) self defense subsystem is desired.
SS	
1-3	Existing SWPA (1st gen) with mission equipment tradeoffs and in standard-day conditions.
4-5	Existing SWPA (1st gen) with full mission equip.-min. performance tradeoffs, standard day.
6-7	Existing SWPA (1st gen.) to include extreme conditions.
8-10	Existing SWPA for 1st gen equipment plus desired growth potential.

(6) Verify candidates. At this point, the "candidates" are the two classes of system (A & B); however, based on results of this exercise, similar structure may be used to compare specific candidates as appropriate.

(7) Scoring. Based on best information available, assign scores based on each candidate's expected rating for each critical parameter against the established scoring standard. (Document sources & rationale.) See attached sheets for sample System A & B scoring input.

Automated CBRA

EVALUATION STRUCTURE WORKSHEET

Level:	Summary 1	Area 2	Element 3	Factor 4	Sub-Factor 5	Raw Scores Sys A	Raw Scores Sys B
	1.0 Summary						
Ref #							
1		1.1 Vehicle					
2			1.1.1 Performance				
3				*1.1.1.1 Power		80	20
4				*1.1.1.2 Maneuverability		45	55
5				*1.1.1.3 Endurance		70	30
6			*1.1.2 Detectability			20	80
7			*1.1.3 Crew Workload			35	65
8			1.1.4 Availability				
9				*1.1.4.1 Logistic Support		40	60
10				*1.1.4.2 Vulnerability		15	85
11		1.2 Mission Equipment					
12			1.2.1 Visionics Pkg.				
13				*1.2.1.1 Type Subsystem		80	20
14				*1.2.1.2 Range/Accuracy		70	30
15				*1.2.1.3 Designation/Handoff		70	30

Automated CBRA

EVALUATION STRUCTURE WORKSHEET

Level:	Summary 1	Area 2	Element 3	Factor 4	Sub-Factor 5	Raw Scores Sys A	Raw Scores Sys B
16			*1.2.2 Communications/ Navigation			70	30
17			*1.2.3 Survivability				
18				*1.2.3.1 Countermeasures		75	25
19				*1.2.3.2 Armament		75	25

(8) At this point in the case exercise (or earlier, if desired) it is advisable to work at the computer terminal. Therefore, subsequent instructions for CBRA computations are provided in the DETAILED OPERATING INSTRUCTIONS, attached. These instructions are designed to lead you through all basic program steps, as outlined and numbered on CBRA "Road Map" (flow chart), included with Quick Reference Summary at IV.C.

AUTOMATED CBRA - DETAILED INSTRUCTIONS

(Computer Operation)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
	Note: Circled numbers are keyed to the CBRA "Road Map" (flow chart) included with Quick Reference Summary, next section (IV.C).	
①	Note: Access instructions are tailored to the IBM 360/65 computer with AGILE typewriter terminal. For other equipment, follow specific local instructions.	1. Access the computer: Turn the AGILE typewriter ON; Set Gandalf box to 30 and switch to READY; Press following top row keys ON: (lighted): RESET, ON LINE, ESC, ALL CAPS; All other top row keys should be OFF (unlighted).
②	• LOGON	2. Logon and activate CBRA program.
	IKJ56700A ENTER USER ID -	Note: Carriage return (C/R) is used at the completion of every entry, to signal the computer to proceed. Do not press C/R more than once for any entry.
	• JEHSDGF	
	ENTER PASSWORD FOR JEHSDGF	Note: • Denotes input by the user; all other lines are provided by the computer.
	• ●●●●●●●●	Blacked out spaces provide password protection.
	JEHSDGF LOGON IN PROGRESS AT 14:44:54 ON DECEMBER 15, 1980	
	WELCOME TO THE MIDWEST S&E TIME SHARING SYSTEM	
	PLEASE PATIENTLY AWAIT "READY"	(Pause)
	READY	
	• EXEC CBRA	(Pause)
	PROGRAM CBRA IS NOW LOADED AND READY	

(Computer Operation)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
(3)	DO YOU WANT TO USE A FILE DATA SET, YES OR NO?	
	• NO	Obviously, on firt-time use, no data is yet in file.
(5)	ENTER THE NUMBER OF LEVELS AND CELLS PER LEVEL	
	LVL C/L ---*---* • 4 3	This entry should be based on the maximum number of vertical levels and horizontal cells within any cell block of the evaluation structure (limit = 9x9).
	YOU WILL BE PROMPTED FOR EACH LINE OF INPUT. ENTER ALPHANUMERICS AND NUMBERS ONLY UNDER THE DASH FIELDS. NUMBERS MUST BE RIGHT-JUSTIFIED (EXCEPT FOR CELL #).	Omit decimals when entering cell #.
	IF YOU MAKE A MISTAKE, GO ON AND FINISH ENTERING DATA. YOU WILL BE GIVEN AN OPPORTUNITY TO EDIT THE INPUT DATA SET BEFORE ROLL-UP BEGINS.	
	ENTER "STORE" UNDER CELL NAME TO STORE WHAT YOU HAVE AND TERMINATE THE RUN.	This is a safety/panic button, provided to keep from losing all input in case of interruption before you finish. Can be used at any point during data entry/edit processes.
	PRESS "RETURN" TO END ENTRIES.	
	DO NOT ENTER LEVEL 1 DATA - YOU WILL BE PROMPTED FOR IT LATER.	"Level 1" means cell #1.0, system summary.
(6)	CELL # CELL NAME SCOR WT --------*----------*---*---* • 11 VEHICLE 45	This is the header provided by the computer for <u>each</u> cell to be entered. Start with Level 2 data as shown.
	CELL # CELL NAME SCOR WT --------*----------*---*---* • 111 PERFORMANCE 35	<u>Note</u>: If you detect a mistake before completing a line of input, just backspace and strike over to make corrections. However, once you've finished the line and hit C/R, wait for the edit routine to make corrections.

(Computer Operation)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION

Cont'd

```
CELL #    CELL NAME          SCOR  WT
--------*------------------*---*---*
• 1111    *POWER*                  30

CELL #    CELL NAME          SCOR  WT
--------*------------------*---*---*
• 1112    *MANEUVERBLTY*           40

CELL #    CELL NAME          SCOR  WT
--------*------------------*---*---*
• 1113    *ENDURANCE*              20

CELL #    CELL NAME          SCOR  WT
--------*------------------*---*---*
• 112     *DETECTABILITY*          30

CELL #    CELL NAME          SCOR  WT
--------*------------------*---*---*
• 113     *CREW WKLOAD*            15

CELL #    CELL NAME          SCOR  WT
--------*------------------*---*---*
• 114     AVAILABILITY             20

CELL #    CELL NAME          SCOR  WT
--------*------------------*---*---*
• 1141    *LOG SUPPORT*            45

CELL #    CELL NAME          SCOR  WT
--------*------------------*---*---*
• 1142    *VULNERABILITY*          55
```

Note: Cell weights, whether dummy or real, should be entered during this stage to permit computer to perform edit and rollup functions. (It also permits the user to review effects of weights for possible imbalances within the overall structure.)

Scores may be entered now, if desired, or left blank until later iterations.

Note: *Asterisks* have been used here to facilitate the location of raw score input levels, in later operations. Strictly optional; no effect on the program or process.

(Computer Operation)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
(7) (14)	CELL # CELL NAME SCOR WT --------*----------*---*---* • STORE	At this point, you suspect you may get interrupted, so decide to store data as a precaution.
	IN WHICH DATA SET DO YOU WANT DATA STORED? VALID SETS ARE 1, 2, 3, or 4. ?	
(15)	• 1	(Pause while data is being stored.)
	DATA HAS BEEN SAVED IN DATA SET 1.	
(16)	DO YOU WISH TO CONTINUE WITH EDITING THIS DATA, YES OR NO?	
	• YES	
(10)	DO YOU WISH TO CHANGE NUMBER OF CELLS PER LEVEL, YES OR NO?	In checking back, you discover that your ES size should be 4x4 rather than 4x3 as originally entered. If you had not detected this until later, computer would "flag" it for you during rollup and permit you to expand the levels at that point.
	• YES	
(11)	LVL C/L ---*---* • 4 4	
(12)	CODES FOR CHANGES ARE: A - ADD OR CHANGE AN ENTIRE CELL LINE. W - CHANGE WEIGHT FOR CELL. V - CHANGE SCORE FOR CELL. D - DELETE CELL. P - PRINT DATA SET FOR REFERENCE S - SAVE DATA AS IS (OPTIONAL JUMP OUT) C/R - END CHANGES AND CONTINUE.	
(17)	ENTER APPROPRIATE CODE FROM ABOVE LIST • P	You choose to review your input so far.

FLOW CHART REF

COMPUTER READ-OUT

DISCUSSION

(9) DATA SET STRUCTURE: 10 CELLS, 4 LEVELS, AND 4 CELLS PER LEVEL

INDEX	CELL #	CELL NAME	SCORE	WEIGHT
1	11000000	VEHICLE	0	45
2	11100000	PERFORMANCE	0	35
3	11110000	*POWER*	0	30
4	11120000	*MANEUVERBLTY*	0	40
5	11130000	*ENDURANCE*	0	20
6	11200000	*DETECTABILITY*	0	30
7	11300000	*CREW WKLOAD*	0	15
8	11400000	AVAILABILITY	0	20
9	11410000	*LOG SUPPORT*	0	45
10	11420000	*VULNERABILITY*	0	55

Note: Line index # provided for ease of reference in the edit process.

(10) DO YOU WISH TO CHANGE NUMBER OF CELLS PER LEVEL, YES OR NO?

• NO

(12) CODES FOR CHANGES ARE:
A - ADD OR CHANGE AN ENTIRE CELL LINE.
W - CHANGE WEIGHT FOR CELL.
V - CHANGE SCORE FOR CELL.
D - DELETE CELL.
P - PRINT DATA SET FOR REFERENCE
S - SAVE DATA AS IS (OPTIONAL JUMP OUT)
C/R - END CHANGES AND CONTINUE.

(17) ENTER APPROPRIATE CODE FROM ABOVE LIST

• A

You may finish entering cell data by using the "add cell" edit code. Begin with next index #.

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
Cont'd	ENTER INDEX # OF CELL TO CHANGE OR ADD ?	
•	11	
	CELL # CELL NAME SCOR WT --------*----------*---*---* • 121 VISIONICS PKG 45	
	ENTER APPROPRIATE CODE FROM ABOVE LIST	
•	@211 (corrected to "A")	
	ENTER INDEX # OF CELL TO CHANGE OR ADD ?	
•	12	
	CELL # CELL NAME SCOR WT --------*----------*---*---* • 1211 *TYPE SUBSYSTEM* 35	
	ENTER APPROPRIATE CODE FROM ABOVE LIST	
•	A	
	ENTER INDEX # OF CELL TO CHANGE OR ADD ?	
•	13	
	CELL # CELL NAME SCOR WT --------*----------*---*---* • 1212 *RANGE/ACCURACY* 40	
	ENTER APPROPRIATE CODE FROM ABOVE LIST	
•	A	

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
Cont'd	ENTER INDEX # OF CELL TO CHANGE OR ADD ? • 14	
	CELL # CELL NAME SCOR WT --------*----------*---*---* • 1213 *DSGN/HANDOFF* 25	
	ENTER APPROPRIATE CODE FROM ABOVE LIST • A	
	ENTER INDEX # OF CELL TO CHANGE OR ADD ?	
	• 15	
	CELL # CELL NAME SCOR WT --------*----------*---*---* • 122 *COMM/NAV* 30	
	ENTER APPROPRIATE CODE FROM ABOVE LIST • A	
	ENTER INDEX # OF CELL TO CHANGE OR ADD ? • 16	
	CELL # CELL NAME SCOR WT --------*----------*---*---* • 123 SURVIVABILITY 25	
	ENTER APPROPRIATE CODE FROM ABOVE LIST • A	

(Computer Operation)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
	ENTER INDEX # OF CELL TO CHANGE OR ADD ?	
•	17	
	CELL # CELL NAME SCOR WT --------*----------*---*---*	
•	1231 *COUNTERMEAS* 55	
	ENTER APPROPRIATE CODE FROM ABOVE LIST	
•	A	
	ENTER INDEX # OF CELL TO CHANGE OR ADD ?	
•	18	
	CELL # CELL NAME SCOR WT --------*----------*---*---*	
•	1232 *ARMAMENT 45	
(8) (18)	ENTER APPROPRIATE CODE FROM ABOVE LIST	(Hit C/R to signal completion.)
(20)	ROLLUP COMPUTATIONS ARE IN PROGRESS.	(Pause)

(Computer Operation)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION

(21) SUM OF CELL WEIGHTS DO NOT ADD TO 100 - A LISTING FOLLOWS

(22)

INDEX	CELL #	CELL NAME	SCORE	WEIGHT
3	11110000	*POWER*	0	30
4	11120000	*MANEUVERBLTY*	0	40
5	11130000	*ENDURANCE*	0	20

ENTER: W - TO CHANGE WEIGHT,
E - TO RETURN TO EDIT FOR MORE CHANGES TO DATA SET,
C/R - TO CONTINUE.
(24)

• W

ENTER INDEX # AND CORRECT CELL WEIGHT
---*---*
• 5 30

You find that CW for "Endurance" should have been 30 (check against your basic worksheet/wiring diagram).

ENTER: W - TO CHANGE WEIGHT,
E - TO RETURN TO EDIT FOR MORE CHANGES TO DATA SET,
C/R - TO CONTINUE.
(23)

At this point, you decide to recheck your entire data set; select edit option.

• E

(10) DO YOU WISH TO CHANGE NUMBER OF CELLS PER LEVEL, YES OR NO?

• NO

(12) CODES FOR CHANGES ARE:

A - ADD OR CHANGE AN ENTIRE CELL LINE
W - CHANGE WEIGHT FOR CELL
S - CHANGE SCORE FOR CELL
D - DELETE CELL
P - PRINT DATA SET FOR REFERENCE
S - SAVE DATA AS IS (OPTIONAL JUMP OUT)
C/R - END CHANGES AND CONTINUE

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION

(17) ENTER APPROPRIATE CODE FROM ABOVE LIST

● P

(9) DATA SET STRUCTURE: 18 CELLS, 4 LEVELS, AND 4 CELLS PER LEVEL

INDEX	CELL #	CELL NAME	SCORE	WEIGHT
1	11000000	VEHICLE	0	45
2	11100000	PERFORMANCE	0	35
3	11110000	*POWER*	0	30
4	11120000	*MANEUVERBLTY*	0	40
5	11130000	*ENDURANCE*	0	30
6	11200000	*DETECTABILITY*	0	30
7	11300000	*CREW WKLOAD*	0	15
8	11400000	AVAILABILITY	0	20
9	11410000	*LOG SUPPORT*	0	45
10	11420000	*VULNERABILITY*	0	55
11	12100000	VISIONICS PKG	0	45
12	12110000	*TYPE SUBSYSTEM*	0	35
13	12120000	*RANGE/ACCURACY*	0	40
14	12130000	*DSGN/HANDOFF*	0	25
15	12200000	*COMM/NAV*	0	30
16	12300000	SURVIVABILITY	0	25
17	12310000	*COUNTERMEAS*	0	55
18	12320000	*ARMAMENT	0	45

(10) DO YOU WISH TO CHANGE NUMBER OF CELLS PER LEVEL, YES OR NO?

● NO

AUTOMATED CBRA - DETAILED INSTRUCTIONS

(Computer Operation)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION

(12) CODES FOR CHANGES ARE:
A - ADD OR CHANGE AN ENTIRE CELL LINE.
W - CHANGE WEIGHT FOR CELL.
V - CHANGE SCORE FOR CELL.
D - DELETE CELL.
P - PRINT DATA SET FOR REFERENCE
S - SAVE DATA AS IS (OPTIONAL JUMP OUT)
C/R - END CHANGES AND CONTINUE.

Note: Cells can be added in any order, so long as cell # identifies its position within the overall structure. Same for cell deletion. Computer will add (delete) cell in the sequence entered (deleted) during input, but will automatically position properly during final output.

ENTER APPROPRIATE CODE FROM ABOVE LIST

(18)

Looks ok, so hit C/R.

(20) ROLLUP COMPUTATIONS ARE IN PROGRESS.

(21) CANNOT FIND LEVEL 2 CELL FOR ROLL-UP - MISSING CELL NUMBER IS 12000000

(22) ENTER CELL DATA LINE, WEIGHT DEFAULTS TO 100. (If no weight is assigned by user.)

```
 CELL NAME       SCOR  WT
----------------*---*---*
```

(25) • MISSION EQUIP 55

(26) ENTER CELL NAME FOR LEVEL 1

Sure enough, Cell #1.2 was omitted.
Rollup is now satisfied.

```
----------------*
```

• SYSTEM $1

(27) DO YOU WANT TO SEE THE FINAL DATA SET, YES OR NO?

• NO

(29) DO YOU WANT TO REPLACE AN OLD DATA SET WITH THIS ONE, YES OR NO?

• YES

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
(30)	IN WHICH DATA SET DO YOU WANT DATA STORED? VALID SETS ARE 1, 2, 3, OR 4. ?	
	● 1	(Pause while data is stored)
(31)	DO YOU WANT TO STORE THIS DATA SET IN ANOTHER FILE, YES OR NO?	Since you plan to run two versions of cell weights, for both systems (sensitivity analysis), the simple approach is to store the structure with Version #1 weights in two files.
	● YES	
(30)	IN WHICH DATA SET DO YOU WANT DATA STORED? VALID SETS ARE 1, 2, 3, OR 4.	
	● 3	
(31)	DO YOU WANT TO STORE THIS DATA SET IN ANOTHER FILE, YES OR NO?	(Up to 4 are possible)
	● NO	
	FOR PROGRAM OUTPUT, ADVANCE PAPER TO CLEAN PAGE, 3 LINES FROM TOP; WHEN READY, PRESS "RETURN" TO CONTINUE.	

(Computer Operation)

FLOW CHART REF

(32)

COMPUTER READ-OUT

DISCUSSION

LEVEL	CELL NAME	SCORE	WEIGHT	SYSTEM WEIGHT
10000000	SYSTEM A-1	0	100.	1.0000
11000000	VEHICLE	0	45.	0.4500
11100000	PERFORMANCE	0	35.	0.1575
11110000	*POWER*	0	30.	0.0472
11120000	*MANEUVERABLTY*	0	40.	0.0630
11130000	*ENDURANCE*	0	30.	0.0472
11200000	*DETECTABILITY*	0	30.	0.1350
11300000	*CREW WKLOAD*	0	15.	0.0675
11400000	AVAILABILITY	0	20.	0.0900
11410000	*LOG SUPPORT*	0	45.	0.0405
11420000	*VULNERABLTY*	0	55.	0.0495
12000000	MISSION EQUIP	0	55.	0.5500
12100000	VISIONICS PKG	0	45.	0.2475
12110000	*TYPE SUBSYSTEM*	0	35.	0.0866
12120000	*RANGE/ACCUR*	0	40.	0.0990
12130000	*DSGN/HANDOFF*	0	25.	0.0619
12200000	*COMM/NAV*	0	30.	0.1650
12300000	SURVIVABILITY	0	25.	0.1375
12310000	*COUNTERMEASURE*	0	55.	0.0756
12320000	*ARMAMENT*	0	45.	0.0619

This is an annotation as to each individual cell's weight-contribution to the total system weight (overall outcome). Useful in checking for weight imbalances and for identifying needed sensitivity analyses.

(33)

DO YOU WISH TO MAKE ANOTHER RUN, YES OR NO?

