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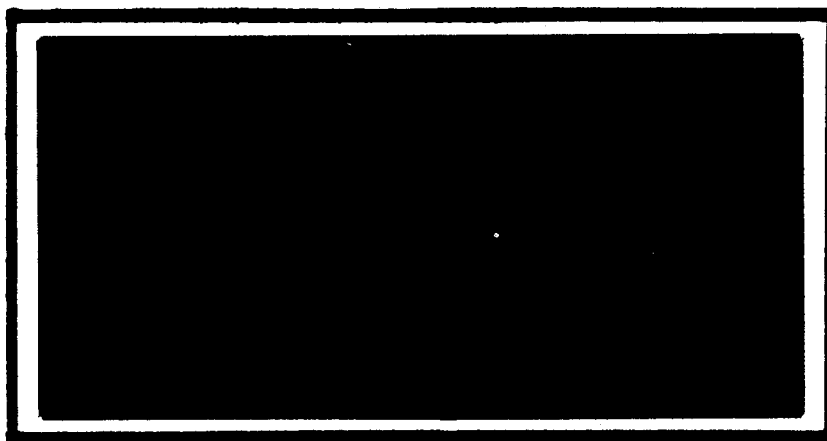
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CPR SOFTWARE ANALYSIS:
DETERMINING "THE IDEAL" SOFTWARE

THESIS

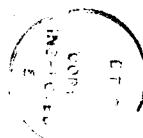
Terry V. Smith
Captain, USAF

AFIT/GCA/LSY/90S-8

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AFIT/GCA/LSY/90S-8

CPR SOFTWARE ANALYSIS:
DETERMINING "THE IDEAL" SOFTWARE

THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Cost Analysis . .

Terry V. Smith, B.S., M.B.A., C.C.A.

Captain, USAF

September 1990

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Preface

The purpose of this study was to determine "the ideal" Cost Performance Report (CPR) analysis software package currently available. As new software programs are developed or new versions of the current software packages are released, the results of this study may change. However, the methodology developed in this thesis may still be applied in studies conducted in the future.

There are several people whom I wish to thank for their assistance in completing this study. First is my thesis advisor, Capt David Christensen, for his advice and guidance in keeping the study focused on the primary objective of the thesis. I would also like to thank the focal points for all software packages that were used and/or evaluated in this study. Their assistance in obtaining and evaluating the software packages is greatly appreciated. Finally, I would like to thank my family and friends for their understanding and support. Most of all, however, I wish to thank my family and especially my parents, James and Bernice (alias Mom and Dad), for their prayers and support not only during this time but always.

Terry V. Smith

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Abstract

Thesis

The purpose of this ~~study~~ was to determine "the ideal" personal computer (PC)-based Cost Performance Report (CPR) analysis software package currently available. In conducting this study, evaluation criteria needed to be selected for analyzing the software. In order to establish what criteria were to be used in evaluating the CPR analysis software, two questionnaires were sent to Air Force Systems Command (AFSC) product divisions. The first questionnaire asked the users what features would be useful and/or ideal in a CPR analysis software package. The second questionnaire then asked the users to rank order the criteria established from the first questionnaire. The final evaluation criteria were then selected based on an analysis of the responses to the second questionnaire. Upon selection of the criteria, four PC-based CPR analysis software packages were evaluated against those criteria.

Further analysis of the CPR software packages was conducted on a decision support software package, Expert Choice. Expert Choice ranked the CPR software packages with respect to the evaluation criteria established. A sensitivity analysis was also performed with regard to the importance of the evaluation criteria in ranking the software packages. *(KAP)*

CPR SOFTWARE ANALYSIS:
DETERMINING "THE IDEAL" SOFTWARE

I. Introduction

General Issue

The Department of Defense must obtain performance data on contracts established with contractors in order to determine how those contractors are performing. To monitor cost and schedule performance, the government requires contractors to submit various performance reports. The primary report required for doing this is the Cost Performance Report (CPR). The CPR reports cost and schedule progress by comparing "planned work versus actual work performed and actual work performed versus actual costs expended" (2:H-11). In order to analyze contractor performance, many software programs have been developed to evaluate the data on CPRs.

Specific Problem

From the many different software programs that are available to analyze contractor data, no one standardized program has been developed or approved for use within the Department of Defense. The issues to be considered are not only which of these software programs is the best evaluator of CPR data, but is there "an ideal" program from the ones that are currently available? "Ideal," as described here, will be determined from criteria established by users of CPR software in Air Force Systems Command (AFSC) product divisions. If there is not "an ideal" program currently available, what combination of features from certain software packages would result in "the ideal" evaluation of CPR data?

Investigative Questions

1. What software packages are currently available in both the government and from contractors for evaluating CPR data?
2. How do government and contractor packages compare in terms of similarities and differences? How do the software packages compare in terms of speed or processing time? Are they "user friendly"?
3. What criteria are needed to evaluate CPR analysis software? Are current software packages mathematically accurate and do the different packages provide the same result for the operation being performed--in calculating the cumulative Budgeted Cost of Work Performed (BCWP), Budgeted Cost of Work Scheduled (BCWS), Actual Cost of Work Performed (ACWP), Cost Variance (CV) and Schedule Variance (SV)?
4. Are the criteria established in (3) above met in the software packages already available?
5. What information/features are omitted from current software packages that government evaluators think should be included? Is there a software package currently available that is better than the others for evaluating CPR data? If not, what combinations of features from different packages would result in "the ideal" software package? And is there any other information and/or features that need to be included that are not currently included in the software packages?

Limitations

The Samsung S330 personal computer (PC) system with an MS-DOS version 3.30 operating system and a Panasonic dot matrix printer was used to conduct this research. Because the Samsung S330 is an IBM-compatible machine, this study is designed to analyze software that is compatible

with the IBM personal computer. Because the IBM-compatible personal computer is the type of technology currently being used in the Air Force at the time of this study, it was chosen as the basis for this study. Therefore, this study will evaluate PC-based CPR analysis software only and will not include mainframe CPR analysis software.

Assumptions

The most important assumption underlying this study is that once the criteria for CPR software analysis have been identified and verified, a standardized software package can be developed. This software package could not only result in standardized procedures for conducting CPR analysis but may also result in reduced expenditures on software packages by the DOD. Because software packages are continually being updated, it is assumed that the criteria decided upon will be able to be used in selecting CPR software packages in future years.

Road Map

In answering the above investigative questions, the following steps will be taken. First of all, Chapter II provides background information on the Cost Performance Report (CPR), lists the names of the four CPR software packages that will be evaluated in this study and provides information on criteria used in four different studies for selecting software packages for various types of functions (i.e., project management and operations research).

As indicated above, evaluation criteria will need to be selected for analyzing the CPR software. In order to establish what criteria should be used to evaluate CPR analysis software, two questionnaires will be

sent to Air Force Systems Command (AFSC) product divisions. The first questionnaire will ask the users what features would be useful and/or ideal in a CPR analysis software package. The second questionnaire will then ask the users to rank order the criteria established from the first questionnaire. The final evaluation criteria will then be established based on analysis of the second questionnaire. After the criteria have been selected, the four CPR analysis software packages will be evaluated against these criteria. Chapter III, Methodology, will consist of five phases in which the above analysis will be performed.

Chapter IV, Results, Conclusions and Recommendations, will consist of further analysis of the four CPR software packages on a decision support software package, Expert Choice. Expert Choice will rank the CPR software packages with respect to the evaluation criteria established in Chapter III. A sensitivity analysis will also be performed with regard to the importance of the evaluation criteria in ranking the software packages.

II. Literature Review

Overview

The purpose of this literature review is threefold. First, the basic concepts of the Cost Performance Report (CPR) will be discussed. This will include the definition of what a CPR is and how it is used to evaluate contractor data. Second, a list and description of the potential CPR software packages that will be analyzed will be discussed. Third, generic criteria used in selecting software packages for functions other than CPR analysis will be reviewed. This review will provide an introductory knowledge base for the methodology chosen in conducting the research.

Justification of the Literature Search

The justification of this research is based on the fact that time and money have been spent needlessly by different companies who regenerate computer software programs that basically perform the same functions. This further results in confusion as to which software program is the best for performing a particular function and should be used in the DOD. When separate commands or separate product divisions within Air Force Systems Command (AFSC) buy different software packages to perform the same function, the result may be nonstandardization of performance evaluation throughout AFSC and the DOD. It is difficult to determine problem areas in the data when using nonstandardized techniques. When using these techniques, the product divisions may use one type of software to conduct the work while the headquarters section may use another type of software to evaluate the work performed on the

same data. This may create potential inconsistencies in evaluating the data.

Buying one software program to perform a particular function not only results in reduced confusion as to how to evaluate the data but may also result in increased savings. The economies from buying in large quantities are well-known and the government could realize substantial savings from buying one software package for all of DOD from one contractor. However, since the topic of single-source versus multiple-source contracting is not the subject of this research topic, the advantages and disadvantages of each will not be discussed.

In determining which software package to purchase for performing a particular function, the first objective that needs to be met is establishing the criteria for selecting that software. The personnel that need to be involved in selecting the criteria are the users of the potential software and the evaluators of the work that the users perform.

After the criteria are determined, the developers of the software, along with the users and the evaluators, need to determine what features should be included in the software in order to meet the criteria chosen. They also need to discuss how those features can be constructed so that the user is able to understand how to use the software in performing his or her work. In other words, the software needs to be "user friendly." However, a necessary part in determining what the ideal CPR software package should include will involve more than soliciting criteria from users of the software. Comparing the currently available software to these criteria is necessary in order to determine "the ideal" CPR analysis software package available at this time.

Scope of the Research Topic

There are basically two purposes for the research that will be conducted. First, the purpose of this study is to determine the criteria necessary to evaluate the software used in conducting CPR analysis. (Some examples of these criteria may include the following: user friendliness - easy to use or can load the software onto the computer with no problems; documentation - easy to understand and follow, indexes all features; tutorials - explains all features and includes "hands on" examples; help menus - includes additional "help" that thoroughly explains how to solve the problem; easy to learn - takes approximately one hour to learn how to use the software.) Once the criteria are selected, software packages will be evaluated against these criteria. Then either "the ideal" software package will be selected or a list of the features to be included in "the ideal" software package will be determined. Criteria, or features, are the desirable characteristics included in CPR analysis software for evaluating CPR data submitted by contractors to the government. Therefore, the following terms will be used interchangeably: criteria, features and characteristics. Second, because IBM-compatible computers are widely used in the Air Force, personal computer (PC) software programs will be evaluated in this study versus programs conducted with mainframe computers.

Discussion of the Literature

Background. In order to determine how government contractors are performing on various contracts that have been established with the Department of Defense (DOD), the government must obtain performance data on the contracts from the contractors' Management Control System (MCS).

A Management Control System is a system "used by a contractor to plan and to control the cost and scheduling of work . . . [and includes] planning, scheduling, budgeting, estimating, work authorization, cost accumulation, performance measuring, and so on" (7:513). The quality and standardization of the MCS determine whether or not this data can be relied upon. To ensure that contractor data are reliable, the contractor's MCS must be "validated as being acceptable under the Cost/Schedule Control System Criteria (C/SCSC)" (2:5-25). AFR 800-6, AFSC Supplement 1 (Ref. [8]), Attachment 4 contains guidance on how to apply C/SCSC. It also "specifies any cost reports that are required by type of contract and dollar value" (2:5-25).

To monitor cost and schedule performance, the government requires contractors to submit various performance reports. The primary report required for doing this is the Cost Performance Report (CPR). When working with the Air Force, contractors are required to submit CPRs each month for "R&D programs over \$40 million or \$160 million production contracts. . . . FFP [firm-fixed price] contracts are [usually] excluded from CPR requirements" (2:H-11). FFP's are usually excluded because the contractor assumes all of the cost risk in a FFP contract. The CPR reports cost and schedule progress by comparing "planned work versus actual work performed and actual work performed versus actual costs expended" (2:H-11). For contracts "that have lower dollar values than those requiring C/SCSC, a C/SSR [Cost/Schedule Status Report] is required" (2:5-26). Currently, a C/SSR is required for contracts over \$2 million which have contract periods greater than twelve months and do not require a CPR (7:239). However, page 298 of the draft version of

Department of Defense Directive (DODD) 5000.1, dated 1989, states that the \$2 million requirement will be changed to \$5 million in 1989 constant dollars.

The basic intent of the CPR is to provide both the contractor and the Government with information regarding the performance of the contractor with respect to cost and schedule. DODI 7000.2, Performance Measurement for Selected Acquisitions, requires the contractor to furnish this information to the Government when certain criteria (R&D programs over \$40M and production contracts over \$160M) for a contract have been met. The CPR is a valuable management tool. It not only provides reliable and structured cost and schedule information, but this information is used to monitor and evaluate the performance of the contractor. CPR information can be used to identify cost and schedule problems early in the program as well as determine the impact or the size of potential problems in those areas. The CPR is typically used by the contractor in addition to other program management techniques. If the contractor is unable to consistently track performance to the CPR, this may be an indication to the contractor and the Government that something is wrong. An in-depth analysis should then be conducted to determine the cause of the problem. The CPR is also used to report to Congress when contractors break the 15% or 25% thresholds (7:239). Variance thresholds are outer limits for cost and schedule parameters and "when a performance threshold has been penetrated beyond a previously agreed-to value, a sort of 'buzzer' goes off, and certain actions must take place in order to comply with the rules of C/SCSC" (7:106).