- YES

AUTOMATED CBRA - DETAILED INSTRUCTIONS

(Computer Operation)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION

Note: Since you have walked through the basic process once, complete instructions will not be repeated in remainder of this section. Rather, the options/steps NOT "exercised" in preceding example will be explored and illustrated without retracing the steps before and after the ones being examined. If further clarification is needed, refer to the "Road Map".

---

③ DO YOU WANT TO USE A FILE DATA SET, YES OR NO?

To incorporate trial scores, first call up an existing file; then input scores via edit routine.

- YES

④ ENTER FILE NUMBER, VALID NUMBERS ARE 1, 2, 3, OR 4.
?

- 1

YOUR DATA SET (NUMBER 1) WAS READ INTO THE COMPUTER AS FOLLOWS:

DATA SET STRUCTURE: 19 CELLS, 4 LEVELS, and 4 CELLS PER LEVEL

(continued next page)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION

(9)

INDEX	CELL #	CELL NAME	SCORE	WEIGHT
1	11000000	VEHICLE	0	45
2	11100000	PERFORMANCE	0	35
3	11110000	*POWER*	0	30
4	11120000	*MANEUVERBLTY*	0	40
5	11130000	*ENDURANCE*	0	30
6	11200000	*DETECTABILITY*	0	30
7	11300000	*CREW WKLOAD*	0	15
8	11400000	AVAILABILITY	0	20
9	11410000	*LOG SUPPORT*	0	45
10	11420000	*VULNERABILITY*	0	55
11	12100000	VISIONICS PKG	0	45
12	12110000	*TYPE SUBSYSTEM*	0	35
13	12120000	*RANGE/ACCURACY*	0	40
14	12130000	*DSGN/HANDOFF*	0	25
15	12200000	*COMM/NAV*	0	30
16	12300000	SURVIVABILITY	0	25
17	12310000	*COUNTERMEAS*	0	55
18	12320000	*ARMAMENT	0	45
19	12000000	MISSION EQUIP	0	55

(10) DO YOU WISH TO CHANGE NUMBER OF CELLS PER LEVEL, YES OR NO?

● NO

(12) CODES FOR CHANGES ARE:
A - ADD OR CHANGE AN ENTIRE CELL LINE.
W - CHANGE WEIGHT FOR CELL.
V - CHANGE SCORE FOR CELL.
D - DELETE CELL.
P - PRINT DATA SET FOR REFERENCE
S - SAVE DATA AS IS (OPTIONAL JUMP OUT)
C/R - END CHANGES AND CONTINUE.

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
(17)	ENTER APPROPRIATE CODE FROM ABOVE LIST U	Remember: Only RS input cells need to have scores entered (cells that were *flagged* during ES input process). For desired scores, refer back to your original ES worksheet. These are for System A.
	ENTER INDEX # AND CORRECT SCORE ---*---* 3 80	
	ENTER APPROPRIATE CODE FROM ABOVE LIST U	
	ENTER INDEX # AND CORRECT SCORE ---*---* 4 45	
	ENTER APPROPRIATE CODE FROM ABOVE LIST U	
	ENTER INDEX # AND CORRECT SCORE ---*---* 5 70	
	ENTER APPROPRIATE CODE FROM ABOVE LIST U	
	ENTER INDEX # AND CORRECT SCORE ---*---* 6 20	
	ENTER APPROPRIATE CODE FROM ABOVE LIST U	
	ENTER INDEX # AND CORRECT SCORE ---*---*	

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
Cont'd	ENTER APPROPRIATE CODE FROM ABOVE LIST U ENTER INDEX * AND CORRECT SCORE ---*---* 9 40 ENTER APPROPRIATE CODE FROM ABOVE LIST U ENTER INDEX * AND CORRECT SCORE ---*---* 10 15 ENTER APPROPRIATE CODE FROM ABOVE LIST U ENTER INDEX * AND CORRECT SCORE ---*---* 12 80 ENTER APPROPRIATE CODE FROM ABOVE LIST U ENTER INDEX * AND CORRECT SCORE ---*---* 13 70 ENTER APPROPRIATE CODE FROM ABOVE LIST U ENTER INDEX * AND CORRECT SCORE ---*---* 14 70	

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
	ENTER APPROPRIATE CODE FROM ABOVE LIST	
	• U	
	ENTER INDEX # AND CORRECT SCORE	
	---*---*	
	• 15 70	
	ENTER APPROPRIATE CODE FROM ABOVE LIST	
	• U	
	ENTER INDEX # AND CORRECT SCORE	
	---*---*	
	• 17 75	
	ENTER APPROPRIATE CODE FROM ABOVE LIST	
	• U	
	ENTER INDEX # AND CORRECT SCORE	
	---*---*	
	• 18 75	
	ENTER APPROPRIATE CODE FROM ABOVE LIST	
		(Hit C/R to continue)
(20) (26)	ROLLUP COMPUTATIONS ARE IN PROGRESS. ENTER CELL NAME FOR LEVEL 1	
	----------*-	
	• SYSTEM A-1	
(27)	DO YOU WANT TO SEE THE FINAL DATA SET, YES OR NO?	
	• YES	

FLOW CHART REF | COMPUTER READ-OUT | DISCUSSION

(28)

```
DATA SET STRUCTURE:  20 CELLS, 4 LEVELS, AND 4 CELLS PER LEVEL

INDEX  CELL #      CELL NAME          SCORE   WEIGHT

  1   11000000   VEHICLE              39       45
  2   11100000   PERFORMANCE          63       35
  3   11110000   *POWER*              80       30
  4   11120000   *MANEUVERBLTY*       45       40
  5   11130000   *ENDURANCE*          70       30
  6   11200000   *DETECTABILITY*      20       30
  7   11300000   *CREW WKLOAD*        35       15
  8   11400000   AVAILABILITY         26       20
  9   11410000   *LOG SUPPORT*        40       45
 10   11420000   *VULNERABILITY*      15       55
 11   12100000   VISIONICS PKG        74       45
 12   12110000   *TYPE SUBSYSTEM*     80       35
 13   12120000   *RANGE/ACCURACY*     70       40
 14   12130000   *DSGN/HANDOFF*       70       25
 15   12200000   *COMM/NAV*           70       30
 16   12300000   SURVIVABILITY        75       25
 17   12310000   *COUNTERMEAS*        75       55
 18   12320000   *ARMAMENT            75       45
 19   12000000   MISSION EQUIP        73       55
 20   10000000   SYSTEM A-1           58      100
```

(29)

```
 DO YOU WANT TO REPLACE AN OLD DATA SET WITH THIS ONE, YES OR NO?
• YES
```

(30)

```
IN WHICH DATA SET DO YOU WANT DATA STORED?  VALID SETS ARE 1, 2, 3, OR 4.
?
• 2
```

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION

(32)

FOR PROGRAM OUTPUT, ADVANCE PAPER TO CLEAN PAGE, 3 LINES FROM TOP WHEN READY,
PRESS 'RETURN' TO CONTINUE.

LEVEL	CELL NAME	SCORE	WEIGHT	SYSTEM WEIGHT
10000000	SYSTEM A-1	58	100.	1.0000
11000000	VEHICLE	39	45.	0.4500
11100000	PERFORMANCE	63	35.	0.1575
11110000	%POWER%	80	30.	0.0472
11120000	%MANEUVERBLTY%	45	40.	0.0630
11130000	%ENDURANCE%	70	30.	0.0472
11200000	%DETECTABILITY%	20	30.	0.1350
11300000	%CREW WKLOAD%	35	15.	0.0675
11400000	AVAILABILITY	25	20.	0.0900
11410000	%LOG SUPPORT%	40	45.	0.0405
11420000	%VULNERABILITY%	15	55.	0.0495
12000000	MISSION EQUIP	73	55.	0.5500
12100000	VISIONICS PKG	74	45.	0.2475
12110000	%TYPE SUBSYSTEM%	80	35.	0.0866
12120000	%RANGE/ACCURACY%	70	40.	0.0990
12130000	%DSGN/HANDOFF%	70	25.	0.0619
12200000	%COMM/NAV%	70	30.	0.1650
12300000	SURVIVABILITY	75	25.	0.1375
12310000	%COUNTERMEAS%	75	55.	0.0756
12320000	%ARMAMENT	75	45.	0.0619

DO YOU WISH TO MAKE ANOTHER RUN, YES OR NO?
YES

By inclusion of scores, final output fully shows the effects of weighting upon a given candidate assessment.

AUTOMATED CBRA - DETAILED INSTRUCTIONS

(Computer Operation)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
(13)		To "save" during the edit process, type "S" code.
(14)	• S	
(15)	IN WHICH DATA SET DO YOU WANT DATA STORED? VALID SETS ARE 1, 2, 3, OR 4. ?	
	• 3	(Pause)
	DATA HAS BEEN SAVED IN DATA SET 3.	
(16)	DO YOU WISH TO CONTINUE WITH EDITING THIS DATA, YES OR NO?	This gives you the option of continuing to work the data, or jumping out of the program entirely.
	• NO	
(33)	DO YOU WISH TO MAKE ANOTHER RUN, YES OR NO?	
	• YES	
(3)	DO YOU WISH TO USE A FILE DATA SET, YES OR NO?	
	• YES	
(4)	ENTER FILE NUMBER, VALID NUMBERS ARE 1, 2, 3, OR 4. ?	
	• 3	
	WARNING: THIS DATA SET WAS PREVIOUSLY STORED PRIOR TO BEING CHECKED.	When data is stored prior to rollup, this warning flag is provided when data is recalled for later use.
	YOUR DATA SET (NUMBER 3) WAS READ INTO THE COMPUTER AS FOLLOWS:	
	DATA SET STRUCTURE: 19 CELLS, 4 LEVELS, AND 4 CELLS PER LEVEL	
	(Etc.)	

AUTOMATED CBRA - DETAILED INSTRUCTIONS

(Computer Operation)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION
(19)	P	To review revised data set during edit process, select code "P" (instead of C/R to continue to rollup) when known changes are complete.

(9) DATA SET STRUCTURE: 19 CELLS, 4 LEVELS, AND 4 CELLS PER LEVEL

INDEX	CELL #	CELL NAME	SCORE	WEIGHT
1	11000000	VEHICLE	0	55
2	11100000	PERFORMANCE	0	25
3	11110000	*POWER*	0	30
4	11120000	*MANEUVERBLTY*	0	40
5	11130000	*ENDURANCE*	0	30
6	11200000	*DETECTABILITY*	0	30
7	11300000	*CREW WKLOAD*	0	20
8	11400000	AVAILABILITY	0	20
9	11410000	*LOG SUPPORT*	0	45
10	11420000	*VULNERABILITY*	0	55
11	12100000	VISIONICS PKG	0	45
12	12110000	*TYPE SUBSYSTEM*	0	35
13	12120000	*RANGE/ACCURACY*	0	40
14	12130000	*DSGN/HANDOFF*	0	25
15	12200000	*COMM/NAV*	0	30
16	12300000	SURVIVABILITY	0	25
17	12310000	*COUNTERMEAS*	0	55
18	12320000	*ARMAMENT	0	45
19	12000000	MISSION EQUIP	0	45

(10) DO YOU WISH TO CHANGE NUMBER OF CELLS PER LEVEL, YES OR NO?
NO

CODES FOR CHANGES ARE:
A - ADD OR CHANGE AN ENTIRE CELL LINE.
(12) W - CHANGE WEIGHT FOR CELL.
V - CHANGE SCORE FOR CELL.
D - DELETE CELL.
P - PRINT DATA SET FOR REFERENCE
S - SAVE DATA AS IS (OPTIONAL JUMP OUT)
C/R - END CHANGES AND CONTINUE.

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION

Notes: To correct an incorrect cell #, use edit code "A" and replace the entire cell line.

When you delete a cell during edit, select code "D " and enter index # of the line to be deleted; computer will show, CELL # 123 HAS BEEN DELETED.

If you try to enter a duplicate cell #, either during data entry or during cell add/edit, computer will show: CANNOT ADD CELL - CELL # ALREADY EXISTS.

If you only have two levels in your evaluation structure, during rollup computer will show: TOO FEW LEVELS, RUN IS CANCELLED; and give you the opportunity to make another run.

If you have an extremely large/complex structure, e.g., more than 55 lines of input, the computer may stop while printing out data set, due to page-line limits set for the terminal. If this happens, just hit C/R to continue printing.

---

(33) DO YOU WISH TO MAKE ANOTHER RUN, YES OR NO? — When you wish to logoff, type "NO" when computer asks if you wish to make another run.

• NO

READY

(34) • LOGOFF — Computer will acknowledge, and show cost of session (if timesharing system).

AUTOMATED CBRA - DETAILED INSTRUCTIONS

(Computer Operation)

FLOW CHART REF	COMPUTER READ-OUT	DISCUSSION

Special Note: When you call up an existing file for edit, readout of that file will include most recent input, including "partial changes" made during previous edit. However, if such changes were stored prior to rollup, previous weights/scores/weighted scores not affected by the edit will also be printed out.

Such "garbage" has no meaning to your immediate exercise, and will NOT impact new output computations--but can be confusing! Therefore, following precautions are recommended:

Keep a record of what you store in each file, by number, and its status. (Routine "bookkeeping".)

Take the time to *flag* raw score input cells for ease of identification in later operations--and remember that these RS cells are the only ones that affect weighted scores/final outcomes.

Similarly flag or mark changes in weights made for sensitivity analyses, so that you can check quickly as to which ones pertain/have been or need to be incorporated.

Following pages complete the output for this case study, showing companion WS computations for System B with Version #1 weights, System A with Version #2 weights, and System B with Version # 2 weights (System A with Version #1 previously shown).

Quick Reference Summary is next (Section IV.C), followed by cost and cost-benefit comparisons and analyses at IV.D.

ROLLUP COMPUTATIONS ARE IN PROGRESS.
ENTER CELL NAME FOR LEVEL 1

----------Z
SYSTEM B-1

DO YOU WANT TO SEE THE FINAL DATA SET, YES OR NO?
NO

DO YOU WANT TO REPLACE AN OLD DATA SET WITH THIS ONE, YES OR NO?
NO

FOR PROGRAM OUTPUT, ADVANCE PAPER TO CLEAN PAGE, 3 LINES FROM TOP WHEN READY,
PRESS 'RETURN' TO CONTINUE.

LEVEL	CELL NAME	SCORE	WEIGHT	SYSTEM WEIGHT
10000000	SYSTEM B-1	43	100.	1.0000
11000000	VEHICLE	62	45.	0.4500
11100000	PERFORMANCE	37	35.	0.1575
11110000	%POWER%	20	30.	0.0472
11120000	%MANEUVERBLTY%	55	40.	0.0630
11130000	%ENDURANCE%	30	30.	0.0472
11200000	%DETECTABILITY%	80	30.	0.1350
11300000	%CREW WKLOAD%	85	15.	0.0675
11400000	AVAILABILITY	74	20.	0.0900
11410000	%LOG SUPPORT%	60	45.	0.0405
11420000	%VULNERABILITY%	85	55.	0.0495
12000000	MISSION EQUIP	27	55.	0.5500
12100000	VISIONICS PKG	27	45.	0.2475
12110000	%TYPE SUBSYSTEM%	20	35.	0.0866
12120000	%RANGE/ACCURACY%	30	40.	0.0990
12130000	%DSGN/HANDOFF%	30	25.	0.0619
12200000	%COMM/NAV%	30	30.	0.1650
12300000	SURVIVABILITY	25	25.	0.1375
12310000	%COUNTERMEAS%	25	55.	0.0756
12320000	%ARMAMENT	25	45.	0.0619

DO YOU WISH TO MAKE ANOTHER RUN, YES OR NO?
YES

DO YOU WANT TO SEE THE FINAL DATA SET, YES OR NO?
:O

DO YOU WANT TO REPLACE AN OLD DATA SET WITH THIS ONE, YES OR NO?
NO

FOR PROGRAM OUTPUT, ADVANCE PAPER TO CLEAN PAGE, 3 LINES FROM TOP WHEN READY,
PRESS 'RETURN' TO CONTINUE.

LEVEL	CELL NAME	SCORE	WEIGHT	SYSTEM WEIGHT
10000000	SYSTEM B-2	48	100.	1.0000
11000000	VEHICLE	65	55.	0.5500
11100000	PERFORMANCE	37	25.	0.1375
11110000	%POWER%	80	30.	0.0412
11120000	%MANEUVERBLTY%	55	40.	0.0550
11130000	%ENDURANCE%	30	30.	0.0412
11200000	%DETECTABILITY%	80	35.	0.1925
11300000	%CREW WKLOAD%	65	20.	0.1100
11400000	AVAILABILITY	74	20.	0.1100
11410000	%LOG SUPPORT%	80	45.	0.0495
11420000	%VULNERABILITY%	85	55.	0.0605
12000000	MISSION EQUIP	87	45.	0.4500
12100000	VISIONICS PKG	87	45.	0.2025
12110000	%TYPE SUBSYSTEM%	20	35.	0.0709
12120000	%RANGE/ACCURACY%	30	40.	0.0810
12130000	%DSGN/HANDOFF%	30	25.	0.0506
12200000	%COMM/NAV%	30	30.	0.1350
12300000	SURVIVABILITY	25	25.	0.1125
12310000	%COUNTERMEAS%	25	55.	0.0619
12320000	%ARMAMENT	25	45.	0.0506

DO YOU WISH TO MAKE ANOTHER RUN, YES OR NO?
YES

LEVEL	CELL NAME	SCORE	WEIGHT	SYSTEM WEIGHT
10000000	SYSTEM A-B	68	100.	1.0000
11000000	VEHICLE	36	55.	0.5500
11100000	PERFORMANCE	83	25.	0.1375
11110000	%POWER%	80	30.	0.0412
11120000	%MANEUVERBLTY%	45	40.	0.0550
11130000	%ENDURANCE%	70	30.	0.0412
11200000	%DETECTABILITY%	60	35.	0.1925
11300000	%CREW WKLOAD%	35	20.	0.1100
11400000	AVAILABILITY	25	20.	0.1100
11410000	%LOG SUPPORT%	40	45.	0.0495
11420000	%VULNERABILITY%	15	55.	0.0605
12000000	MISSION EQUIP	73	45.	0.4500
12100000	VISIONICS PKG	74	45.	0.2025
12110000	%TYPE SUBSYSTEM%	80	35.	0.0709
12120000	%RANGE/ACCURACY%	70	40.	0.0810
12130000	%DSGN/HANDOFF%	70	25.	0.0506
12200000	%COMM/NAV%	70	30.	0.1350
12300000	SURVIVABILITY	75	25.	0.1125
12310000	%COUNTERMEAS%	75	55.	0.0619
12320000	%ARMAMENT	70	45.	0.0506

DO YOU WISH TO MAKE ANOTHER RUN, YES OR NO?

C. QUICK REFERENCE SUMMARY

1. Basic process (manual or automated).

a. CBRA Technique-Ten Steps*

(1) Define task.

(2) Identify critical parameters (CP).

(3) Design evaluated structure (ES).

(4) Allocate cell weights (CW).

(5) Establish scoring standards (SS).

(6) Verify evaluation candidates.

(7) Assign raw scores (RS); compute weighted scores (WS).

(8) Obtain candidate costs (CC).

(9) Compute cost-benefit ratio (CBR).

(10) Perform analyses.

b. Formula: CW x RS = WS + CC = CBR.

2. Automated CBRA - Flow Chart (next page).

*Document rationale throughout the process.