What is a CPR versus a C/SSR. The CPR and C/SSR contain important differences other than the dollar threshold amounts. This can be illustrated as follows:

Cost Performance Report (CPR). The purpose of the CPR is to allow the contractor to identify variances in cost and schedule performance from the budgeted and scheduled work that was originally planned. The CPR enables the contractor to analyze in detail the financial condition of the contract by being able to relate problems in terms of their dollar value and by displaying any trends that may be developing. The CPR is composed of the following five formats:

Format 1 (Work Breakdown Structure or WBS): Data are provided by summary level WBS structure elements to evaluate cost and schedule performance.

Format 2 (Functional Categories): Data are provided by organizational or functional cost categories to evaluate cost and schedule performance.

Format 3 (Baseline): Performance is measured against the budget baseline.

Format 4 (Manpower Loading): Forecasts of manpower loading illustrates the relationship of manhours with the budget plan and estimated cost.

Format 5 (Problem Analysis): An explanation of significant contract problems including significant cost and schedule variance problems is included in this report written by the contractor (13:2-3).

Cost/Schedule Status Report (C/SSR). The C/SSR is used to report C/SCSC information on programs "too small to qualify for full C/SCSC application" (13:3). Whereas the CPR consists of five formats and requires some depth of reporting, the C/SSR consists of summary information and "is a scaled-down version of Format 1 of the C/SCSC" (13:3). The two major parts of Format 1 of the C/SSR are Contract Data and

Performance Data. The contract data determines overall contract value so that a comparison can be made to the baseline. The performance data reports the status of the contract for specific WBS items on a cumulative-to-date basis. The C/SSR also includes the contractor's latest revised estimate (LRE) of cost at completion. And like the CPR, the C/SSR is not usually applied to firm-fixed price contracts.

There are essentially four important differences between the CPR and the C/SSR. First, the C/SSR does not require performance reporting by functional area whereas it is required in the CPR. Second, as stated in the above paragraph, WBS performance is reported on a cumulative-to-date basis for the C/SSR. Therefore, current-period or incremental information for ACWP, BCWP, BCWS, etc. are not provided by the C/SSR whereas the CPR does include this information. Third, baseline reporting and projections for manpower loading are not required for the C/SSR but are required for the CPR. Fourth, the definition of BCWS and BCWP are different for the C/SSR and the CPR. Whereas the CPR requires that BCWS and BCWP are amounts determined by summing work package budgets, the C/SSR determines BCWS and BCWP amounts by methods other than work packages. The method used for the C/SSR is negotiated between the DOD project manager and the contractor. Therefore, the C/SSR allows greater flexibility than the CPR in selecting an internal performance measurement system (13:3).

How to Evaluate the CPR. In evaluating how a contractor is performing on its contract, the two major areas that are considered are cost and schedule. Contractor data used in evaluating cost and schedule performance include the Budgeted Cost of Work Scheduled (BCWS), Budgeted Cost

of Work Performed (BCWP), Actual Cost of Work Performed (ACWP), Cost Variance (CV), Schedule Variance (SV) and Estimate at Completion (EAC). As mentioned before, cost and schedule performance are recorded on the CPR and the C/SSR. The contractor is required to establish detailed work packages for all known work accomplished in the previous six months. A monthly budget is then developed for each month of the contract based on the start and stop dates of each work package and on the budgets assigned to them. At the end of each reporting period, the contractor reports the dollar amount of work budgeted for each month for the CPR. The contractor also reports the cumulative dollar amount budgeted to date for the CPR and the C/SSR. The dollar amount of work budgeted to be performed is the Budgeted Cost of Work Scheduled to be accomplished or BCWS. BCWS can also be stated as: Of the work I scheduled to have done, how much did I budget for it to cost?

The contractor is also required to provide the budgeted dollar value of work completed during the current monthly period. This is referred to as the Budgeted Cost of Work Performed or BCWP. BCWP can also be stated as: Of the work I actually performed, how much did I budget for it to cost (not how much did it actually cost)? The Schedule Variance (SV) is the difference between the BCWP and BCWS. Therefore, the SV is the amount of work, in dollars, that the contractor is either ahead or behind schedule.

The Actual Cost of Work Performed, or ACWP, is also provided by the contractor for each reporting period. ACWP can also be stated as: Of the work I actually performed, how much did it actually cost? The Cost Variance (CV) is the difference between the BCWP and ACWP.

The contractor must also provide an estimate for costs at the completion of the contract. This is referred to as Estimate at Completion or EAC. There are a variety of ways to calculate the EAC as will be seen in the next section titled "Statistical Measures of Contract Status."

As stated before, all costs (budgeted, actual and estimated) are required to be summarized both by Work Breakdown Structure or WBS (Format 1 of the CPR) and by the contractor's functional or organizational structure (Format 2 of the CPR). The WBS is defined in MIL-STD-881A and "is a product oriented tree-like structure that relates the hardware, software, services and other work tasks required during development and production" (13:2). The contractor is required to summarize his performance down to the third level of the WBS and must be able to identify variances at least at the fourth level, or one level below that reported to the government. Thus, the contractor must not only be able to identify the work package(s) associated with a particular variance but must also know the reason or cause of that variance. This can be easily accomplished by working downwards through the data in the WBS format until the precise area for the cause of the variance can be determined. Also, by reporting at a summary level on the CPR and C/SSR, small variances will cancel out whereas large variances will appear on the reports. This enables the analyst to know where to begin searching for the causes of the variances (11:162).

Various formulas have been derived to evaluate contractor cost and schedule performance. It is not only important to know what information is contained in the formulas, but also to be able to interpret the information that the formulas provide:

Statistical Measures of Contract Status

1. Cost Performance Index [for Efficiency] (CPI_g): The CPI_g is an indicator of the cost efficiency at which work is being accomplished. [It indicates with what efficiency the contractor is staying within his budget. (11:322)] It is defined as the ratio of BCWP to ACWP expressed as a percent. (13:4)

$$CPI_g\% = \frac{BCWP}{ACWP} \times 100$$

Calculation of CPI_g can be made for both incremental, i.e. monthly, or cumulative-to-date data. The CPI_g is interpreted to mean that for every budget dollar spent a CPI_g percent return value is received. Thus, a CPI_g of 90% indicates that for every dollar spent only 90 cents in value is being received. An efficiency or CPI_g of 100 means that the contract is on target. A CPI_g of less than 100 indicates poor efficiency and cost overrun. A CPI_g of greater than 100 indicates good efficiency and cost underrun. (13:4)

[Cost Performance Index Profile: $CPI_p = \frac{ACWP}{BCWP}$

Indicates the actual cost of each one dollar's worth of work accomplished. (11:322)]

2. Schedule Performance Index [for Efficiency] (SPI_g): The SPI_g is an indicator of the schedule efficiency at which work is being accomplished. [It indicates with what efficiency the contractor is staying within his schedule plan for getting the work done. (11:322)] It is defined as the ratio of BCWP to BCWS expressed as a percent. (13:4)

$$SPI_g\% = \frac{BCWP}{BCWS} \times 100$$

Calculation of SPI_g can be made for both incremental, i.e. monthly, or cumulative-to-date data. The SPI_g is interpreted to mean that work is proceeding at a rate given by the SPI_g . Thus, an SPI_g of 100% indicates that work is on schedule. An SPI_g greater than 100% indicates an ahead-of-schedule condition. (13:4)

3. Cost Variance (CV): [The difference between budgeted costs and actual costs (for all work actually performed) is a variance in costs. (11:30)] The cost variance is expressed as both a dollar value and a percent as follows: (13:4)

$$CV(\$) = BCWP - ACWP$$

$$CV(\%) = \frac{CV(\$)}{BCWP} \times 100$$

The cost variance expressed as a dollar value does not always indicate the true magnitude of the problem. The significance of

this statistic can often be more clearly displayed by use of comparison to some base. This base is the cost of work accomplished or BCWP, and is used in the calculation of the cost variance percent. The cost variance can be calculated on either an incremental or cumulative-to-date basis. The cost variance percent can also be expressed as: (13:4)

$$CV[\%] = 100 - \frac{100}{CPI[E]}$$

4. Schedule Variance (SV): [The difference between work scheduled and work performed (in terms of budgeted cost) is a variance in schedule. (11:29)] The schedule variance is expressed as a dollar value, a percent, and also a months ahead/behind statistic as follows: (13:4-5)

$$SV(\$) = BCWP - BCWS$$

$$SV(\%) = \frac{SV(\$)}{BCWS} \times 100$$

$$SV(\text{months}) = \frac{SV(\$)}{BCWS}$$

The schedule variance expressed as a dollar value does not always indicate the true magnitude of the problem. The significance of this statistic can often be more clearly displayed by comparison to some base. This base is the cost of work scheduled or BCWS, and is used in the calculation of the schedule variance percent. The cost variance can be calculated on either an incremental or cumulative-to-date basis. The schedule variance percent can also be expressed as: (13:5)

$$SV(\%) = SPI[(100)] - 100$$

Negative values for the schedule variance statistic indicate an unfavorable, that is, a behind-schedule position.

5. Percent Complete: This is defined as the relationship between work accomplished to date (BCWP) and budgeted total amount of work planned. The usual base in determining percent complete is the Budget at Completion (BAC) as shown on the CPR. (13:5)

$$\text{Percent Complete} = \frac{BCWP}{BAC} \times 100$$

6. Percent Spent: Defined as the relationship between dollar amounts actually spent to date (ACWP) to the budgeted total amount of work planned. The base in determining percent spent is the BAC. The Latest Revised Estimate may also be used. (13:5)

$$\text{Percent Spent} = \frac{\text{ACWP}}{\text{BAC}} \times 100$$

Comparison of Percent Complete to Percent Spent is one method of determining the financial state of the contract. When percent spent exceeds percent complete, it indicates that actual cost of work exceeds the budgeted cost of the work. This comparison is similar in nature to the reasoning behind the use of the CPI. (13:5)

To Complete Performance Index (TCPI): This index is defined as the CPI that must be attained to have the contract meet the planned budget. (13:5)

$$\text{TCPI}_g = \frac{\text{work remaining}}{\text{money remaining}} = \frac{(\text{BAC} - \text{BCWP}_{\text{cum}})}{(\text{BAC} - \text{ACWP}_{\text{cum}})} \times 100$$

Whereas the CPI_p indicates past fiscal efficiency, the TCPI indicates the budget/cost efficiency at which the contractor must perform in the future to complete the contract within the targeted BAC. The CBB or EAC may be substituted for the BAC in the denominator to indicate the future efficiency needed to complete the contract within their respective target goals. (11:322)

In addition to having only one formula used in calculating a certain statistic (as in the above examples), many different formulas may also exist for calculating a single performance parameter. The Estimate at Completion (EAC) is an example of this:

Latest Revised Estimate of Cost at Completion (LRE/EAC): All formulae for calculating LRE/EAC must take into account all actual costs already expended and the amount of work remaining to be accomplished. EAC formulae may only differ in their projections of the future work environment (i.e. with what efficiency future work will be accomplished). (11:322)

a. $\text{EAC} = \text{ACWP} + \text{CPI}_p(\text{BAC} - \text{BCWP}_{\text{cum}}) = \text{CPI}_p(\text{BAC})$
[This is true only for cumulative data in the CPI.]

b. $\text{EAC} = \text{ACWP}_{\text{cum}} + \frac{(\text{BAC} - \text{BCWP}_{\text{cum}})}{(\text{CPI}_g)} = \frac{\text{BAC}}{\text{CPI}_g}$
[This is true only for cumulative data in the CPI.]

c. $\text{EAC} + \frac{\text{ACWP}_{\text{cum}}}{\text{BCWP}_{\text{cum}}/\text{BAC}} = \frac{\text{ACWP}_{\text{cum}}}{\% \text{ complete}}$

NOTE: All the above formulae will give the same EAC; each is equal to the other. All are projecting the EAC based upon a past efficiency factor. [This is true only for cumulative data in the CPI.]

$$d. \quad EAC = ACWP_{cum} + \frac{(BAC - BCWP_{cum})}{(SPI_E)}$$

NOTE: This EAC is based upon the past work (schedule) efficiency.

$$e. \quad EAC = ACWP_{cum} + \frac{(BAC - BCWP_{cum})}{(.5(SPI_E) + .5(CPI_E))}$$

NOTE: This EAC is based upon an equal weighting of the past schedule and budget efficiency factors. Different weighting may be substituted for the 50/50 spread shown above. This weighting of SPI_E and CPI_E is an SCI_E (Schedule/Cost Index of Efficiency). (11:322)

If the evaluator determines that significant variances exist in the CPR data, an examination of the contractor problem analysis section may reveal the cause of the problems:

When significant variances exist, the CPR or C/SSR should contain a problem analysis page. This page should be reviewed to determine if the contractor has provided the following: specific causes for the significant variances, the action that is needed to be taken to correct the situation, and the period of time needed to correct the problem. This narrative should be clear and complete; if it is not, then the contractor should be required to submit a more coherent analysis. The information in this narrative is the type of information that should be blended with the statistical analysis to provide a more comprehensive picture of the trends and changing nature of the contract. (13:6)

CPR Software Analysis Packages. As stated previously, the data on Cost Performance Reports (CPRs) are used to analyze the contractor's performance in terms of dollars (cost) and time (schedule) required to complete the work. In order to analyze contractor performance, many software programs have been developed to evaluate the data on CPRs. A list and description of the CPR software packages that will be analyzed is discussed in Appendix A. The software packages that will be analyzed include the following:

Space Systems Division (SSD) Performance Analyzer (PA)

Air Force Cost Center CPR-EZ

Air Force Cost Center Contractor Cost Analysis System (CCAS)

Defense Systems Management College (DSMC) Contract Appraisal
System (CAPPS)

Criteria for Selecting Software Packages. In evaluating and comparing software packages, the evaluator must have a set of criteria with which to compare the software packages. The objective of this study is to first determine the criteria needed to conduct CPR software analysis. Then the different types of software can be evaluated against these criteria for performing CPR analysis.

In determining how to select these criteria for conducting CPR software analysis, criteria used previously in selecting software packages for functions other than CPR analysis will be reviewed. Various software packages have been selected based upon certain criteria that are applicable to all types of software and other criteria that are applicable only to the type of software being acquired. Therefore, criteria used in selecting the following software packages may or may not be the same as the criteria that will be used in selecting CPR software analysis packages. The following studies will be evaluated with regard to selecting criteria for evaluating CPR software packages: a student thesis regarding criteria used in selecting project management software; a review of AFSCP 800-14, Air Force Systems Command Software Quality Indicators; criteria used in selecting educational operations research software; and a PC Magazine test comparing 55 word processors against nine criteria.

Project Management Study. Capt. Robert J. Hartnett, Jr., a GSM (Graduate of Systems Management) student of AFIT class of 1989S, wrote a thesis titled Project Management Software: Proper Selection for Use Within Air Force Systems Command. In his thesis, Capt. Hartnett used four criteria for his "minor project" and twelve criteria to evaluate his "major project".

The four criteria used in Capt. Hartnett's "minor project" were installation, tutorial, data entry and reporting. Installation refers to whether the system can be installed quickly and easily without thorough knowledge of how the operating system works. A helpful tutorial must exist that can be used easily by both beginning and experienced operators. Data must be able to be manipulated in many different ways when the software system will be used by a variety of people in different jobs. The data must be able to be entered quickly and easily and must consider dependencies between various tasks, resource information and cost data. It is essential to have a reporting capability in which reports can be viewed on the computer screen and immediately sent to a printer for a hardcopy printout. The four criteria listed above must be easily learned and performed so that the software packages allow the user to quickly become productive. This is just as important as the system being capable of performing those functions.

Capt. Hartnett's "major project" involved using software packages to plan, track and report on a government defense contract. As stated above, the "major project" included twelve criteria. Some of these criteria apply to CPR software analysis packages and some do not. The twelve criteria are as follows: project modeling capability, scheduling

capability, resource management, cost management, tracking and controlling existing projects, reporting capability, advanced project management functionality, documentation, ease of learning, ease of use, vendor and cost.

The first criterion, project modeling capability, is divided into two parts--capacity of system and extensiveness of options or features. Project modeling capability must allow for easy entry of incomplete project data and insertion of additional information and updating procedures. Capacity of the system refers to the number of activities allowed per project and the number of dependencies allowed per activity. Extensiveness of options or features refers to whether the managers are forced to model their projects in a certain way or if they can choose their own style of modeling.

The second criterion, scheduling capability, includes the ability to present, produce and manipulate scheduling information so that resources and activities can be examined and modified easily. Hartnett used the following three areas to describe this criteria: schedule type (Gantt, PERT); scheduling time base (can activities be viewed by hours, days, weeks, months and years?); and accessibility of information (can the project's logic with regard to precedence relationships and the activity details be easily examined and modified?).

Resource management, the third criterion, includes planning, leveling and tracking. Resource management refers to whether or not the system can efficiently allocate scarce resources to different projects which require the use of those resources. It includes being able to handle individual resource calendars (planning) as well as allocating

resources to conflicting activities (leveling) while ensuring all resources are being used as efficiently as possible (tracking).

Cost management, the fourth criterion, is divided into planning, programming, budgeting and tracking. Cost management compares the required funding to the approved funding for a project. Therefore, it is essential that a project management software package includes information to plan, allocate and track funds to different projects and activities.

The fifth criterion, tracking and controlling existing projects, involves comparing revised or actual data with the original planned information and activity using this information to keep the project on schedule. This criterion consists of data entry and analysis.

Reporting capability involves the ability to provide reports that are easy to read and understand with varying levels of detail. The reports must offer summary detail, graphics and quality that is sufficient for presentation purposes. This criterion includes customized reports and quality of output. Customized reports refer to whether the report formats can be changed, if reporting can be performed only on items of interest and if sorting can be accomplished in a variety of ways. Quality of output refers to whether reports can be viewed on the computer screen, whether the printed output is of presentation quality and if the software package supports plotter graphics.

Advanced project management functionality is the seventh criterion and includes baselining, analyses and interfacing with other programs and computers. This criterion deals with being able to compare alternatives by baselining. It also includes being able to obtain an optimum solution by conducting "what if" analyses and risk assessments. It is also impor-

tant for the system to be able to interface with other programs and computers by importing and exporting different file formats and being able to be used over a Local Area Network (LAN).

Documentation must not only be understandable but also usable. In order to be able to use the software to its utmost potential, the user must be able to obtain answers to questions quickly and easily. This can be accomplished if the documentation is clear and well-written so that it will be understood by all users, especially the non-technical user. All information should be thoroughly indexed so that the user can find information quickly and easily.

Ease of learning, the ninth criterion, includes a hands-on tutorial and productivity. Because people quickly become frustrated with computers when they are hard to learn how to use, it is important that the learning process is as easy as possible for the user. A hands-on tutorial enables the user to learn by performing the task. This normally results in the user learning how to perform the task more quickly. The user will also become less frustrated if he or she can become productive quickly on the software instead of having to learn how to use the entire software package before it can be used correctly.