FLOW PROCESS CHART

APPENDIX NO	DIRECTIVE NO	DATE
SECTION IV.C	TR #81-F-2	December 1980

CBRA TECHNIQUE - USER'S GUIDE

"ROAD MAP"

SUBJECT OF PROCESS

Cost-Benefit Ratio Analysis (CBRA) Technique - Computer Operation Flow Chart

NARRATIVE DESCRIPTION OF ACTIONS

Follow local equipment instructions to access uter. Also, see Detail Instructions, IV.B.2.

Type LOGON/User ID; enter password; await "READY", n type EXEC CBRA.

If you wish to use a data set already in file, YES and go to (4) ; if not, type NO and skip to .

Enter desired file #; skip to (9) .

Enter max. number of vertical (V) levels and rizontal (H) cells needed within any part of the luation structure (limit = 9x9). Go to (6) .

Enter cell data; go to (7) .

If for any reason you wish to save the data red so far, skip to (14) ; if not, proceed to (8).

If ES is complete, hit C/R and go to (9) ; if not, ack to (6) .

The data set from either (4) or (6) will be played for review. Go to (10) .

If you wish to change the ES size (e.g., number ells per level), type YES and go to (11) . Otherse, type NO and skip to (12) .

Enter desired structure size and go to (12) .

If needed changes are spotted at this time, skip) . If not, go to (13) .

If you need to store this data set and/or jump to program, go to (14) ; if not, hit C/R and to (20) .

To store data as-is, type "S" (if edit code) or E (if cell name) and go to (15) .

TE: Anytime data is stored in file before rollup, arning/reminder statement is included when that e is called up for later use.

Enter file # in which you wish to store the data go to (16) .

TE: Any data which was previously stored in that e will automatically be replaced by the new data.

If you wish to continue working the data set you ved, type YES and go back to (9) . If not, type NO d skip to (33) .

Enter desired revision code and index # of line o be edited, and go to (18) .

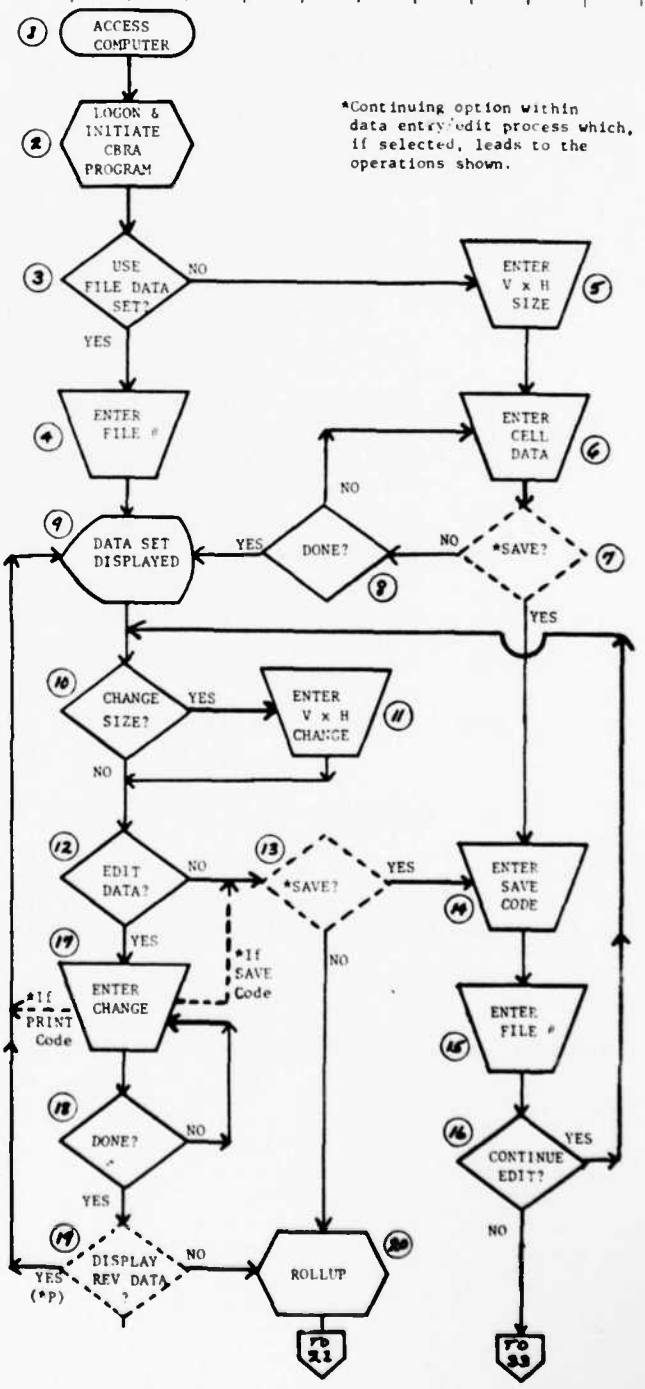
NOTE: If edit code "P" (to print out data set) is selected, go back to (9) . If code "S" (save) is selected, go back to (14) .

If changes are complete, go to (19) ; if not, go back to (17) .

19. If you wish to review the revised data, type "P" and go back to (9) ; if not, type C/R and go to (20) .

20. Here the computer begins the rollup process, including edit of cell weights. Go to (21) .

GRAPHIC DESCRIPTION OF ACTIONS



*Continuing option within data entry/edit process which, if selected, leads to the operations shown.

DD FORM 1 Oct 78 992

Edition of 1 Oct 77, may be used.

FLOW PROCESS CHART	APPENDIX NO	DIRECTIVE NO	DATE
	SECTION IV.C	TR #81-F-2	December 1980
CBRA TECHNIQUE - USER'S GUIDE "ROAD MAP"	SUBJECT OF PROCESS: Cost-Benefit Ratio Analysis (CBRA) Technique - Computer Operation Flow Chart		

NARRATIVE DESCRIPTION OF ACTIONS

GRAPHIC DESCRIPTION OF ACTIONS

. If cell weights add properly at all levels, puter skips automatically to (26) . If not, go (22) .

Data for the "problem cell" is displayed for to determine necessary correction. Go to (23) .

. If you find that you need to add or delete a l, rather than revise weights of existing cells, e "E" and go back to (10) . Otherwise, go to (24) .

Enter desired CW change and go to (25) .

. If changes are complete, hit C/R; computer goes k to (21) and continues rollup. If more changes needed, go back to (24) .

. When edit/rollup computations for all levels are plete, enter cell name for cell 1.0 (System mary) and go to (27) .

. If you wish to see the final data set, type YES go to (28) ; if not, type NO and skip to (29) .

The final data is displayed for reference, but not be edited further in thia run. Go to (29) .

If you wish to store the final data set, either replacing old data or loading new file, type YES go to (30) ; if not, type NO and skip to (32) .

Enter file # of desired storage location; go to .

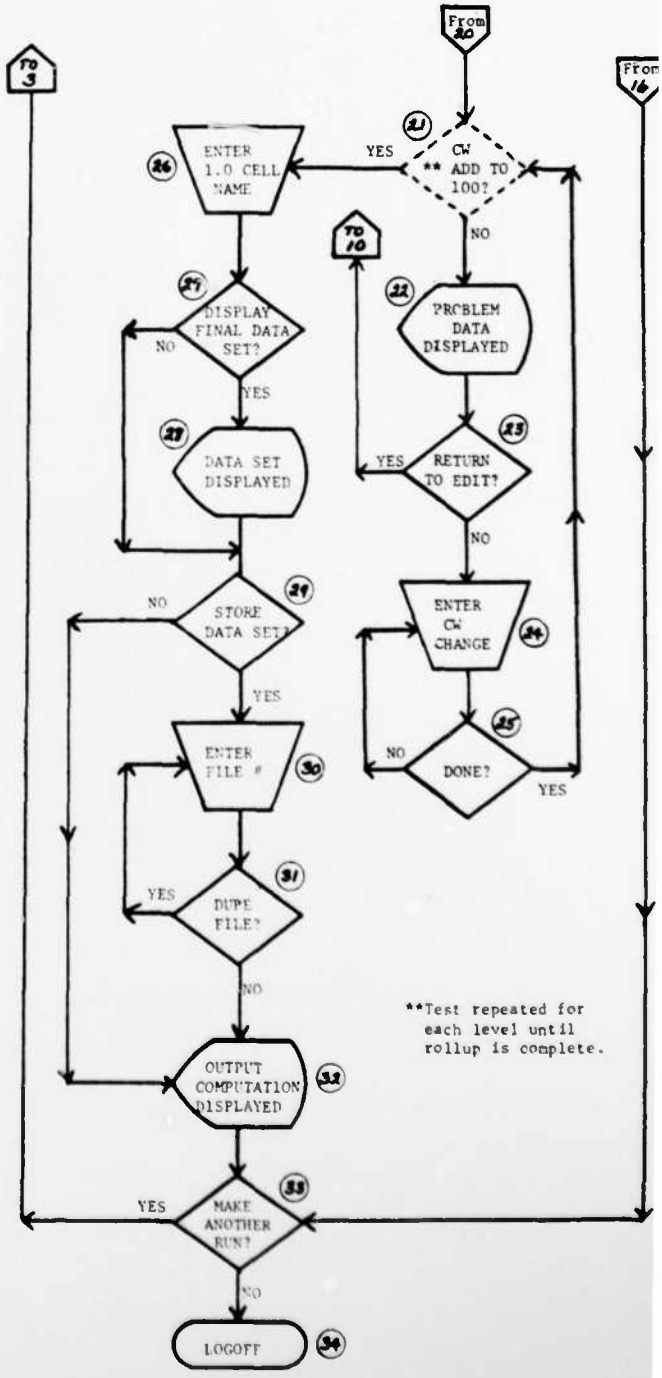
If duplicate storage is desired, type YES and go to (30) ; if not, type NO and go to (32) .

Advance paper to start fresh page and hit RTN output. Go to (33) .

E: Output includes annotation of each individual l's weight-contribution to the total system weight.

If you wish to make another run (e.g., to fill scores, add a candidate, perform sensitivity lysis, etc.) type YES and go back to (3) . If not, e NO and go to (34) .

Type LOGOFF. Computer will acknowledge. Turn terminal.



**Test repeated for each level until rollup is complete.

D. RESULTS: ANALYSIS AND PRESENTATION

1. Review of the output, plus consideration of candidate costs, may lead to several angles of analysis--identification of acute sensitivity/imbalance within the evaluation structure or cell weights, anomalies or questions in expected data relationships, aspects deserving further study--as well as preliminary assessment of System A vs. B "bang for bucks". There are probably as many ways to approach the review and presentation of data as there are individuals; so in this case, we'll start with a recap of the data itself:

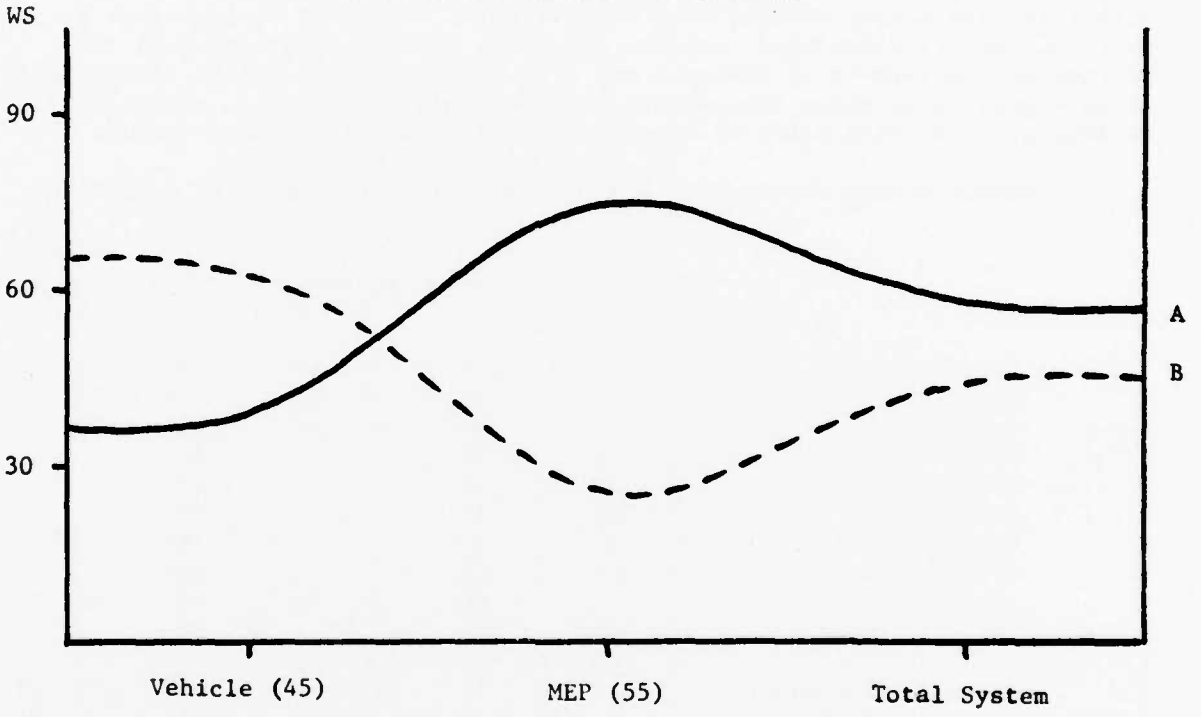
a. Output scores for Systems A & B under both versions of ES weighting.

		Raw Scores		CW-#1	Weighted Scores		CW-#2	Weighted Scores	
		A	B		A	B		A	B
1.0	System Summary			100	58	43	100	52	48
1.1	Vehicle			45	39	62	55*	35	65
1.1.1	Performance			35	63	37	25*	63	37
1.1.1.1	Power	80	20	30			30		
1.1.1.2	Maneuverability	45	55	40			40		
1.1.1.3	Endurance	70	30	30			30		
1.1.2	Detectability	20	80	30			35*		
1.1.3	Crew Workload	35	65	15			20*		
1.1.4	Availability			20	26	74	20	26	74
1.1.4.1	Logistic Support	40	60	45			45		
1.1.4.2	Vulnerability	15	85	55			55		
1.2	Mission Equipment			55	73	27	45*	73	27
1.2.1	Visionics Package			45	74	27	45	74	27
1.2.1.1	Type Subsystem	80	20	35			35		
1.2.1.2	Range/Accuracy	70	30	40			40		
1.2.1.3	Designation/Handoff	70	30	25			25		
1.2.2	Comm/Navigation	70	30	30			30		
1.2.3	Survivability			25	75	25		75	25
1.2.3.1	Countermeasures	75	25	55			55		
1.2.3.2	Armament	75	25	45			45		

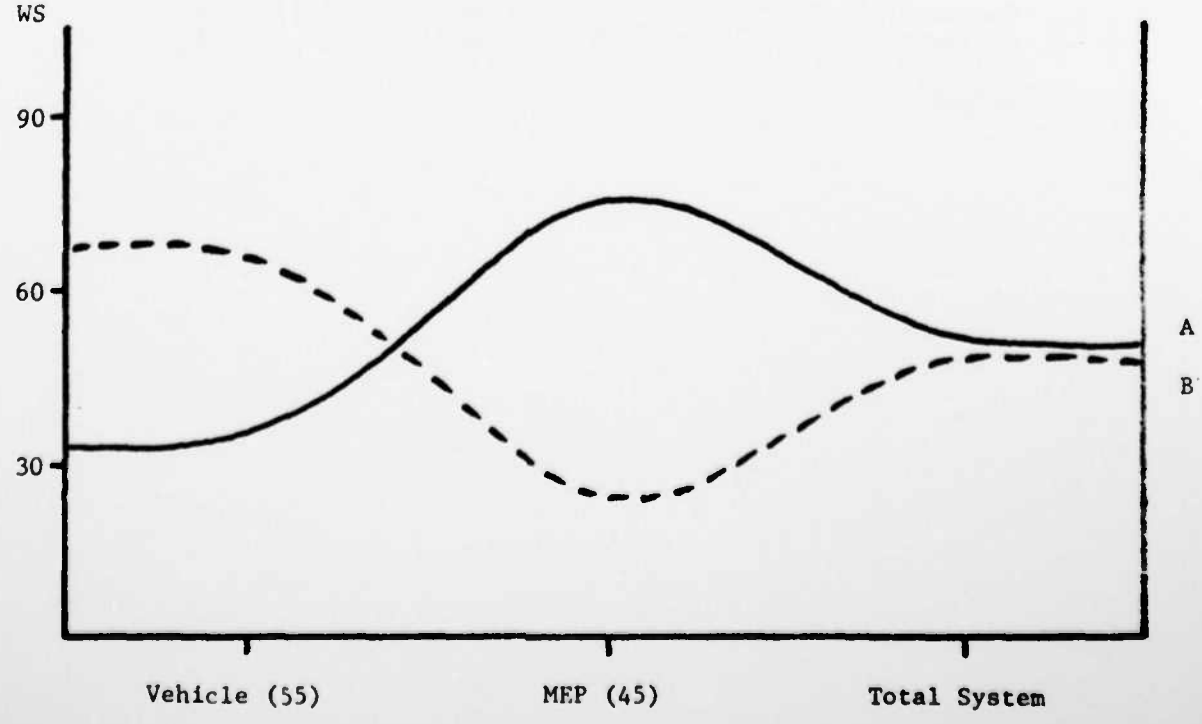
*Revised weights

b. Shown graphically for ease of analysis.

BENEFIT COMPARISON - VERSION #1



BENEFIT COMPARISON - VERSION #2



c. Observations:

(1) The two types of systems being explored are to a great extent opposites in terms of attributes: System A can carry more capable mission equipment and has greater speed and endurance, but is weak in the areas of detectability, maneuverability, crew workload, and vulnerability; System B tends to have just the reverse strengths and weaknesses. This is an expected relationship, given the task definition, and appears to be reflected in the scoring of the candidates.

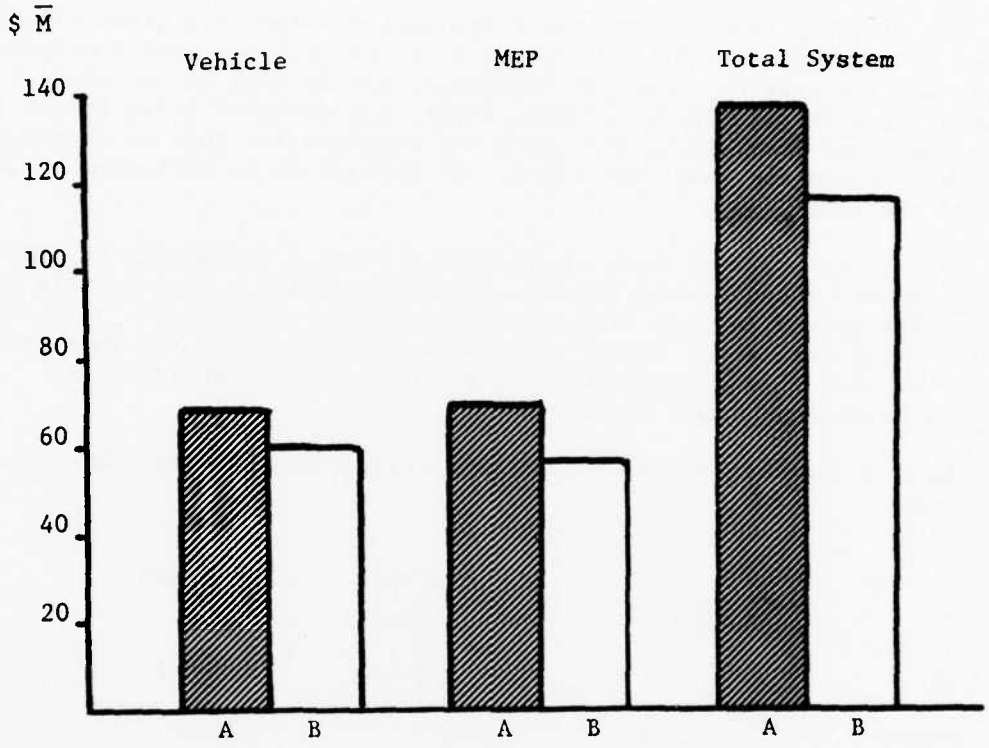
(2) It is apparent that fairly modest changes in Vehicle vs. MEP cell weights have a fairly significant effect on outcome - particularly so because of the opposite-characteristic nature of the candidates. In this instance, the change is not enough to reverse the overall system rank order, but enough to show that determination of Vehicle vs. MEP importance is critical in reaching further decisions.

d. Next, a look at estimated candidate costs (constant year XX dollars in millions).