The tenth criterion is ease of use and includes screen color mix, program hierarchy, command presentations and a "help" function. If a software package is easy to use and understand, the worker will become more productive and will enjoy using the software package. For example, a user is more apt to use a software package that includes a screen color mix that is aesthetically pleasing and can be easily changed than one that is offensive to the eyesight. Program hierarchy refers to whether

the command structure is logical in that there is an input-processing-output format. It also refers to whether an operation requires a large number of commands in order to be performed. Command presentations refer to whether a menu system or function keys are used as well as whether or not all possible options are displayed for review before a certain command is performed. The "help" function includes whether help is available for context-sensitive information and whether error messages are useful in that they direct the user to where he or she can receive further assistance.

When acquiring a software package, the user will want to select a vendor that is technically competent and easy to work with. Therefore, the user will want to consider experience, technical assistance, implementation, training and learning from user feedback. With regard to experience, the user will want to look at the amount of time the vendor has been in business and whether the company is well-managed and financially sound. The user will also want to consider how quickly the vendor is able to answer the user's questions and whether the vendor can answer specific application questions (i.e., CPR-related questions) as well as questions about the features of the software package. A vendor that is able to employ high-quality consultants to implement and support the software package is preferable to one who cannot do this. Likewise, a vendor which provides different levels of training programs for novice, intermediate and expert users is also preferable to one who does not do this. Another important aspect of choosing a vendor is whether the vendor learns from user feedback and implements user suggestions in new releases of the software package. The user will also want to consider

whether the updated versions were adequate for the user's needs and if the vendor made the new releases available when they were needed.

The twelfth and final criterion is cost. There may be a wide range of costs depending on what software packages are available and what features are essential to get the job accomplished. Capt. Hartnett assigned various grades to the different price ranges (i.e., excellent for \$0 to \$500, very good for \$501 to \$1000, etc.) (8:50-65).

AFSC Software Quality Indicators. AFSCP 800-14, Air Force Systems Command Software Quality Indicators, outlines the following list (with associated definitions) of eleven software quality factors:

Correctness. The degree to which the software satisfies its specified requirements.

Efficiency. The degree to which the software performs its intended functions with minimum consumption of computer time and storage resources.

Flexibility. The effort required to enhance the software or to modify it to meet new requirements. Flexibility and maintainability make software supportable.

Integrity. The degree to which the software controls unauthorized access to or modification of system software and data.

Interoperability. The degree to which the software is able to interface with other systems.

Maintainability. The effort required to locate and correct any error in the software. Maintainability and flexibility make software supportable.

Portability. The effort required to transfer the software from one hardware or software environment to another.

Reliability. The degree to which the software consistently performs its intended functions.

Reusability. The degree to which the software can be used in multiple applications.

Testability. The effort required to ensure that the software performs its intended functions.

Usability. The effort required to learn the human interface with the software, to prepare input, and to interpret output of the software. (4:36)

Operations Research Study. The criteria used in a study for selecting educational operations research software included "accuracy, speed, ease of use, ease of learning and caliber of documentation"

(15:65). The following criteria for each category were determined from the article:

1. accuracy

- a. number of decimal places in result
- b. round-off errors

2. speed

- a. amount of time it takes the software to accept, process and execute the data
- b. whether the software keeps up with the data being entered or causes errors because of not accepting the data readily as it is entered

3. ease of use ("user friendly")

- a. ability to move around the spreadsheet easily (can only input information one cell at a time versus being able to jump across rows or columns; data entered in response to prompting versus flexibility of inputting various information)
- b. if the software uses prompts, are there words with the prompts so that the user knows what information to input?
- c. can information be edited at any time (correcting errors is easy) or can corrections be made only after all data is entered using the "edit" function?
- d. if there is an error message, does the software show what type of error has been made?
- e. flexibility of software (i.e. avoid having user respond "yes" or "no" as to whether the number he/she just entered is correct or not; software accepts inputs that are either in lower case or capital letters and does not require that inputs be made using the "CAPS" mode at all times; if software uses prompts, it does not require "yes" or "no" responses to be spelled out completely)
- f. capability to add and/or delete data

4. ease of learning

- a. easy-to-follow instructions

- b. assumes little previous computer knowledge, software program knowledge and subject area (CPR) knowledge
- c. includes a "helpful" tutorial

5. caliber of documentation

- a. assumes little previous computer knowledge, software program knowledge and subject area (CPR) knowledge
- b. includes sections on "what to do if it does not work"
- c. includes explanations of error messages
- d. includes adequate explanations on how to use/enter data
- e. includes examples for all features and uses; user is carefully led through examples
- f. all features are listed and explained in documentation
- g. instructions are clearly written and easy to read and follow
- h. includes index
- i. includes all of the features that the documentation lists

Word Processor Study. In February 1988, PC Magazine conducted a test in which the following nine criteria were used in comparing 55 word processors: the import file size test, document manipulation test, global search and replace test, cursor movement test, search for middle test, block manipulation test, the merge test, the text delete test and the print whole document test.

The import file size test measured the size of the final imported file after the software program brought a 50K document into its own environment. The imported file size varies because programs manipulate files differently in the way formatting codes are inserted into the document. Eight of the fifty-five word processing programs were unable to import a file the size of 50K and one program was unable to read the ASCII file because it used a non-DOS format (12:278).

The document manipulation test was based on the time it took each word processor to load and save a file. This test was divided into two parts: document load, and save and resume.

The global search and replace test measured the length of time required to replace the word "his" with the word "theirs". The test that was conducted required the word "his" to be replaced 115 times.

The cursor movement test determined the length of time required to move the cursor through the document. This test was conducted in two parts: a cursor top-to-middle test and a cursor middle-to-bottom test.

The search for middle test measured the length of time required to locate a sentence in the middle of the document. The test that was conducted allowed for searching on a single keyword or string of words because some word processors are unable to search for an entire sentence.

The block manipulation test was based on a block-and-move test and a block-and-copy test. The block-and-move test measured the time it took to highlight the first three pages of the document and then to move it to the middle of the document. The block-and-copy test measured the time it took to copy the same three pages to an external file. Because both tests required the pages to be renumbered, the performance of programs with smaller RAM buffers was slower than programs with larger buffers.

The merge test measured the amount of time it took the program to import an external file to where it was positioned immediately after the middle of the document. As in the block manipulation test, the performance of the programs was affected by reformatting the pages.

The text delete test measured the length of time required to highlight and delete the file that was imported by the merge test. Again,

page reformatting affected the performance of programs with smaller buffers.

The print whole document test measured how long it took the word processor to print the 50K document to an external file (12:279).

Summary of the Literature

The primary report that the government requires contractors to submit for the purpose of monitoring cost and schedule performance is the Cost Performance Report (CPR). In order to analyze contractor performance, many software programs have been developed to evaluate the data on CPRs. In determining which of those software packages is the ideal evaluator of CPR data, certain criteria need to be established for evaluating those software packages. These criteria must be validated not only by the users of those packages, but also by the evaluators of the work that the users perform. Once the software packages are evaluated against these criteria, "the ideal" software package for evaluating CPRs can be determined. If "an ideal" software program for evaluating CPRs does not currently exist, a software program can then be developed which includes the features or criteria that have been chosen for accomplishing this objective. The developers of the software, along with the users and the evaluators, will need to determine what features should be included in the software in order to meet the chosen criteria. They also need to discuss how those features can be constructed so that the user is able to understand how to use the software in performing his or her work.

Criteria used in selecting software packages for use in project management, educational operations research and word processors were reviewed along with criteria for evaluating software quality used by Air

Force Systems Command (AFSCP 800-14). Table 1 is a summary of the criteria used in selecting those software packages that may also be applied to CPR software packages. Criteria that are application-specific, such as scheduling capability as well as tracking and controlling existing projects, will not be listed because they apply only to the project management study.

TABLE 1

SUMMARY OF SOFTWARE CRITERIA FOR FOUR DIFFERENT STUDIES

<u>Criteria</u>	<u>Project Management Study</u>	<u>AFSC Software Quality Indicators</u>	<u>Operations Research Study</u>	<u>Word Processor Study</u>
Installation	x			
Tutorial	x		x	
Hands-on Tutorial	x			
Data Entry Flexibility	x		x	
Reporting	x			
Customized Reports	x			
Quality of output	x	x		
Interfacing with other programs and computers	x	x		x
Understandable documentation	x		x	
Usable documentation	x		x	
Easy to learn (become productive quickly)	x	x	x	
Easy to Use - Screen color mix	x			
color mix		x		
Easy to Use - Program hierarchy	x	x		
Easy to Use - Command presentations	x	x		
Easy to Use - help function/useful error messages	x		x	
Vendor experience	x			
Vendor technical assistance	x			
Vendor implementation and support	x			
Vendor - training prgms.	x			
Vendor - considers user feedback	x			

TABLE 1

SUMMARY OF SOFTWARE CRITERIA FOR FOUR DIFFERENT STUDIES (Continued)

<u>Criteria</u>	<u>Project Management Study</u>	<u>AFSC Software Quality Indicators</u>	<u>Operations Research Study</u>	<u>Word Processor Study</u>
Cost	x			
Correctness (satisfies requirements)		x		
Efficient		x		
Flexible (effort to enhance or modify SW)		x		
Integrity (ability to control unauthorized access or modification to software)		x		
Maintainable (effort reqd. to locate and correct errors in software)		x		
Portable		x		
Reliable		x		
Reusable (multiple applications)		x		
Testable (effort reqd. to ensure SW performs intended functions)		x		
Accurateness			x	
Speed			x	x

In Chapter II, four different studies were evaluated with regard to identifying criteria used in selecting various types of software packages. In Chapter III, criteria used in selecting "the ideal" CPR analysis software package will be identified from questionnaires sent to Air Force Systems Command (AFSC) product divisions.

III. Methodology

The general method of evaluating CPR analysis software will involve using decision support software and consists of two parts. The first part will be to determine the criteria necessary to evaluate CPR analysis software packages. The second part will be to evaluate and compare CPR personal computer (PC) software packages based on those criteria. From this, "the ideal" software package or features of "the ideal" software package for analyzing CPR data will be determined.

An initial objective of this study was to obtain CPR software packages from both the government (Army, Navy and Air Force) and contractors in order to compare them in terms of similarities and differences. Because the following contractors work with the government in implementing C/SCSC and in developing software to evaluate CPR data, they were contacted to determine if any software packages to evaluate CPR data were currently in existence and/or development: Humphreys & Associates, The Phoenix Group, Decision Planning Corporation, Langford & Associates, Technical Marketing Society of America (TMSA) and Performance Management Associates. Information obtained from these contractors revealed that there were no CPR software packages currently in development. From contacting the Army and Navy Performance Measurement Joint Executive Group (PMJEG) focal points, it was discovered that Naval Air Systems Command is currently updating ESD's Automated Financial Analysis (AFA) program so that it will be available in a PC version. It is referred to as the Automated Financial Analysis (AFA) Tabular Report Generator. The majority of CPR software packages that will be evaluated are either currently being used in the Air Force or can be obtained from

Defense Systems Management College (DSMC). The CPR software packages that will be evaluated include:

Space Systems Division (SSD) Performance Analyzer (PA)

Air Force Cost Center CPR-EZ

Air Force Cost Center Contractor Cost Analysis System (CCAS)

Defense Systems Management College (DSMC) Contract Appraisal System
(CAPPS)

Phase I: Initial Selection of Criteria to Evaluate CPR PC Software

As stated before, in order to evaluate the above CPR software packages, certain criteria need to be established against which the software packages will be compared. The personnel best qualified to establish the criteria for CPR software packages are the users of that software. Therefore, a questionnaire was sent to the following Air Force Systems Command (AFSC) product divisions to request assistance in establishing those criteria:

ASD/ACC	Aeronautical Systems Division, Wright-Patterson AFB, OH
BSD/ACI	Ballistic Systems Division, Norton AFB, CA
ESD/ACC	Electronic Systems Division, Hanscom AFB, MA
HSD/ACC	Human Systems Division, Brooks AFB, TX
MSD/ACC	Missile Systems Division, Eglin AFB, FL
SSD/ACC	Space Systems Division, Los Angeles AFS, CA

The information contained in the questionnaire for the initial selection of the criteria to be used in evaluating CPR software is as follows:

1. An evaluation of CPR software currently being used by the various product divisions is being conducted at AFIT. The purpose of this

evaluation is to determine essential features that need to be included in CPR software.

2. In conducting this evaluation, it is important that the following questions be answered as explicitly as possible:

- a. What CPR software are you currently using?
- b. What features do you find useful (please clarify)? (ie. user friendly - easy to use or can load the software onto the computer with no problems; documentation - easy to understand and follow, indexes all features; tutorials - explains all features and includes "hands on" examples; help menus - includes additional "help" that thoroughly explains how to solve the problem; easy to learn - takes approximately one hour to learn how to use the software)
- c. What should the ideal CPR software include?

3. If you have any further suggestions on how CPR software can be improved and/or used, please attach them on a separate sheet of paper.