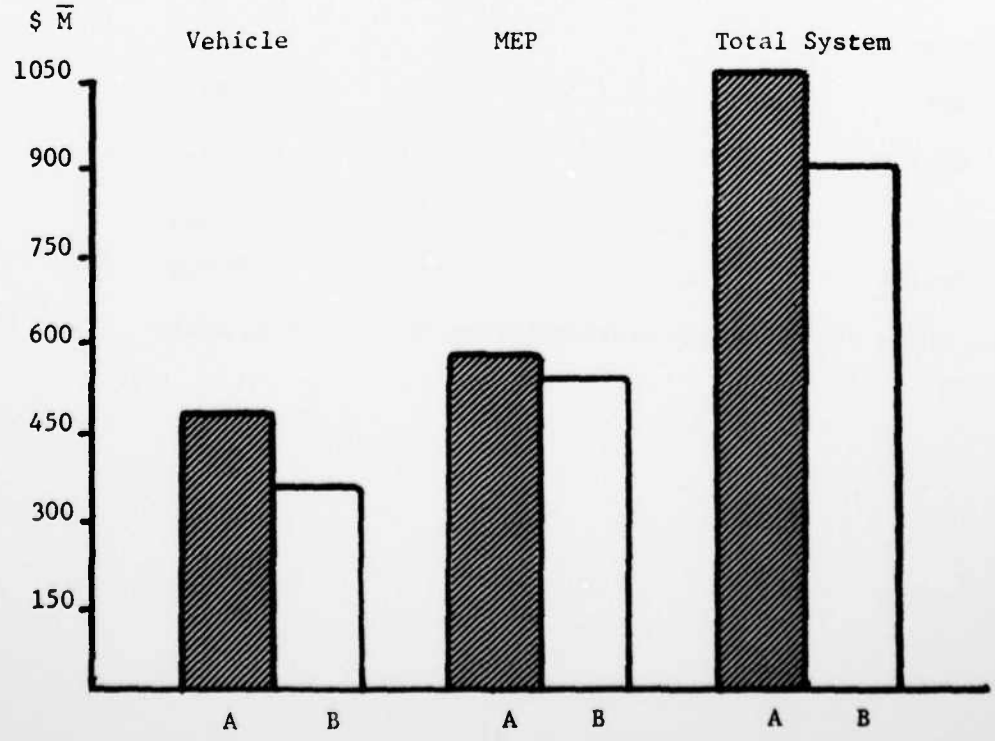
Sys A	Dev	(Qty 500) Proc	(Qty 500) Acqn
MEP	69.0	586.8	655.9
Vehicle	68.4	478.1	546.5
System	137.4	1064.9	1202.3
System B			
MEP	56.5	547.3	603.8
Vehicle	59.6	355.6	415.2
System	116.1	902.9	1019.0

e. Costs are portrayed graphically on the following pages.

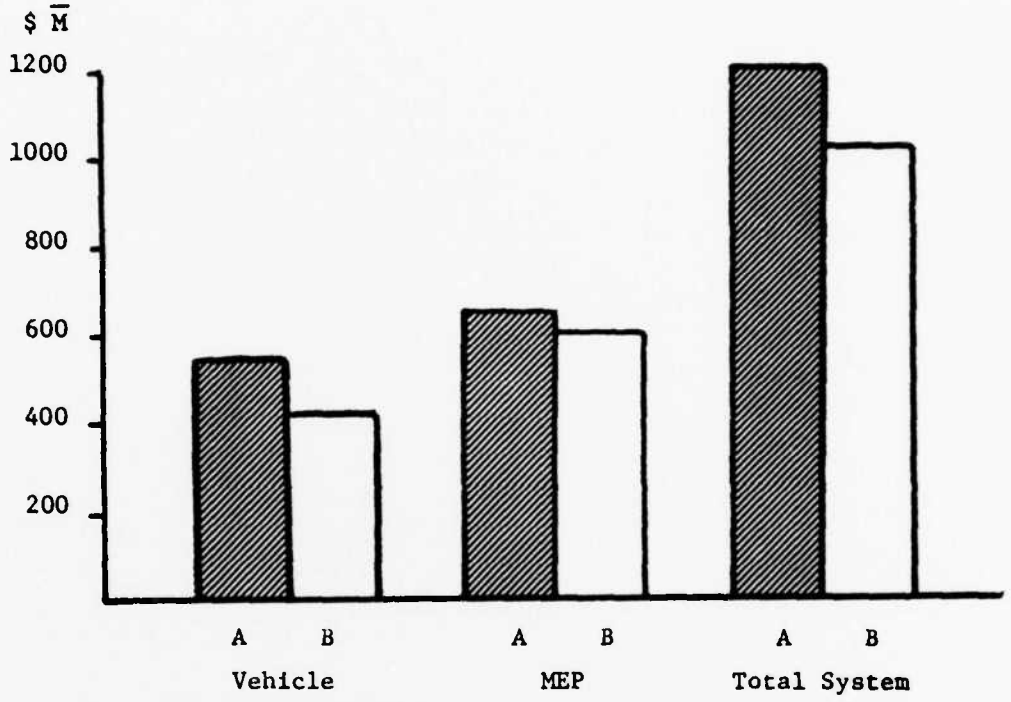
DEVELOPMENT COST COMPARISON



PROCUREMENT COST COMPARISON
(Qty 500)



ACQUISITION COST COMPARISON
(Qty = 500)



f. Observations:

(1) System A costs more - no surprise, since greater capability/complexity usually costs more. Further, the cost diferences appear to be fairly consistent in all categories of cost examined.

(2) Therefore, primary cost considerations will be those of affordability and of overall bang for bucks, rather than further scrutiny of cost breakdown.

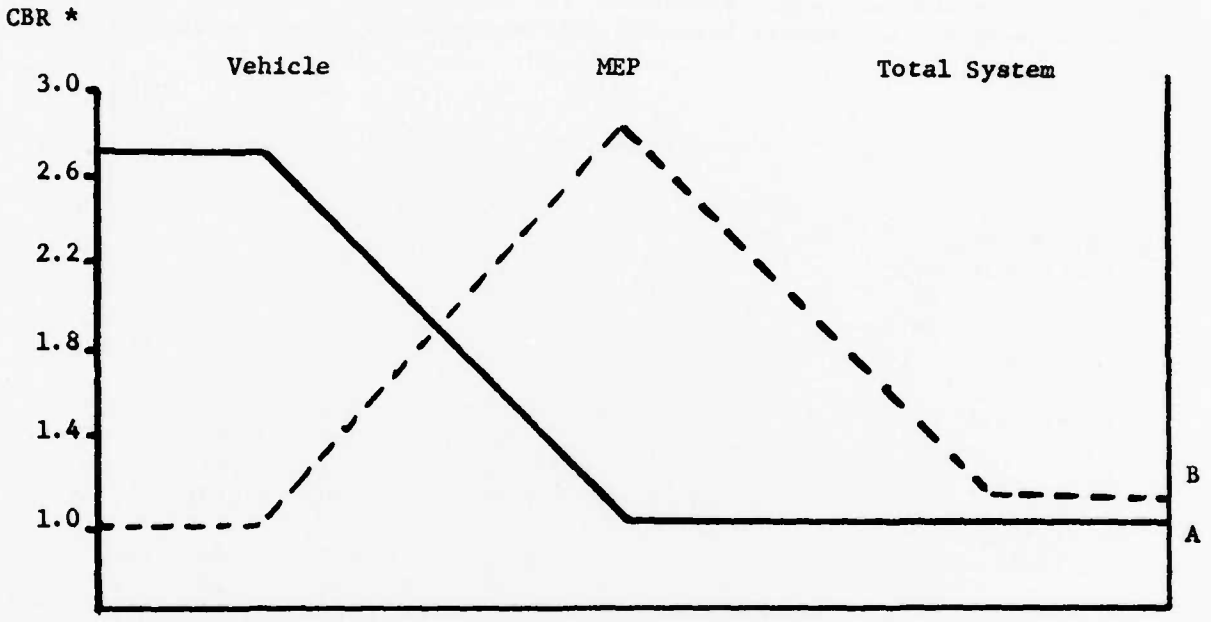
g. Cost-benefit ratio computations.

NOTE: "Normalization" of data applies only to the figures being directly compared; i.e., System A vs. B for each cost in isolation. If other normalized comparison is desired (e.g., Version #1 vs. Version #2), it may be computed from the data on this sheet; but care must be taken to avoid "mixing apples and oranges."

		System A			System B		
		Vehicle	MEP	System	Vehicle	MEP	System
Version #1 Wts.							
Development:	Cost	68	69	137	60	56	116
	WS.	39	75	58	62	25	43
	Ratio	1.74	.92	2.36	96	2.24	270
	Normalized CBR	(1.81)	(1.00)	(1.00)	(1.00)	(2.43)	(1.14)
Procurement:	Cost	478	587	1065	356	547	903
	WS.	39	75	58	62	25	43
	Ratio	12.26	7.83	18.36	5.74	21.88	21.00
	Normalized CBR	(2.13)	(1.00)	(1.00)	(1.00)	(2.79)	(1.14)
Acquisition:	Cost	546	656	1202	415	604	1019
	WS.	39	75	58	62	25	43
	Ratio	14.00	8.75	20.72	6.69	24.16	23.10
	Normalized CBR	(209)	(1.00)	(1.00)	(1.00)	(2.76)	(1.14)
Version #2 Wts.							
Development:	Cost	68	69	137	60	56	116
	WS.	35	75	52	65	25	48
	Ratio	1.94	.92	2.63	.92	2.24	2.42
	Normalized CBR	(2.10)	(1.00)	(1.09)	(1.00)	(2.43)	(1.00)
Procurement:	Cost	478	578	1065	356	547	903
	WS.	35	75	52	65	25	48
	Ratio	13.7	7.83	20.48	5.48	21.88	18.81
	Normalized CBR	(2.5)	(1.00)	(1.09)	(1.00)	(2.79)	(1.00)
Acquisition:	Cost	546	656	1202	415	604	1019
	WS.	35	75	52	65	25	48
	Ratio	15.6	8.75	23.12	6.38	24.16	21.23
	Normalized CBR	(2.45)	(1.00)	(1.09)	(1.00)	(2.76)	(1.00)

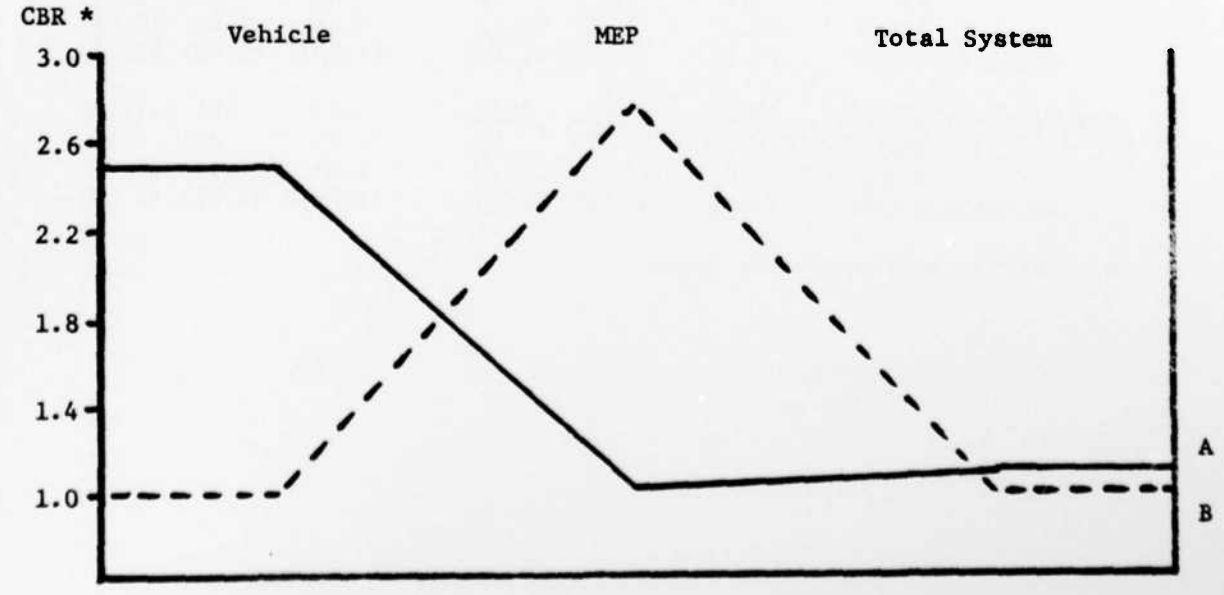
h. Graphic portrayal next page.

COST BENEFIT RATIO COMPARISON - VERSION #1



* CBR normalized for System A vs B in each category.

COST BENEFIT RATIO COMPARISON - VERSION #2



* CBR normalized for System A vs B in each category.

1. Observations:

(1) The impact of cell weight changes, when cost is included in the comparison, is significant enough to alter the rank order of the candidates.

(2) However, the margins (in terms of total system outcome) are so narrow for both benefit and CBR, that decisions based on the evaluation so far would not be solidly supportable.

2. So, where next? Following are suggested directions for further analysis:

a. Deeper examination of the system requirements - how much capability is essential to mission performance for this system, as opposed to desirable? And which aspects of the two basic categories (vehicle and MEP) should be emphasized? Perhaps separate, detail sensitivity analyses in these two areas would shed more light on the problem.

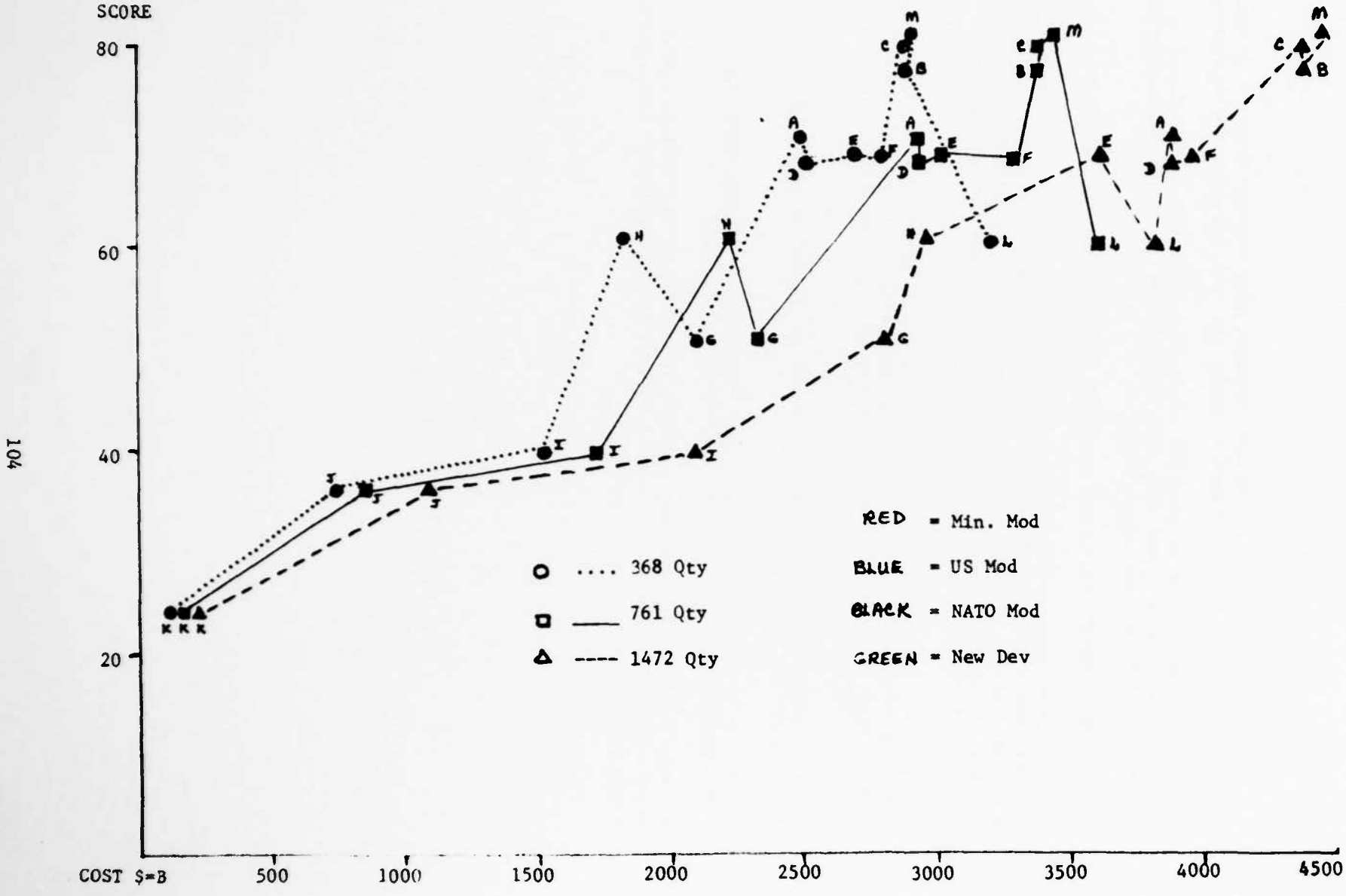
b. What is the affordability picture? Is it possible to modify either system to overcome some of the existing limitations? If so, how would this affect cost? (Be sure to consider the possibility of spillover technical ramifications, too.)

c. Should other categories of cost (e.g., operating and support costs, force costs) be considered?

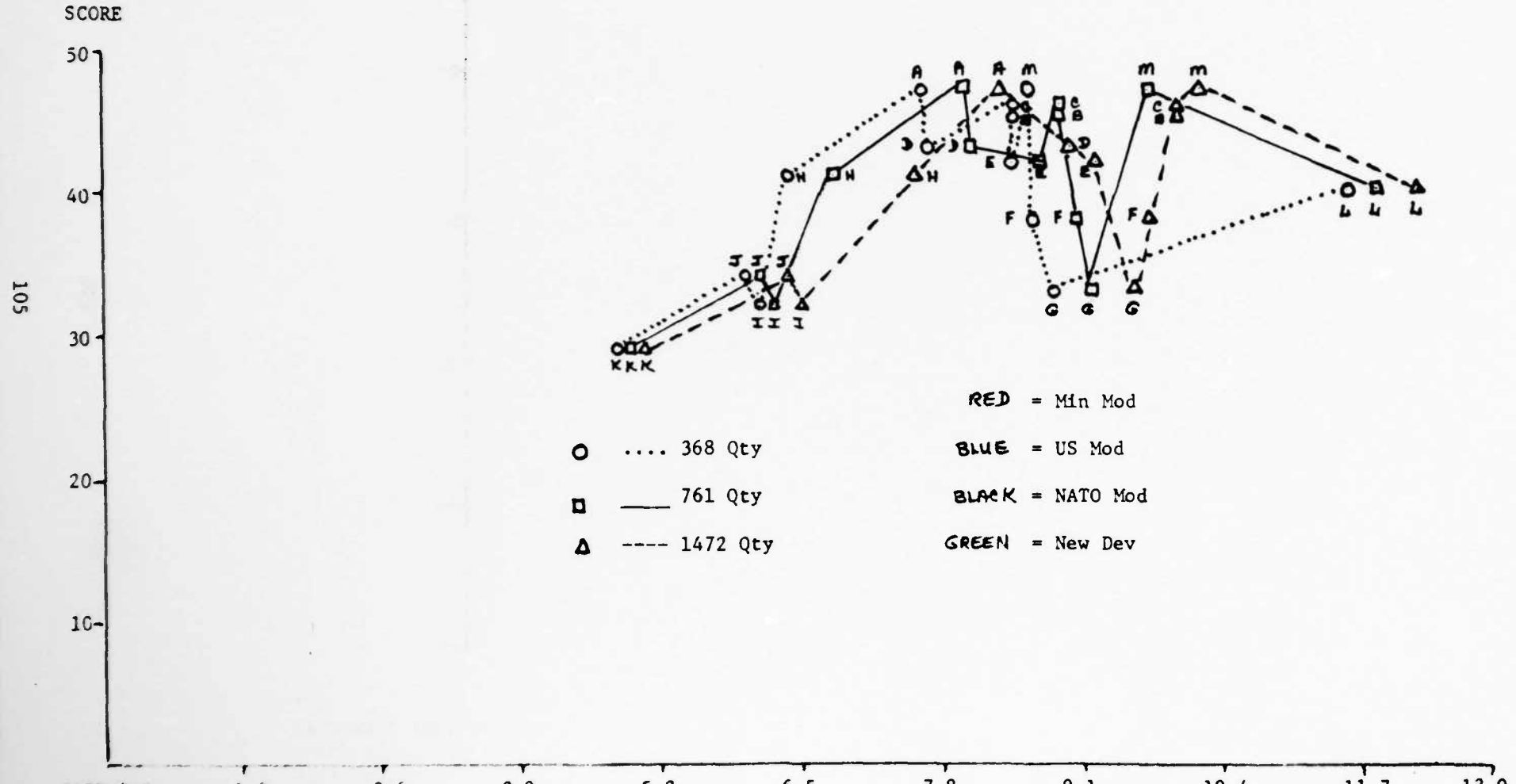
d. In the areas of greatest uncertainity/softest data, what tests or simulations might be run to provide better information?

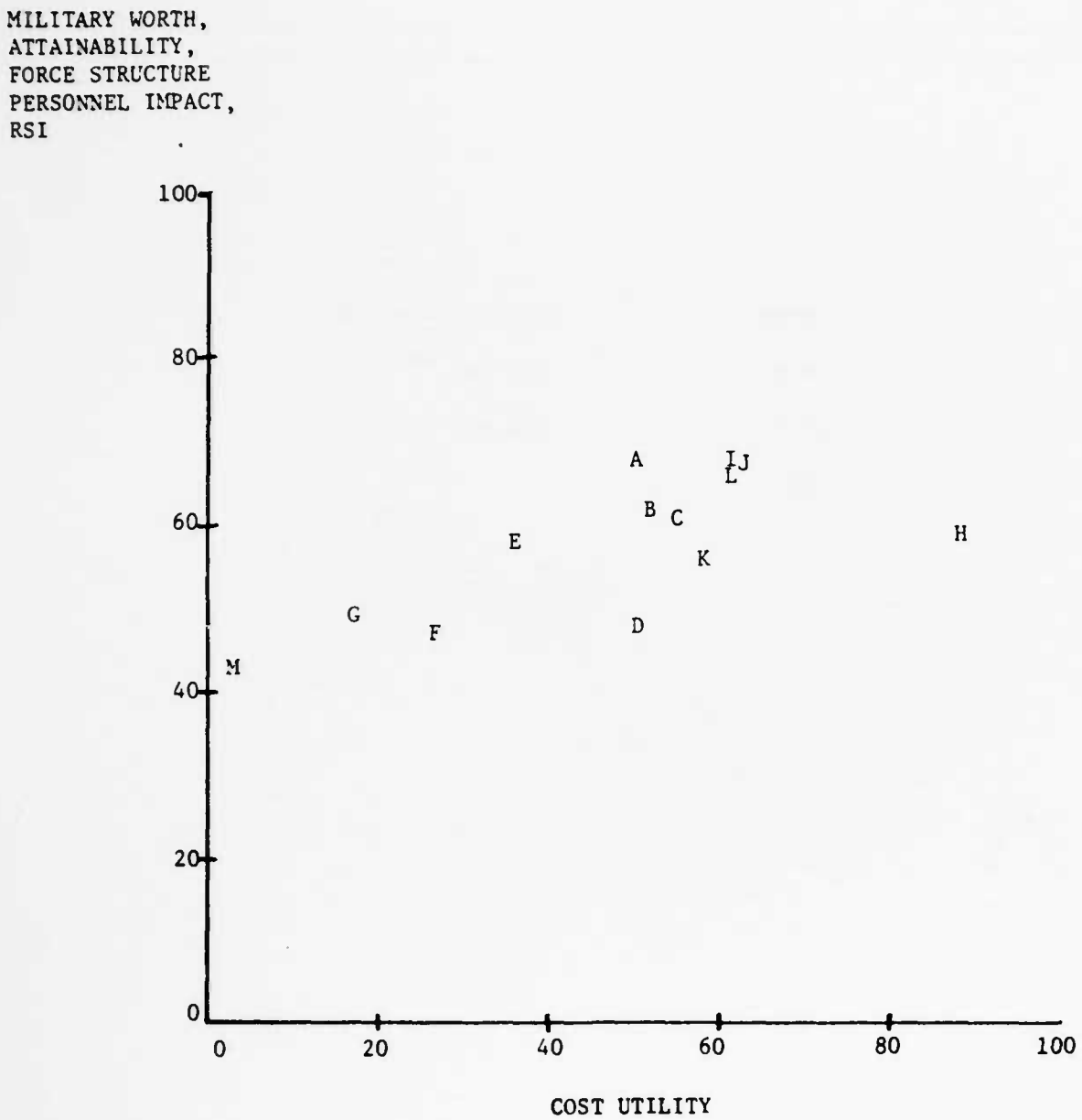
3. When analysis is complete, presentation of output/conclusions can be drawn directly from the data and charts used in the analysis. Some additional samples are included, following pages.

MILITARY WORTH VS ACQUISITION COST

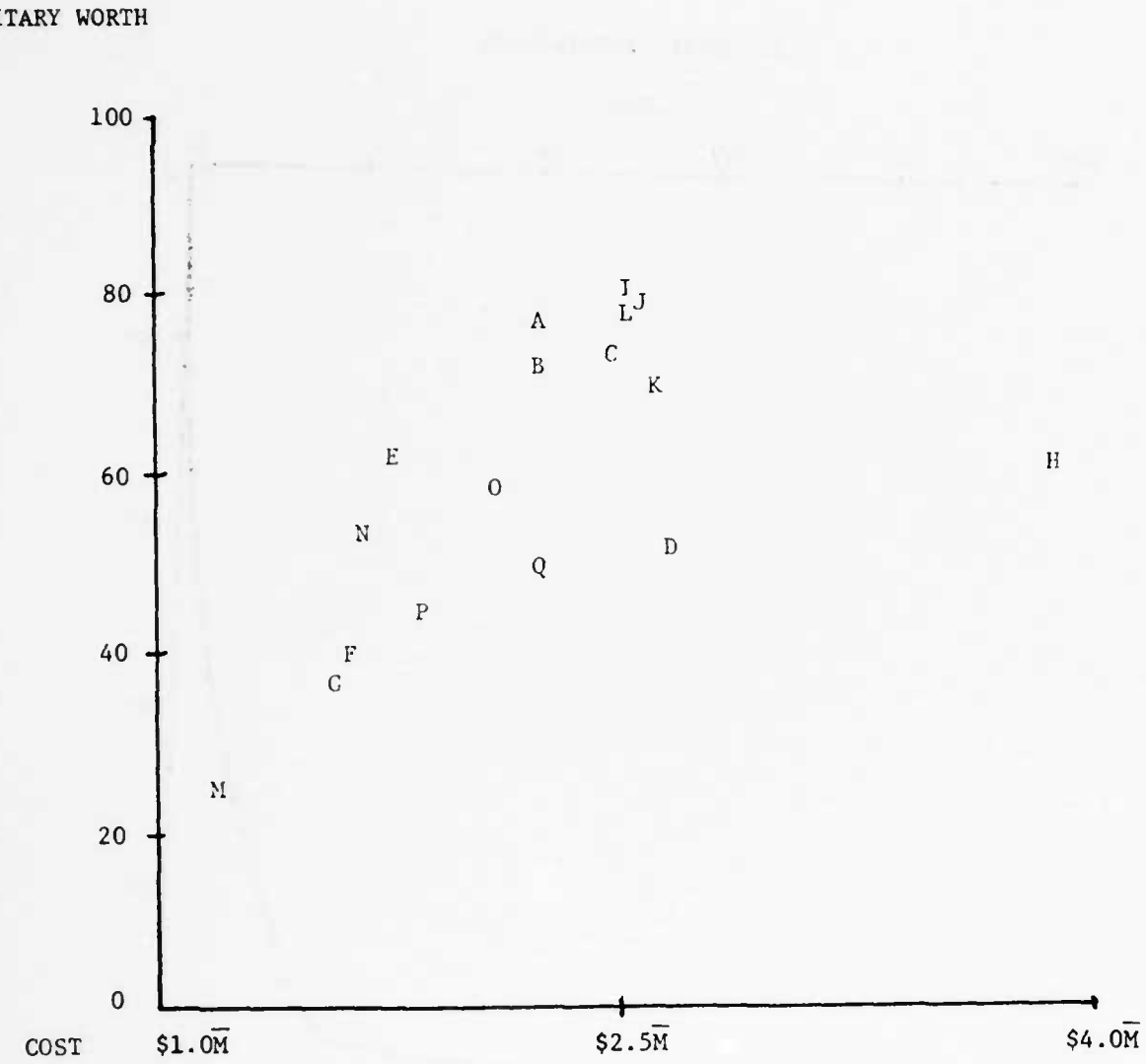


TOTAL WORTH VS TOTAL (LCC) COST

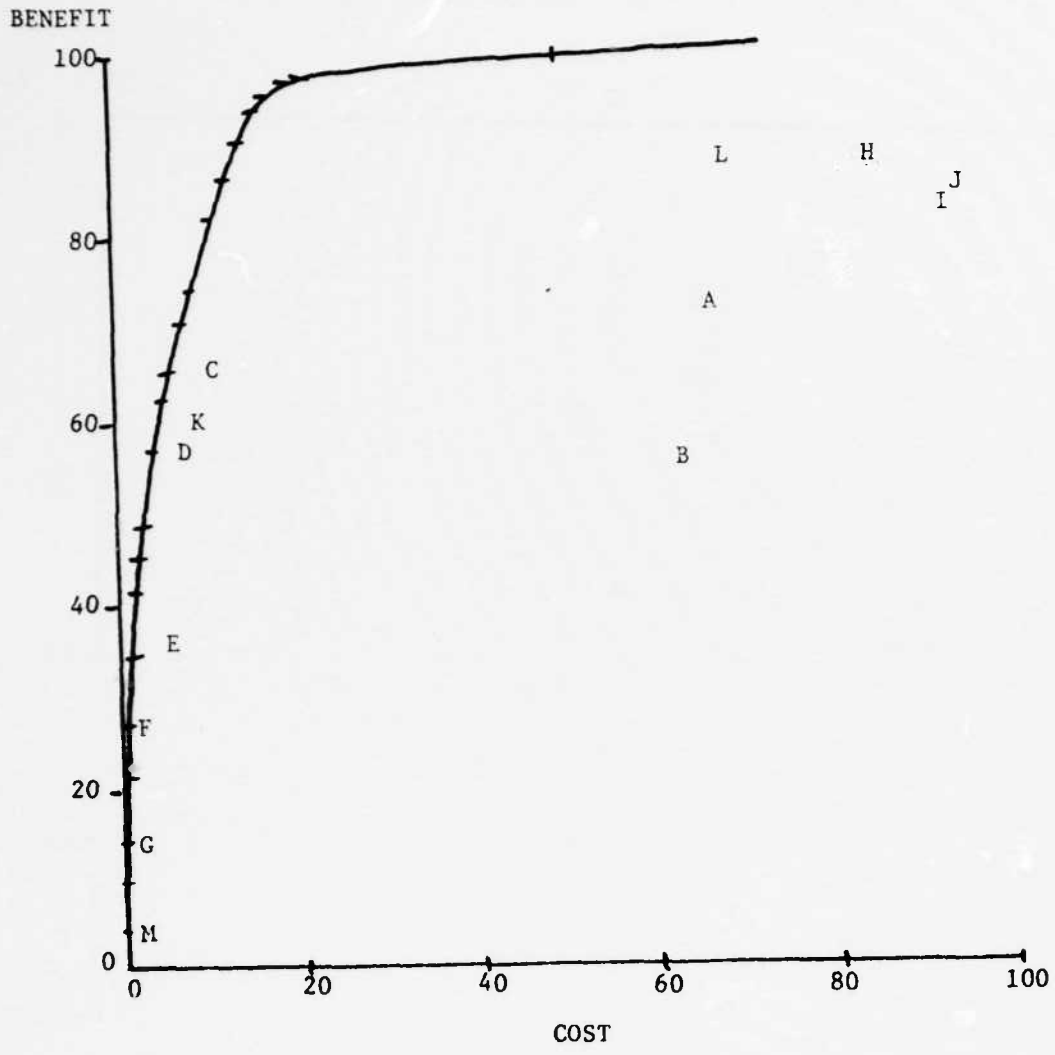




VALUES OF XXX CANDIDATES VERSUS COST



MILITARY WORTH VERSUS UNIT ACQUISITION COST



COST/BENEFIT TRADE-OFFS

AD-A142 521 COST BENEFIT RATIO ANALYSIS (CBRA) TECHNIQUE A SIMPLIFIED SYSTEM EVALUATI..(U) ARMY AVIATION RESEARCH AND DEVELOPMENT COMMAND ST LOUIS MO J H FITE ET AL. 2/2

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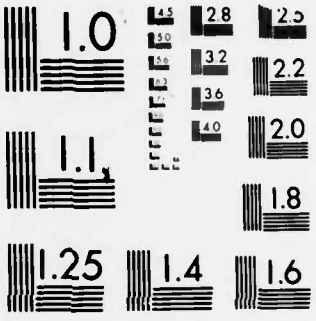
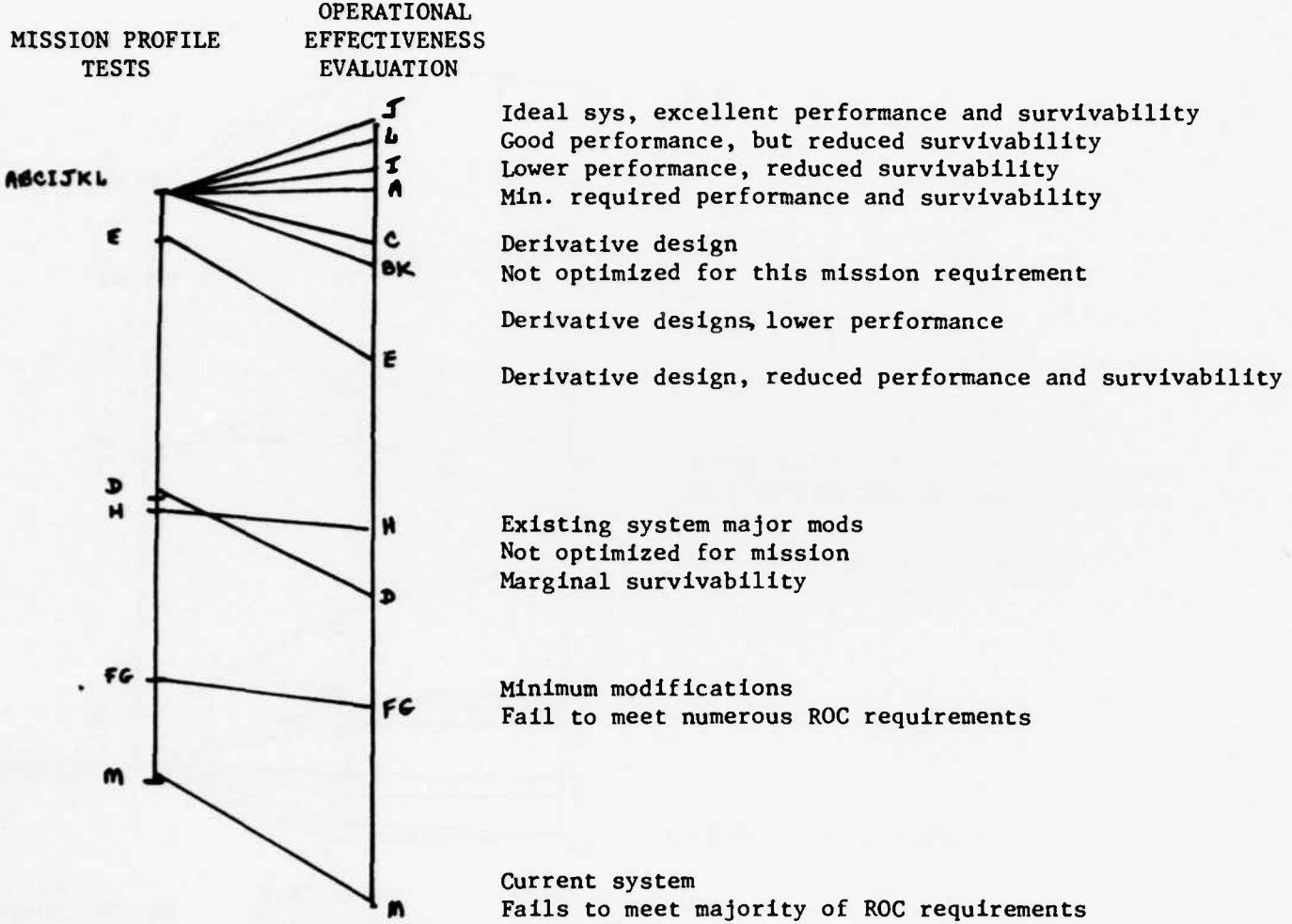
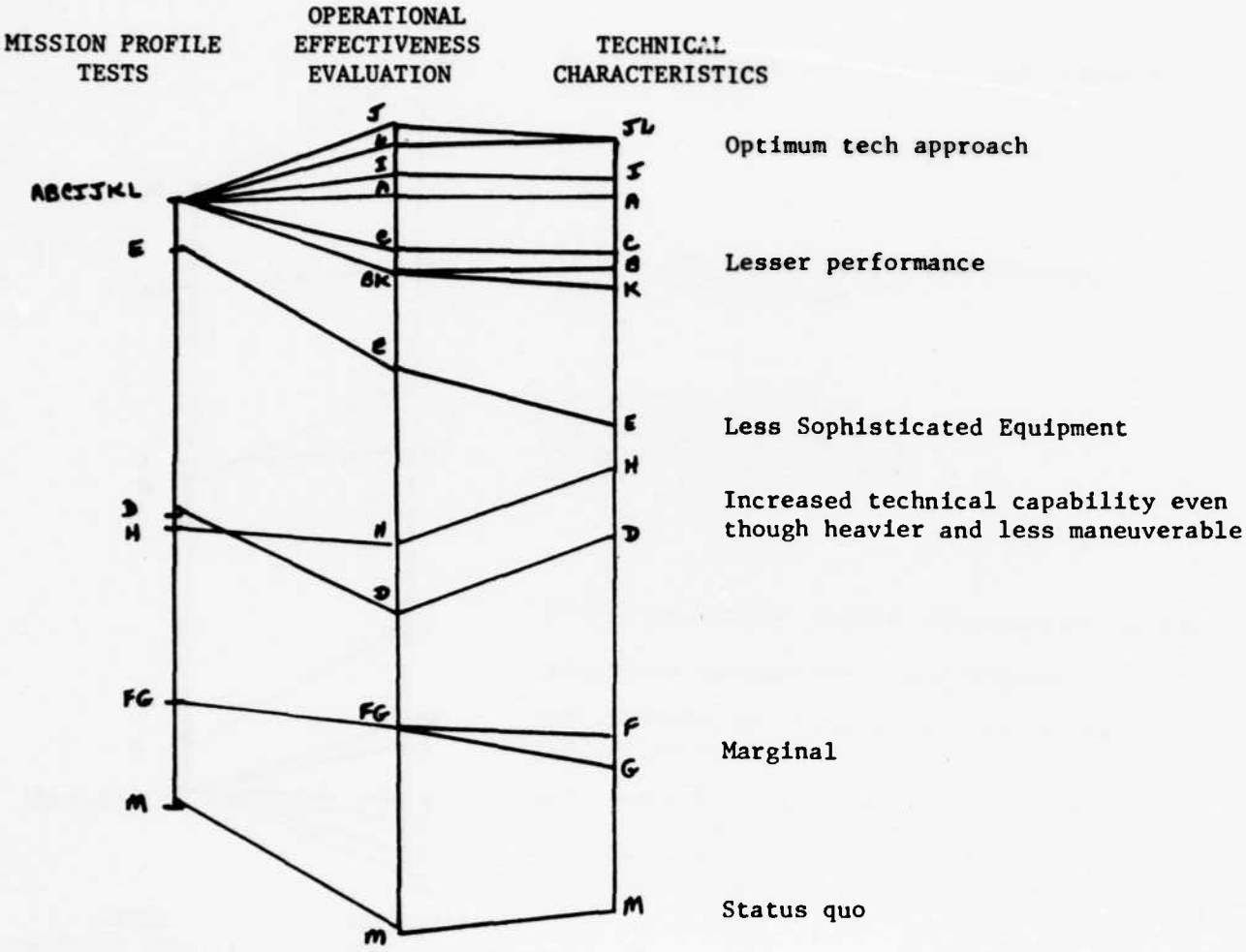
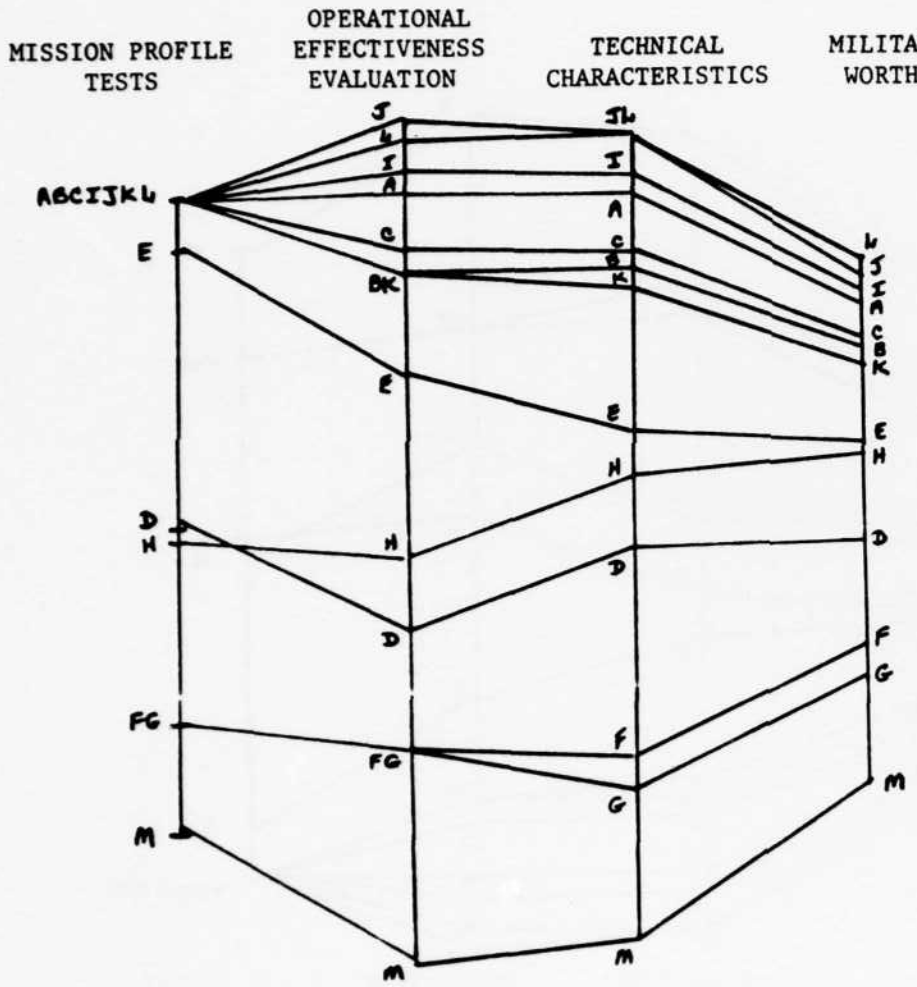




EVALUATION PERSPECTIVES: MISSION SUITABILITY



EVALUATION PERSPECTIVES: TECH CAPABILITY

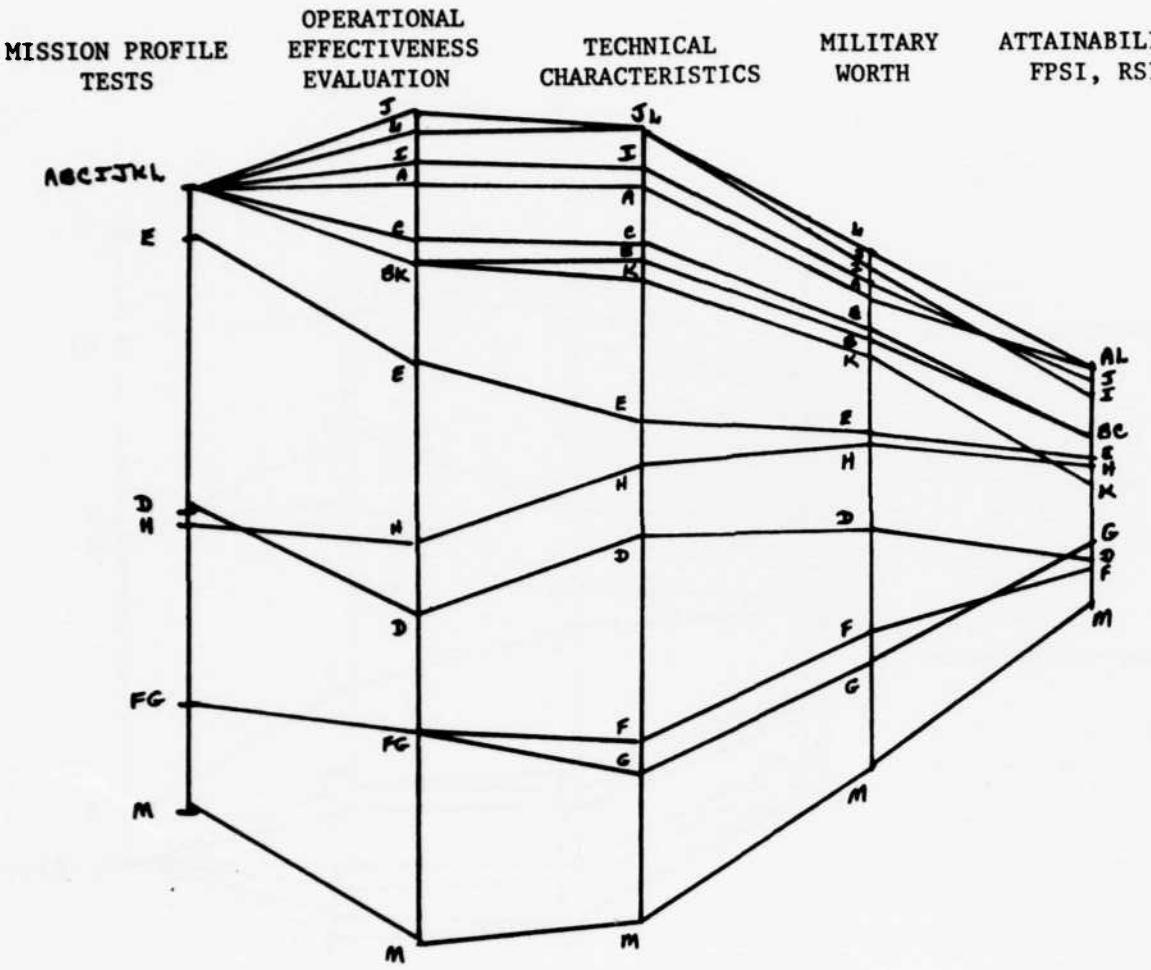


New Designs — Highest Risk; Most Training; Good "ilities"

Intermediate Designs — High Risk; Much Training; Good "ilities"

Minor Modifications — Moderate risk; Minor impact on training; Marginal "ilities"

EVALUATION PERSPECTIVES: MILITARY WORTH



- A and G relative positions improved

  K decreases its relative position

- Attainability is major reason for change

- Attainability is also the major reason for reduced scale

EVALUATION PERSPECTIVES: ATTAINABILITY/OVERVIEW

E. TIPS & CAUTIONS.

1. Approach & Documentation.

a. Evaluation criteria and scoring.

(1) Obviously, it is desirable to utilize the most objective possible basis for measuring and scoring in the evaluation process. Therefore, wherever possible, use established requirements/data to formulate these aspects. However, whenever/wherever hard data is simply not available, then go to the technical experts and obtain opinions/ratings to use in these areas.

(2) Remember that the purpose of the CBRA technique is to yield more systematic basis for decisions/recommendations; never to predispose or limit a decision itself. In this regard, a "final score" has no more meaning than scores for isolated segments of evaluation. In fact, it is advantageous to compute cost and/or benefit from several different perspectives, or at several different levels, to yield a more complete picture and to surface particularly sensitive facets of the overall evaluation.

b. Managing the problem. In a large or complex evaluation structure, entailing disparate disciplines or categories of information, it may be desirable to break down the effort into "modules" to be worked on initially by separate proponents. It is then relatively easy to "marry up" these modules when you are ready, so long as each has an identified place within the overall structure (wiring diagram).

c. Documentation. Be sure to define and document the assumptions, sources of information and rationale applied. This is always important in supporting an analysis, but is particularly so in using an informal, quick-reaction technique such as CBRA.

(1) Extra care should be taken in defining qualitative inputs and the criteria for dealing with them. In addition, sensitivity analyses, to establish "bands" in areas of uncertainty, will be valuable in defusing challenges based on nitpicky disagreement with input/assumptions.

(3) Good documentation is also the best defense against--real or alleged--abuse or manipulation of results. (Since the computation process itself is easily auditable, clear visibility of input and assumptions leaves little room for "mystery" or tempering with outcomes.)

d. A philosophical comment: Whenever possible within time and other constraints, it is a good idea to involve in the process of analysis some of the disparate elements who will likely review or react to the outcome; e.g., by participation in selection of critical parameters, evaluation criteria, weighting, or even scoring of intangible aspects.

(1) This approach may require an arbiter or referee, but pays off in terms of strengthening of the evaluation by broadening the foundation and by fostering better appreciation of the task via greater exposure.

(2) It also reduces the opportunity for nonconstructive criticism, since the major players will have become at least "associate team members" by virtue of having contributed to the game plan.

2. Software Adaptation.

a. The CBRA source program is written in Fortran IV language for interactive use on an IBM 360/65 computer, accessible from a remote terminal. It is easily transportable to any computer which utilizes a Fortran compiler.

b. If you have access to personal-interactive type computers, better results (and virtually infinite variations) can be attained by merely applying the CBRA flow chart logic IAW the specific computer operating instructions, rather than attempting to actually convert the program. (Some sample output, using Apple II with Visi-Calc package, is attached.) It should also be noted that this type of computer application is much faster than "main frame" type application.

c. If you encounter difficulty in adapting the CBRA model to your situation, and cannot obtain needed programming assistance locally, use the Questionnaire provided at V.D to contact the authors for assistance.

APPLE II VERSION OF CBRM MODEL USING VISICALC AS SOFTWARE BASIS
ADAPTED SEPTEMBER 1980 BY MAJ JAMES P. BELL ASH PMO

/FORMAT 1 /

LEVEL 1 SCORE 0

INDEX	CELL #	CELL ID	VALUE	PRIME SUB WEIGHT	INDEX	CELL #	CELL ID	VALUE	WEIGHT
1	X110000	TECH	0	40	73	X130000	LOG SUPT	0	15
2	111000	A/C PERF	0	35	74	131000	TRANSPOR	0	15
3	111100	VROC	0	15	75	131100	C-5	0	15
4	111200	AIR SPD	0	15	76	131200	C-130	0	25
5	111300	ENDURANC	0	20	77	131300	C-141	0	50
6	111400	AGIL/MAN	0	50	78	131400	SELF	0	10
7	111410	LOW SPED	0	35	79	132000	SUPY SPT	0	25
8	111420	CONTOUR	0	40	80	132100	INT PROD	0	50
9	111430	LANDING	0	25	81	132200	REPLNSH	0	35
10	112000	MMS	0	35	82	132300	COMMONAL	0	15
11	112100	TGT DET	0	25	83	133000	RAM	0	25
12	112110	DAY	0	50	84	133100	MTBF	0	50
13	112120	NIGHT	0	40	85	133110	MEP	0	60
14	112130	OBSCURNT	0	10	86	133120	AIRCRAFT	0	40
15	112200	TGT RECO	0	25	87	133200	MMH/FH	0	50
16	112210	DAY	0	50	88	133210	AVUM	0	40
17	112220	NIGHT	0	40	89	133211	MEPXXXXX	0	50
18	112230	OBSCURNT	0	10	90	133212	AIRCRAFT	0	50
19	112300	TGT DESI	0	20	91	133220	AVIM	0	60
20	112310	DAY	0	35	92	133221	MEP	0	60
21	112320	NIGHT	0	30	93	133222	AIRCRAFT	0	70
22	112330	INTERUP	0	35	94	134000	ACCIDENT	0	5
23	112400	TGT LOC	0	20	95	135000	MAT INTR	0	30
24	112410	ACCURACY	0	60	96	135100	PERSONNL	0	30
25	112420	FEATURES	0	40	97	135200	SKILLS	0	15
26	112500	P FEEDBK	0	10	98	135300	TRAINING	0	15
27	112510	DISPLAY	0	60	99	135400	DATA/MAN	0	30
28	112520	RECORD	0	40	100	135500	TOE CHGS	0	10
29	113000	OTHR MEP	0	10	101	X140000	ATTAINAB	0	10
30	113100	COMMO EQ	0	40	102	141000	ACQN APP	0	35
31	113200	NAV EQ	0	50	103	141100	DEVELOPM	0	30
32	113300	ASE EQ	0	10	104	141200	PRODUCTI	0	40
33	114000	ARMAMENT	0	5	105	141300	OVERHAUL	0	10
34	115000	SURVIVAB	0	5	106	141400	$ TIMING	0	20
35	115100	CRASHWOR	0	30	107	142000	RISK	0	55
36	115200	VULNERAB	0	70	108	142100	SCHEDULE	0	35
37	115210	PH/PK	0	20	109	142110	IOC	0	65
38	115220	STRIKE	0	40	110	142120	CONCURRE	0	35
39	115230	BALLISTI	0	40	111	142200	TECHNICA	0	40
40	115231	CREW	0	60	112	142210	MEP	0	25
41	115232	FLT CONT	0	40	113	142220	SYS INTE	0	35
42	116000	GROWTH P	0	10	114	142230	STE/PGSE	0	10
43	116100	ARMAMENT	0	35	115	142240	PRODUCIB	0	15
44	116100	MEP	0	35	116	142250	A/C PERF	0	15
45	116300	SURVIVAB	0	10	117	142300	COST REA	0	25
46	116400	A/C PERF	0	20	118	142310	DEVELOPM	0	40
47	116410	VROC	0	20	119	142320	PROCUREM	0	60
48	116420	DASH	0	10	120	143000	MGT PLAN	0	10
49	116430	NOE	0	40					
50	116440	ENDURANC	0	30					

51	X120000	DE SUIT	0	35	121	X150000 COST	0	0
52	121000	NSN ANAL	0	50	122	151000 LIFE CYC	0	85
53	121100	SCT RULE	0	50	123	151100 ACQ COST	0	85
54	121110	ATTACK	0	30	124	151110 RDTE	0	40
55	121120	AIR CAV	0	40	125	151120 APA	0	60
56	121130	FIRE ADJ	0	30	126	151200 O/S OTHR	0	15
57	121200	TIME	0	50	127	152000 FORCE CO	0	15
58	121210	ENROUTE	0	60				
59	121211	LOW LEVL	0	20				
60	121212	CONTOUR	0	30				
61	121213	NOE	0	50				
62	121220	BTL MOVE	0	40				
63	121221	FWD PSN	0	60				
64	121222	BTWN PSN	0	40				
65	122000	DETECTAB	0	10				
66	122100	ENROUTE	0	65				
67	122200	BTL MAINT	0	35				
68	123000	USER ACC	0	40				
69	123100	P WKLOAD	0	60				
70	123110	NOE FLT	0	60				
71	123120	BTL OPNS	0	40				
72	123200	HANDLING	0	40				

APPLE II VERSION OF COBRA MODEL USING VISICALC AS SOFTWARE BASIS
ADAPTED SEPTEMBER 1980 BY MAJ JAMES P. BELL ASH PMO

//BASE BASE

PRIME SUB LEVEL 1 SCORE 36.70E4

INDEX	CELL #	CELL ID	VALUE	WEIGHT	INDEX	CELL #	CELL ID	VALUE	WEIGHT
1	110000	TECH	33.3585	50	73	130000	LOG SUPT	35.25	15
2	111000	A/C PERF	25.75	35	74	131000	TRANSPOR	34.5	15
3	111100	VROC	15	15	75	131100	C-5	15	15
4	111200	AIR SPD	15	15	76	131200	C-130	25	25
5	111300	ENDURANC	20	20	77	131300	C-141	50	50
6	111400	AGIL/MAN	34.5	50	78	131400	SELF	10	10
7	111410	LON SPED	35	35	79	132000	SUPY SPT	39.5	25
8	111420	CONTOUR	40	40	80	132100	INT PROV	50	50
9	111430	LANDING	25	25	81	132200	REPLNSH	35	35
10	112000	MNS	43.3	30	82	132300	COMMONAL	15	15
11	112100	TGT DET	42	30	83	133000	RAM	51.6	25
12	112110	DAY	50	50	84	133100	MTBF	52	50
13	112120	NIGHT	40	40	85	133110	MEP	60	60
14	112130	OBSCURNT	10	10	86	133120	AIRCRAFT	40	40
15	112200	TGT RECO	42	20	87	133200	MMH/FH	51.2	50
16	112210	DAY	50	50	88	133210	AVUM	50	40
17	112220	NIGHT	40	40	89	133211	MEPXXXXX	50	50
18	112230	OBSCURNT	10	10	90	133212	AIRCRAFT	50	50
19	112300	TGT DESI	33.5	20	91	133220	AVIM	52	60
20	112310	DAY	35	35	92	133221	MEP	60	60
21	112320	NIGHT	30	30	93	133222	AIRCRAFT	40	40
22	112330	INTERUP	35	35	94	134000	ACCIDENT	5	5
23	112400	TGT LOC	52	20	95	135000	MAT INTR	23.5	30
24	112410	ACCURACY	60	60	96	135100	PERSONNL	30	30
25	112420	FEATURES	40	40	97	135200	SKILLS	15	15
26	112500	P FEEDBK	52	10	98	135300	TRAINING	15	15
27	112510	DISPLAY	60	60	99	135400	DATA/MAN	30	30
28	112520	RECORD	40	40	100	135500	TOE CHGS	10	10
29	113000	OTHR MEP	42	10	101	140000	ATTAINAB	34.4213	10
30	113100	COMMO EQ	40	40	102	141000	ACQN APP	30	35
31	113200	NAV EQ	50	50	103	141100	DEVELOPM	30	30
32	113300	ASE EQ	10	10	104	141200	PRODUCTI	40	40
33	114000	ARMAMENT	5	5	105	141300	OVERHAUL	10	10
34	115000	SURVIVAB	37.56	10	106	141400	$ TIMING	20	20
35	115100	CRASHWOR	30	30	107	142000	RISK	41.675	55
36	115200	VULNERAB	40.8	70	108	142100	SCHEDULE	54.5	35
37	115210	PH/PK	20	20	109	142110	IOC	65	65
38	115220	STRIKE	40	40	110	142120	CONCURRE	35	35
39	115230	BALLISTI	52	40	111	142200	TECHNICA	24	40
40	115231	CREW	60	60	112	142210	MEP	25	25
41	115232	FLT CONT	40	40	113	142220	SYS INTE	35	35
42	116000	GROWTH P	31.5	10	114	142230	STE/PGSE	10	10
43	116100	ARMAMENT	35	35	115	142240	PRODUCIB	15	15
44	116100	MEP	35	35	116	142250	A/C PERF	15	15
45	116300	SURVIVAB	10	10	117	142300	COST REA	52	25
46	116400	A/C PERF	30	20	118	142310	DEVELOPM	40	40
47	116410	VROC	20	20	119	142320	PROCUREM	60	60
48	116420	DASH	10	10	120	143000	MGT PLAN	10	10
49	116430	NOE	40	40					
50	116440	ENDURANC	30	30					

USAAVRADCOM TR# 81-F-2

Cost Benefit-Ratio Analysis (CBRA) Technique

ERRATA SHEET

Page	Paragraph	Correction
20	f (2)	"delectability" should be "detectability".
29	7a	CW for last column (Schedule) should be (.15) vs. (.10)
30	7b	Same - CW for Schedule column should be (.15).
97	d, Sys A	MEP Acqn Cost (last column) should be 655.8 vs. 655.9.
104-105	Comment:	Since these charts are purely for illustration, no effort was made to portray the colors referred to in the chart legend.

V - APPENDICES

A. GLOSSARY OF TERMS/ACRONYMS

ASF:	Army Stock Fund
APA:	Aircraft Procurement Army
BCE:	Baseline Cost Estimate
CA:	Cost Analysis
CB:	Cell Block
CBRA:	Cost Benefit Ration Analysis
CBR:	Cost Benefit Ratio
CC:	Candidate Cost
CCM:	Counter-Countermeasures
CFP:	Concept Formulation Package
CM:	Countermeasures
COEA:	Cost & Operational Effectiveness Analysis
CP:	Critical Parameter
CTEA:	Cost & Training Effectiveness Analysis
CW:	Cell Weight
EA:	Economic Analysis
ECP:	Engineering Change Proposal
ED:	Engineering Developmet
EPA:	Extended Planning Annex

ES:	Evaluation Structure
EW:	Electronic Warfare
FSED:	Full Scale Engineering Development
LCC:	Life Cycle Cost
LCCE:	Life Cycle Cost Estimate
MTBF:	Mean Time Between Failure
OMA:	Operations & Maintenance Army
O&S	Operating & Support
PIP:	Product Improvement Program
POM:	Program Objective Memorandum
RA:	Risk Assessment
RAM:	Reliability and Maintainability
RDTE:	Research, Development, Test & Evaluation
RISNET:	Risk Information System & Network Evaluation Technique
RS:	Raw Score
RW:	Relative Worth
SA:	Sensitivity Analysis
SS:	Scoring Standard
S&E:	Scientific & Engineering
SSEB:	Source Selection Evaluation Board
TOA ($):	Total Obligation Authority
TOA:	Tradeoff Analysis
TOD:	Tradeoff Determination
TRACE:	Total Risk Assessing Cost Estimate
WS:	Weighted Score

B. LIST OF ILLUSTRATIONS

C. REFERENCES

Dept. of Army Pubs:

AR	11-4	System Program Reviews
	11-18	The Cost Analysis Program
	11-28	Economic Analysis and Program Evaluation for Resource Management
	70-15	Product Improvement of Material
	71-9	Material Objectives and Requirements
	230-16	Risk Management Program (RIMP)
PAM	5-10	Review and Analysis
	11-2	Research and Development Cost Guide for Army Material Systems
	11-3	Investments Cost Guide for Army Material Systems
	11-4	Operating and Support Cost Guide for Army Material Systems
	11-5	Standards for Presentation and Documentation of Life Cycle Cost Estimate for Army Material Systems
	11-25	Life Cycle System Management Model for Army Systems
	70-20	Qualitive Requirements Information (QRI) -- QRI Managers Guide

DARCOM Pubs:

AMCR/DARCOMR	11-27	Life Cycle Management of DARCOM Materiel
	11-31	Resource Management-Cost Analysis Principles and Responsibilities
	70-5	Material Acquisitition Decision Process Reviews Field Liaison Visits
	70-30	Concept Formulation-Prerequisites to Initiating Engineering or Operational Systems Development Effort
PAM	715-3	Proposal Evaluation and Source Selection

CBRA.FORT

```
C
C       PROGRAM CBRA - COST BENEFIT RATIO ANALYSIS
C
C       THIS PROGRAM ROLLS UP THE WEIGHTED SCORES OF AN N LEVEL PYRAMIDAL
C          STRUCTURE WITH AN EXPANSION OF (IWIDE) ELEMENTS PER LEVEL.
C          DATA CAN BE RETAINED IN A PERMANENT DATA SET FOR LATER
C          REVISION AND USE.  MAXIMUM IWIDE IS 8.
C
       INTEGER ALPH(300,4),TEST,ID(300),CELL(10),DSET(300,8)
       INTEGER BASE,HUNTH,TENTH,ONETH,ONEH,TEN,ONE
       COMMON ID,TEST,DSET,CELL,IEND,ALPH,L,BASE,IWIDE,IEDIT
C      ********************************************************************
C      *                                                                  *
C      *   INSTRUCTIONS FOR ACCESSING S&E COMPUTER:                       *
C      *                                                                  *
C      *     1.  TURN THE AQILE TYPEWRITER ON.                            *
C      *     2.  SET GANDALF BOX TO '30', SWITCH TO 'READY'.              *
C      *     3.  PRESS 'RESET' KEY TO 'ON'.                               *
C      *     4.  PRESS 'ON LINE' KEY TO 'ON'.                             *
C      *     5.  PRESS 'ALL CAPS' KEY TO 'ON'.                            *
C      *     6.  PRESS 'ESC' KEY TO 'ON'.                                 *
C      *     7.  ALL OTHER TOP KEYS SHOULD BE 'OFF'.                      *
C      *     8.  TYPE 'LOGON USERID/PASSWORD', PRESS 'RETURN'.            *
C      *     9.  WHEN MACHINE TYPES 'READY', TYPE IN 'EXEC CBRA'          *
C      *           AND PRESS 'RETURN' (C/R).                              *
C      *    10.  WHEN FINISHED WITH PROGRAM, TYPE IN 'LOGOFF' AND         *
C      *           AND PRESS 'RETURN' (C/R).                              *
C      *                                                                  *
C      ********************************************************************
C
  999 FORMAT(' PROGRAM CBRA IS NOW LOADED AND READY'//)
  998 FORMAT(/' CELL #     CELL NAME          SCOR  WT'/
     *' --------*---------------*---*---*')
  997 FORMAT(1X,I8,1X,4A4,1X,I3,1X,I3)
  996 FORMAT(/' YOUR DATA SET (NUMBER ',I1,') WAS READ INTO THE ',
     *'COMPUTER AS FOLLOWS:'/)
  995 FORMAT(I5,2X,I8,4X,4A4,4X,I3,6X,I3)
  994 FORMAT(/' CODES FOR CHANGES ARE:'//'     A - ADD OR CHANGE ',
     *'AN ENTIRE CELL LINE.'//'     W - CHANGE WEIGHT FOR CELL.'/
     *'     S - CHANGE SCORE FOR CELL.'//'     D - DELETE CELL.'/
     *'     P - PRINT DATA SET FOR REFERENCE'//'     $ - SAVE DATA AS ',
     *'IS (OPTIONAL JUMP OUT)'//'     C/R - END CHANGES AND CONTINUE.')
  992 FORMAT(/I5,' CELLS USED')
  991 FORMAT(//' FOR PROGRAM OUTPUT, ADVANCE PAPER TO CLEAN PAGE, ',
     *'3 LINES FROM TOP WHEN READY,'//'     PRESS 'RETURN' TO CONTINUE.')
  990 FORMAT(7X,'LEVEL',2SX,'CELL NAME',8X,'SCORE',2X,'WEIGHT',3X,
     *'SYSTEM WEIGHT'/)
  989 FORMAT(6X,I8,22X,4A4,3X,I4,3X,F5.0,6X,F8.4)
  988 FORMAT(8X,I8,19X,4A4,3X,I4,3X,F5.0,9X,F8.4)
  987 FORMAT(11X,I8,16X,4A4,3X,I4,3X,F5.0,12X,F8.4)
  986 FORMAT(14X,I8,13X,4A4,3X,I4,3X,F5.0,15X,F8.4)
```

```
00540    985 FORMAT(17X,I8,10X,4A4,3X,I4,3X,F6.0,18X,F8.4)
00550    984 FORMAT(20X,I8,7X,4A4,3X,I4,3X,F6.0,21X,F8.4)
00560    983 FORMAT(23X,I8,4X,4A4,3X,I4,3X,F6.0,24X,F8.4)
00570    982 FORMAT(/' YOU WILL BE PROMPTED FOR EACH LINE OF INPUT.  ENTER ',
00580       $'ALPHANUMERICS AND NUMBERS ONLY UNDER THE DASH FIELDS.'/,
00590       $'   NUMBERS MUST BE RIGHT JUSTIFIED (EXCEPT FOR CELL #).',
00600       $'  IF YOU MAKE A MISTAKE, '
00610       $'GO ON AND FINISH ENTERING DATA.'//'   YOU WILL BE GIVEN ',
00620       $'AN OPPORTUNITY TO EDIT THE INPUT DATA SET BEFORE ROLL-UP ',
00630       $'BEGINS.'///'   ENTER 'STORE' UNDER CELL NAME TO STORE WHAT ',
00640       $'YOU HAVE NOW AND TERMINATE THE RUN.'//'   PRESS 'RETURN' TO END ',
00650       $'ENTRIES.'//'   DO NOT ENTER LEVEL 1 DATA - YOU WILL BE PROMPTED ',
00660       $'FOR IT LATER.'///)
00670    981 FORMAT(/' ENTER APPROPRIATE CODE FROM ABOVE LIST')
00680    980 FORMAT(2X,I8,25X,4A4,3X,I4,3X,F5.0,3X,F8.4)
00690    979 FORMAT(////' DO YOU WISH TO MAKE ANOTHER RUN, YES OR NO?')
00700    978 FORMAT(A4)
00710    977 FORMAT(/' DO YOU WANT TO SEE THE FINAL DATA SET, YES OR NO?')
00720    976 FORMAT(' DO YOU WANT TO USE A FILE DATA SET, YES OR NO?')
00730    975 FORMAT(' DO YOU WANT TO SEE THE REVISED DATA SET, YES OR NO?')
00740    974 FORMAT(//' DO YOU WANT TO REPLACE AN OLD DATA SET WITH THIS ',
00750       $'ONE, YES OR NO?')
00760    973 FORMAT(/' INDEX   CELL #       CELL NAME              SCORE   WEIGHT'/)
00770    972 FORMAT(' ENTER FILE NUMBER, VALID NUMBERS ARE 1, 2, 3, AND 4.')
00780    971 FORMAT(' FILE NUMBER INCORRECT - MUST BE 1, 2, 3, OR 4')
00790    970 FORMAT(/' ENTER INDEX # AND CORRECT SCORE'/' ---#---#')
00800    969 FORMAT(/' ENTER INDEX # AND CORRECT WEIGHT'/' ---#---#')
00810    968 FORMAT(I3,1X,I3)
00820    967 FORMAT(' IN WHICH DATA SET DO YOU WANT DATA STORED?  VALID SETS ',
00830       $'ARE 1, 2, 3, OR 4.')
00840    966 FORMAT(/' YOUR DATA SET WAS READ INTO THE COMPUTER AS FOLLOWS:')
00850    965 FORMAT(I8,1X,4A4,1X,I3,1X,I3)
00860    964 FORMAT(' WARNING! THIS DATA SET WAS PREVIOUSLY STORED PRIOR ',
00870       $'TO BEING CHECKED.')
00880    963 FORMAT(' DO YOU WANT TO STORE THIS DATA SET IN ANOTHER FILE,',
00890       $' YES OR NO?')
00900    962 FORMAT(/' ROLLUP COMPUTATIONS ARE IN PROGRESS.')
00910    961 FORMAT(' CELL ',I8,' HAS BEEN DELETED.')
00920    960 FORMAT(4I6)
00930    959 FORMAT(/' ENTER THE NUMBER OF LEVELS AND CELLS PER LEVEL',
00940       $'//' LVL C/L'//' ---#---#')
00950    957 FORMAT(' TOO FEW LEVELS, RUN IS CANCELLED.')
00960    956 FORMAT(/' DATA SET STRUCTURE: ',I3,' CELLS, ',I1,' LEVELS,',
00970       $' AND ',I1,' CELLS PER LEVEL')
00980    955 FORMAT(/' DO YOU WISH TO CHANGE NUMBER OF CELLS PER LEVEL, ',
00990       $'YES OR NO?')
01000    954 FORMAT(/' ENTER INDEX # OF CELL TO DELETE')
01010    953 FORMAT(/' ENTER INDEX # OF CELL TO CHANGE OR ADD')
01020    952 FORMAT(/' DATA HAS BEEN SAVED IN DATA SET',I2/'   DO YOU ',
01030       $'WISH TO CONTINUE WITH EDITING THIS DATA, YES OR NO?')
01040    951 FORMAT(/' CANNOT ADD CELL - CELL # ALREADY EXISTS')
01050 C
01060 C      INITIATE PROGRAM VARIABLES
01070 C
```

```
      DATA IYES/'YES '/,IWT/'W   '/,IVAL/'V   '/,ICR/'    '/
      DATA ISTO/'STOR'/,ISTO/'S   '/,IDLT/'D   '/,INO/'NO  '/
      DATA IA/'A   '/,IBR/'B   '/
      WRITE(6,999)
   20 NSET=0
      DO 25 I=1,300
      DO 24 J=1,4
   24 ALPH(I,J)=ICR
      ID(I)=0
      DSET(I,3)=0
      DSET(I,1)=0
   25 DSET(I,2)=0
   26 WRITE(6,976)
      READ(5,978)K
      IF(K.NE.IYES.AND.K.NE.INO)GO TO 26
      IF(K.EQ.INO)GO TO 36
C
C     READ DATASET FROM A FILE
C
   30 WRITE(6,972)
      READ(5,*)NSET
      IF(NSET.LT.5.AND.NSET.GT.0)GO TO 32
      WRITE(6,971)
      GO TO 30
   32 READ(NSET,960)IEND,IWIDE,IDEEP
      IF(IEND.GT.300)WRITE(6,964)
      IF(IEND.GT.300)IEND=IEND-299
      I=0
      IEND=IEND-1
      DO 35 K=1,IEND
      I=I+1
      READ(NSET,967)ID(I),(ALPH(I,J),J=1,4),(DSET(I,J),J=1,2)
      IF(ID(I).NE.0.AND.ID(I).LT.40000000)GO TO 34
      I=I-1
      GO TO 35
   34 ID(I)=ID(I)+10000000
   35 CONTINUE
      IEND=I
      REWIND NSET
      GO TO 52
C
C     READ DATASET FROM TERMINAL INPUT
C
   36 WRITE(6,969)
      READ(5,968)IDEEP,IWIDE
      WRITE(6,982)
      IEND=1
   40 WRITE(6,988)
      READ(5,985)ID(IEND),(ALPH(IEND,I),I=1,4),(DSET(IEND,I),I=1,2)
      IF(ID(IEND).EQ.0)GO TO 50
      IEND=IEND+1
      GO TO 40
   50 IEND=IEND-1
      IF(ALPH(IEND+1,1).EQ.ISTO)KODE=ISTO
```

```
      IF(ALPH(IEND+1,1).EQ.ISTO)GO TO 98
   52 IF(NSET.GE.1)WRITE(6,996)NSET
      IF(NSET.EQ.0)WRITE(6,988)
C
C     DECIDE ABOUT PRINTING OUT THE DATA SET
C
   58 WRITE(6,956)IEND,IDEEP,IWIDE
      WRITE(6,973)
      DO 60 I=1,IEND
      IF(ID(I).GT.40000000)GO TO 60
      WRITE(6,995)I,ID(I),(ALPH(I,J),J=1,4),(DSET(I,J),J=1,2)
   60 CONTINUE
C
C     MAKE ANY CHANGES NEEDED IN THE DATASET
C
   62 IEDIT=0
      WRITE(6,955)
      READ(5,978)KODE
      IF(KODE.NE.IYES.AND.KODE.NE.INO)GO TO 62
      IF(KODE.EQ.INO)GO TO 68
      WRITE(6,959)
      READ(5,968)IDEEP,IWIDE
   68 LMT=10-IWIDE
      LMT1=LMT*10
      LMT2=LMT1*10
      LMT3=LMT2*10
      LMT4=LMT3*10
      LMT5=LMT4*10
      L=IDEEP
      WRITE(6,994)
   70 WRITE(6,981)
      READ(5,978)KODE
      IF(KODE.EQ.ICR)GO TO 90
      IF(KODE.EQ.IPR)GO TO 58
      IF(KODE.EQ.IWT)GO TO 80
      IF(KODE.EQ.IVAL)GO TO 75
      IF(KODE.EQ.JSTO)GO TO 90
      IF(KODE.EQ.IDLT)GO TO 85
      IF(KODE.NE.IA)GO TO 70
      WRITE(6,953)
      READ(5,*)I
      IF(I.GT.IEND)I=IEND+1
      IF(I.GT.IEND)IEND=I
      WRITE(6,998)
      READ(5,966)ID(I),(ALPH(I,J),J=1,4),(DSET(I,J),J=1,2)
      IF(ALPH(I,1).EQ.ISTO)GO TO 666
      J=IEND-1
      DO 72 I=1,J
      IF(ID(IEND).EQ.ID(J))GO TO 73
   72 CONTINUE
      GO TO 70
   73 WRITE(6,951)
      IEND=J
      GO TO 70
```

```
02250      75 WRITE(6,970)
02260         READ(5,968)I,DSET(I,1)
02280         GO TO 70
02290      80 WRITE(6,969)
02300         READ(5,968)I,DSET(I,2)
02320         GO TO 70
02330      85 WRITE(6,964)
02340         READ(5,*)I
02350         WRITE(6,961)ID(I)
02360         ID(I)=50000000
02370         GO TO 70
02380      90 DO 95 I=1,IEND
02390      95 ID(I)=ID(I)-10000000
02400         IF(ALPH(IEND+1,1).EQ.ISTO.OR.KODE.EQ.JSTO)GO TO 686
02410         WRITE(6,962)
02420 C
02430 C       ROLLUP OF LEVEL 8 INTO LEVEL 7
02440 C
02450         IF(IDEEP.LT.8)GO TO 200
02460    :00  TEST=11111110
02470         DO 180 I7=1,IWIDE
02480         DO 170 I6=1,IWIDE
02490         DO 160 I5=1,IWIDE
02500         DO 150 I4=1,IWIDE
02510         DO 140 I3=1,IWIDE
02520         DO 130 I2=1,IWIDE
02530         DO 120 I=1,IWIDE
02540         TEST=TEST+1
02550         DO 110 J=1,IEND
02560         IF(TEST.EQ.ID(J))GO TO 115
02570    110  CONTINUE
02580         CELL(I)=J
02590         GO TO 120
02600    115  CELL(I)=J
02610    120  CONTINUE
02620         TEST=TEST+LMT-10
02630         CALL ROLLUP
02640         IF(IEDIT.EQ.1)GO TO 62
02650    130  TEST=TEST+10
02660    140  TEST=TEST+LMT1
02670    150  TEST=TEST+LMT2
02680    160  TEST=TEST+LMT3
02690    170  TEST=TEST+LMT4
02700    180  TEST=TEST+LMT5
02710         L=L-1
02720 C
02730 C       ROLLUP OF LEVEL 7 INTO LEVEL 6
02740 C
02750    200  IF(IDEEP.LT.7)GO TO 300
02760         TEST=11111100
02770         DO 270 I7=1,IWIDE
02780         DO 260 I6=1,IWIDE
02790         DO 250 I5=1,IWIDE
02800         DO 240 I4=1,IWIDE
```

```
02810          DO 230 I3=1,IWIDE
02820          DO 220 I2=1,IWIDE
02830          TEST=TEST+10
02840          DO 210 J=1,IEND
02850          IF(TEST.EQ.ID(J))GO TO 215
02860      210 CONTINUE
02870          CELL(I2)=0
02880          GO TO 220
02890      215 CELL(I2)=J
02900      220 CONTINUE
02910          TEST=TEST+LAT1-100
02920          CALL ROLLUP
02930          IF(IEDIT.EQ.1)GO TO 62
02940      230 TEST=TEST+100
02950      240 TEST=TEST+LAT2
02960      250 TEST=TEST+LAT3
02970      260 TEST=TEST+LAT4
02980      270 TEST=TEST+LAT5
02990          L=L-1
03000  C
03010  C       ROLLUP OF LEVEL 6 INTO LEVEL 5
03020  C
03030      300 IF(IDEEP.LT.6)GO TO 400
03040          TEST=1111000
03050          DO 360 I7=1,IWIDE
03060          DO 350 I6=1,IWIDE
03070          DO 340 I5=1,IWIDE
03080          DO 330 I4=1,IWIDE
03090          DO 320 I3=1,IWIDE
03100          TEST=TEST+100
03110          DO 310 J=1,IEND
03120          IF(TEST.EQ.ID(J))GO TO 315
03130      310 CONTINUE
03140          CELL(I3)=0
03150          GO TO 320
03160      315 CELL(I3)=J
03170      320 CONTINUE
03180          TEST=TEST+LAT2-1000
03190          CALL ROLLUP
03200          IF(IEDIT.EQ.1)GO TO 62
03210      330 TEST=TEST+1000
03220      340 TEST=TEST+LAT3
03230      350 TEST=TEST+LAT4
03240      360 TEST=TEST+LAT5
03250          L=L-1
03260  C
03270  C       ROLLUP OF LEVEL 5 INTO LEVEL 4
03280  C
03290      400 IF(IDEEP.LT.5)GO TO 500
03300          TEST=1110000
03310          DO 460 I7=1,IWIDE
03320          DO 440 I6=1,IWIDE
03330          DO 430 I5=1,IWIDE
03340          DO 420 I4=1,IWIDE
```

```
03360          TEST=TEST+1000
03370          DO 410 J=1,IEND
03380          IF(TEST.EQ.ID(J))GO TO 415
03390      410 CONTINUE
03400          CELL(I4)=0
03410          GO TO 420
03420      415 CELL(I4)=J
03430      420 CONTINUE
03440          TEST=TEST+LMT3-10000
03450          CALL ROLLUP
03460          IF(IEDIT.EQ.1)GO TO 62
03470      430 TEST=TEST+10000
03480      440 TEST=TEST+LMT4
03490      450 TEST=TEST+LMT5
03500          L=L-1
03510 C
03520 C        ROLLUP OF LEVEL 4 INTO LEVEL 3
03530 C
03540      500 IF(IDEEP.LT.4)GO TO 600
03550          TEST=1110000
03560          DO 540 I7=1,IWIDE
03570          DO 530 I6=1,IWIDE
03580          DO 520 I5=1,IWIDE
03590          TEST=TEST+10000
03600          DO 510 J=1,IEND
03610          IF(TEST.EQ.ID(J))GO TO 515
03620      510 CONTINUE
03630          CELL(I5)=0
03640          GO TO 520
03650      515 CELL(I5)=J
03660      520 CONTINUE
03670          TEST=TEST+LMT4-100000
03680          CALL ROLLUP
03690          IF(IEDIT.EQ.1)GO TO 82
03700      530 TEST=TEST+100000
03710      540 TEST=TEST+LMT5
03720          L=L-1
03730 C
03740 C        ROLLUP OF LEVEL 3 INTO LEVEL 2
03750 C
03760      600 IF(IDEEP.LT.3)GO TO 900
03770          TEST=1000000
03780          DO 830 I7=1,IWIDE
03790          DO 820 I6=1,IWIDE
03800          TEST=TEST+10000
03810          DO 810 J=1,IEND
03820          IF(TEST.EQ.ID(J))GO TO 815
03830      810 CONTINUE
03840          CELL(I6)=0
03850          GO TO 820
03860      815 CELL(I6)=J
03870      820 CONTINUE
03880          TEST=TEST+LMT5-1000000
03890          CALL ROLLUP
```

```
03920          IF(IEDIT.EQ.1)GO TO 62
03930    630   TEST=TEST+1000000
03940          L=L-1
03950  C
03960  C       ROLLUP OF LEVEL 2 INTO LEVEL 1
03970  C
03980    650   TEST=0000000
03990          DO 670 I7=1,IWIDE
04000          TEST=TEST+1000000
04010          DO 660 J=1,IEND
04020          IF(TEST.EQ.ID(J))GO TO 665
04030    660   CONTINUE
04040          CELL(I7)=0
04050          GO TO 670
04060    665   CELL(I7)=J
04070    670   CONTINUE
04080          TEST=TEST+(LMTS*10-10000000)
04090          CALL ROLLUP
04100          IF(IEDIT.EQ.1)GO TO 62
04110          L=L-1
04120  C
04130  C       ROUTINE TO PRINT OUT FINAL DATA SET FROM ROLLUP
04140  C
04150    672   WRITE(6,977)
04160          READ(5,978)K
04170          IF(K.NE.IYES.AND.K.NE.INO)GO TO 672
04180          IF(K.EQ.INO)GO TO 685
04190          WRITE(6,956)IEND,IDEEP,IWIDE
04200          WRITE(6,973)
04210          DO 680 I=1,IEND
04220          IDJ=ID(I)+10000000
04230          IF(IDJ.GT.40000000)GO TO 680
04240          IF(I.EQ.IEND)IDJ=ID(I)
04250          WRITE(6,995)I,IDJ,(ALPH(I,J),J=1,4),(DSET(I,J),J=1,2)
04260    680   CONTINUE
04270  C
04280  C       ROUTINE TO STORE DATASET IN A FILE OR NOT
04290  C
04300    685   WRITE(5,974)
04310          READ(5,978)K
04320          IF(K.NE.IYES.AND.K.NE.INO)GO TO 685
04330          IF(K.EQ.INO)GO TO 700
04340    686   WRITE(6,987)
04350          READ(5,*)NSET
04360          IF(NSET.LT.6.AND.NSET.GT.0)GO TO 688
04370          WRITE(6,971)
04380          GO TO 686
04390    688   REWIND NSET
04400          JEND=IEND
04410          IF(KODE.EQ.JSTO.OR.ALPH(IEND+1,1).EQ.ISTO)JEND=JEND+300
04420          WRITE(NSET,980)JEND,IWIDE,IDEEP
04430          DO 690 I=1,300
04440          IF(ID(I).GT.40000000)GO TO 690
04450          WRITE(NSET,997)ID(I),(ALPH(I,J),J=1,4),(DSET(I,J),J=1,8)
```

```
      690 CONTINUE
      698 REWIND NSET
          IF(KODE.EQ.JSTO.OR.ALPH(IEND+1,1).EQ.ISTO)GO TO 840
      699 WRITE(6,963)
          READ(5,978)K
          IF(K.NE.IYES.AND.K.NE.INO)GO TO 699
          IF(K.EQ.IYES)GO TO 686
C
C     PRINT OUT RESULTS OF THE ROLLUP
C
      700 WRITE(6,991)
      720 READ(5,995)I
          IF(I.NE.0)GO TO 700
          WRITE(6,990)
          BASE=10000000
          CALL FIND(BASE,IDENT)
          WT1=DSET(IDENT,2)/100.
          CUT=DSET(IDENT,2)
          WRITE(6,980)BASE,(ALPH(IDENT,J),J=1,4),DSET(IDENT,1),CUT,WT1
          DO 750 I7=1,IWIDE
          MIL=I7*1000000
          CALL FIND(MIL,IDENT)
          IF(IDENT.EQ.0)GO TO 750
          WT2=WT1*DSET(IDENT,2)/100.
          CUT=DSET(IDENT,2)
          LEVEL=MIL+10000000
          WRITE(6,989)LEVEL,(ALPH(IDENT,J),J=1,4),DSET(IDENT,1),CUT,WT2
          DO 750 I6=1,IWIDE
          HUNTH=(I6*100000)+MIL
          CALL FIND(HUNTH,IDENT)
          IF(IDENT.EQ.0)GO TO 750
          WT3=WT2*DSET(IDENT,2)/100.
          CUT=DSET(IDENT,2)
          LEVEL=HUNTH+10000000
          WRITE(6,988)LEVEL,(ALPH(IDENT,J),J=1,4),DSET(IDENT,1),CUT,WT3
          DO 750 I5=1,IWIDE
          TENTH=(I5*10000)+HUNTH
          CALL FIND(TENTH,IDENT)
          IF(IDENT.EQ.0)GO TO 750
          WT4=WT3*DSET(IDENT,2)/100.
          CUT=DSET(IDENT,2)
          LEVEL=TENTH+10000000
          WRITE(6,987)LEVEL,(ALPH(IDENT,J),J=1,4),DSET(IDENT,1),CUT,WT4
          DO 750 I4=1,IWIDE
          ONETH=(I4*1000)+TENTH
          CALL FIND(ONETH,IDENT)
          IF(IDENT.EQ.0)GO TO 750
          WT5=WT4*DSET(IDENT,2)/100.
          CUT=DSET(IDENT,2)
          LEVEL=ONETH+10000000
          WRITE(6,986)LEVEL,(ALPH(IDENT,J),J=1,4),DSET(IDENT,1),CUT,WT5
          DO 750 I3=1,IWIDE
          ONEH=(I3*100)+ONETH
          CALL FIND(ONEH,IDENT)
```

```
      IF(IDENT.EQ.0)GO TO 750
      UT6=UT5*DSET(IDENT,2)/100.
      CUT=DSET(IDENT,2)
      LEVEL=ONEH+10000000
      WRITE(6,985)LEVEL,(ALPH(IDENT,J),J=1,4),DSET(IDENT,1),CUT,UT6
      DO 750 I2=1,IWIDE
      TEN=(I2*10)+ONEH
      CALL FIND(TEN,IDENT)
      IF(IDENT.EQ.0)GO TO 750
      UT7=UT6*DSET(IDENT,2)/100.
      CUT=DSET(IDENT,2)
      LEVEL=TEN+10000000
      WRITE(6,984)LEVEL,(ALPH(IDENT,J),J=1,4),DSET(IDENT,1),CUT,UT7
      DO 750 I1=1,IWIDE
      ONE=I1+TEN
      CALL FIND(ONE,IDENT)
      IF(IDENT.EQ.0)GO TO 750
      UT8=UT7*DSET(IDENT,2)/100.
      CUT=DSET(IDENT,2)
      LEVEL=ONE+10000000
      WRITE(6,983)LEVEL,(ALPH(IDENT,J),J=1,4),DSET(IDENT,1),CUT,UT8
  750 CONTINUE
      GO TO 850
C
C     END OF PRINT ROUTINE
C
  840 WRITE(6,952)NSET
      READ(5,978)K
      IF(K.NE.IYES.AND.K.NE.INO)GO TO 840
      IF(K.EQ.INO)GO TO 850
      DO 842 I=1,IEND
  842 ID(I)=ID(I)+10000000
      GO TO 62
  850 WRITE(6,978)
      READ(5,978)K
      IF(K.NE.IYES.AND.K.NE.INO)GO TO 850
      IF(K.EQ.IYES)GO TO 20
      IF(K.EQ.INO)GO TO 1000
  900 WRITE(6,957)
      GO TO 850
 1000 STOP
      END
C
      SUBROUTINE ROLLUP
C
C     THIS SUBROUTINE TESTS (IWIDE) CELLS AND ROLLS-UP TO NEXT LEVEL
C
      INTEGER ALPH(300,4),TEST,ID(300),CELL(10),DSET(300,2)
      INTEGER BASE
      COMMON ID,TEST,DSET,CELL,IEND,ALPH,L,BASE,IWIDE,IEDIT
      DATA IU/'U   '/,IE/'E   '/,ICR/'    '/
C
  999 FORMAT(//' SUM OF CELL WEIGHTS DO NOT ADD TO     - A LISTING',
     $' FOLLOWS'//'  INDEX  CELL #      CELL NAME          SCORE   ',
```

```
     $'WEIGHT'/)
 998 FORMAT(I8,3X,I8,4X,4A4,4X,I3,8X,I3)
 997 FORMAT(/' ENTER:  U - TO CHANGE WEIGHT,'//
     $'E - TO RETURN TO EDIT FOR MORE CHANGES TO DATA SET,'/
     $'          C/R - TO CONTINUE.')
 996 FORMAT(I8,1X,4A4,1X,I3,1X,I3)
 995 FORMAT(/' CANNOT FIND LEVEL ',I1,' CELL FOR ROLL-UP - MISSING',
     $' CELL NUMBER IS ',I8)
 993 FORMAT(/' ENTER CELL DATA LINE, WEIGHT DEFAULTS TO ',
     $'100.'//'  CELL NAME      SCOR  WT'/
     $' ---------------$---$---$')
 991 FORMAT(I3,1X,I3)
 990 FORMAT(' ENTER CELL NAME FOR LEVEL ',I1//' ---------------$')
 989 FORMAT(4A4)
 987 FORMAT(5X,8I5)
 986 FORMAT(5X,I5,F10.5)
 984 FORMAT(/' ENTER INDEX # AND CORRECT CELL WEIGHT'/
     $' ---$---$')
 983 FORMAT(4A4,1X,I3,1X,I3)
C
C     CHECK TO SEE IF CELLS ARE USED.
C
      LU=L-1
      SUM=0
      DO 50 I=1,IWIDE
   50 SUM=SUM+CELL(I)
      IF(SUM.EQ.0.)GO TO 200
C
C     CHECK WEIGHTS TO SEE IF THEY ADD TO 100.
C
   60 SUM=0
      DO 70 I=1,IWIDE
      J=CELL(I)
   70 IF(J.NE.0)SUM=SUM+DSET(J,2)
      IF(SUM.EQ.100.)GO TO 100
C
C     WEIGHTS DO NOT ADD TO 100 - LIST OUT FOR USER
C
      WRITE(6,999)
      DO 80 I=1,IWIDE
      J=CELL(I)
      IF(J.EQ.0)GO TO 80
      IDJ=ID(J)+10000000
      WRITE(6,998)J,IDJ,(ALPH(J,K),K=1,4),(DSET(J,K),K=1,2)
   80 CONTINUE
C
C     ACCEPT CHANGES TO CELL WEIGHTS - LEVELS 2 THRU 8
C
   90 WRITE(6,997)
      READ(5,989)K
      IF(K.NE.IW.AND.K.NE.IE.AND.K.NE.ICR)GO TO 90
      IF(K.EQ.ICR)GO TO 80
      IF(K.EQ.IE)GO TO 92
      WRITE(6,984)
```

```
06130         READ(5,991)K,DSET(K,2)
06140         GO TO 90
06150      92 IEDIT=1
06151         DO 93 I=1,IEND
06152      93 ID(I)=ID(I)-10000000
06160         GO TO 200
06170 C
06180 C       MAKE SURE CELLS HAVE NEXT LEVEL CELL FOR STORAGE
06190 C
06200     100 IF(TEST.EQ.0)GO TO 115
06210     105 DO 110 I=1,IEND
06220         I=I
06230         IF(TEST.EQ.ID(I))GO TO 120
06240     110 CONTINUE
06250         K=TEST+10000000
06260         WRITE(6,996)LU,K
06270         WRITE(6,993)
06280         IEND=IEND+1
06290         I=IEND
06300         ID(I)=TEST
06310         READ(5,983)(ALPH(I,K),K=1,4),(DSET(I,K),K=1,2)
06320         IF(DSET(I,2).EQ.0)DSET(I,2)=100
06330         GO TO 105
06340     115 IEND=IEND+1
06350         I=IEND
06360         ID(I)=10000000
06370         WRITE(6,990)LU
06380         READ(5,989)(ALPH(I,J),J=1,4)
06390         DSET(I,2)=100
06400     120 SUM=0
06410         DO 130 J=1,IWIDE
06420         K=CELL(J)
06430     130 IF(K.NE.0)SUM=SUM+DSET(K,1)*DSET(K,2)
06440         DSET(I,1)=(SUM/100.+.5)
06450     200 RETURN
06460         END
06470 C
06480         SUBROUTINE FIND(NUM,IDENT)
06490 C
06500 C       THIS SUBROUTINE FINDS GIVEN LEVEL WITHIN THE ID ARRAY
06510 C
06520         INTEGER ALPH(300,4),TEST,ID(300),CELL(10),DSET(300,2)
06530         INTEGER BASE
06540         COMMON ID,TEST,DSET,CELL,IEND,ALPH,L,BASE,IWIDE,IEDIT
06550 C
06560         DO 10 J=1,IEND
06570         IF(NUM.EQ.ID(J))GO TO 20
06580      10 CONTINUE
06590         IDENT=0
06600         GO TO 30
06610      20 IDENT=J
06620      30 RETURN
06630         END
READY
```

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4. Following additional information/clarification is requested. (Continue on additional pages if needed.)

5. This organization ☐ has applied/adapted, ☐ is considering utilization/adaptation of CBRA Technique, in the following instances/areas:

6. Based on ☐ review, ☐ utilization of the Guide, following comments/suggestions for improvement are offered. (Continue on additional pages if needed.)


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