Phase II: Analysis of Criteria for Software (Criteria Validation by Users)

From the first questionnaire conducted in Part I above, twenty-one criteria were identified. A second questionnaire was then administered requesting the AFSC product divisions to rank order the following criteria established from the first questionnaire:

- (a) help indexes that tutor on the analyses instead of referring to a manual
- (b) a program that does not need a computer dedicated onto that software
- (c) a separate tutorial which includes different case scenarios
- (d) user friendly, menu-driven screens

- (e) easy to use or can load the software onto the computer with no problems
- (f) learn as you use -- get to work right away
- (g) needs to be able to print on plotter or printers
- (h) needs to be able to print graphics or data
- (i) full CPR/C/SSR analysis that uses regression analysis to predict trends
- (j) variance analysis, with indicators of major problem areas
- (k) a way to determine if data has been inputted correctly
- (l) narrative section which sums all data, trends and variance problems and provides suggestions for further research
- (m) documentation - easy to understand and follow
- (n) ability to modify formulas, update charts
- (o) help menus - includes additional "help" that thoroughly explains how to solve the problem
- (p) capability to accept floppy disks from contractors
- (q) software is available on personal computer
- (r) interactive Management Information System (MIS) with contractor--contractor CPR data comes in electronically and automatically goes into a spreadsheet to be analyzed
- (s) includes several different Estimate at Completion (EAC) calculations with a guide to determine which EAC is most applicable for a given program
- (t) good summary report format that is easy to read and understand in a short period of time
- (u) allows flexibility toward user familiarity with the subject (i.e., has an expert mode to bypass menus)

Phase III: Final Selection of Evaluation Criteria

From the responses by the AFSC product divisions to the second questionnaire administered in Phase II, the criteria for evaluating CPR analysis software packages were chosen. From studies that have been

conducted, it has been found that most people can only concentrate on seven plus or minus two items at a time before they become overwhelmed (9:81-97). Therefore, the first seven criteria that the users have identified as being most important will be analyzed. Criteria that are considered to be similar in nature may be grouped together into a single category. In order to evaluate and compare the responses in a variety of ways, three different comparisons were conducted.

First Comparison. First, the scores from the rank order were averaged and the seven criteria were selected from the lowest averages. The results are as follows:

TABLE 2
FIRST COMPARISON METHOD

<u>Criteria</u>	<u>Average</u>	<u>Order of Importance</u>
a	12.8	18
b	13.8	19
c	15.59	20
d	6.41	1
e	8.29	4
f	10.11	9
g	10.07	8
h	10.22	10
i	8.15	3
j	7.19	2
k	12.63	16
l	9.93	7
m	11.22	12
n	9.59	5
o	12.74	17
p	12.26	14
q	10.22	11
r	12.33	15
s	9.66	6
t	12.07	13
u	15.67	21

The seven criteria, in order of importance, are:

1. user friendly, menu-driven screens
2. variance analysis, with indicators of major problem areas
3. full CPR/C/SSR analysis that uses regression analysis to predict trends
4. easy to use or can load the software onto the computer with no problems
5. ability to modify formulas, update charts
6. includes several different Estimate at Completion (EAC) calculations with a guide to determine which EAC is most applicable for a given program
7. narrative section which sums all data, trends, and variance problems and provides suggestions for further research

Second Comparison. Second, the criteria were selected based on the number of times each criterion was rank ordered in the range of 1 to 5. This range was selected because as stated previously, most people can only concentrate on seven plus or minus two items before becoming overwhelmed. The seven criteria were selected from the highest ratings. In the event of a tie in the 1 to 5 range, the number of times the criteria were ranked in the range of 1 to 6 was considered. The results are listed in Table 3 below. The seven criteria based on this method are as follows (in order of importance):

1. user friendly, menu-driven screens
2. variance analysis, with indicators of major problem areas
3. full CPR/C/SSR analysis that uses regression analysis to predict trends
4. easy to use or can load the software onto the computer with no problems
5. learn as you use - get to work right away

6. interactive Management Information System (MIS) with contractor--contractor CPR data comes in electronically and automatically goes into a spreadsheet to be analyzed
7. includes several different Estimate at Completion (EAC) calculations with a guide to determine which EAC is most applicable for a given program

The two other criteria that tied for seventh place were:

8. needs to be able to print on plotter or printers
9. software is available on personal computer

TABLE 3

SECOND COMPARISON METHOD

<u>Criteria</u>	<u>Rank of 1 to 5</u>	<u>Rank of 1 to 6</u>	<u>Rank of 1 to 7</u>	<u>Order of Importance</u>
a	7	7	8	10
b	3	5		17
c	2	3		20
d	15			1
e	11			4
f	9			5
g	7	8		8
h	6	9		11
i	12	13		3
j	12	15		2
k	3	3	3	19
l	6	7		12
m	4	7		13
n	3	8		16
o	4	5	6	14
p	4	5	5	15
q	7	7	10	9
r	8			6
s	7	9		7
t	3	3	4	18
u	2			21

Third Comparison. Finally, the criteria were selected based on the number of times each criterion was rank ordered in the range of 1 to 7. The seven criteria were selected from the highest ratings. In the event

of a tie, the ranges 1 to 8 and 1 to 9 were used, respectively. The results are listed in Table 4:

TABLE 4
THIRD COMPARISON METHOD

<u>Criteria</u>	<u>Rank of 1 to 7</u>	<u>Rank of 1 to 8</u>	<u>Rank of 1 to 9</u>	<u>Order of Importance</u>
a	8	10		12
b	7			15
c	4	4	4	19
d	17			1
e	15	17	0 (13 is	3
f	12	13	next no.*)	5
g	9	13		10
h	12	12		6
i	15	17	0 (11 is	2
j	15	16	next no.*)	4
k	3			20
l	8	0		14
m	8	9		13
n	10	12	12	8
o	6			16
p	5			17
q	10	10	10	9
r	9	10		11
s	10	12	15	7
t	4	7		18
u	2			21

* no. = number

The seven criteria, in order of importance, are:

1. user friendly, menu-driven screens
2. full CPR/C/SSR analysis that uses regression analysis to predict trends
3. easy to use or can load the software onto the computer with no problems
4. variance analysis, with indicators of major problem areas
5. learn as you use -- get to work right away
6. needs to be able to print graphics or data

7. includes several different Estimate at Completion (EAC) calculations with a guide to determine which EAC is most applicable for a given program

The two other criteria that were tied for seventh place were:

8. ability to modify formulas, update charts
9. software is available on personal computer

Following are the results for each of the three comparison methods:

TABLE 5

SUMMARY OF THE THREE COMPARISON METHOD RESULTS

FIRST COMPARISON METHOD		SECOND COMPARISON METHOD		THIRD COMPARISON METHOD	
<u>Order of Importance</u>	<u>Criteria</u>	<u>Order of Importance</u>	<u>Criteria</u>	<u>Order of Importance</u>	<u>Criteria</u>
1	d	1	d	1	d
2	j	2	j	2	i
3	i	3	i	3	e
4	e	4	e	4	j
5	n	5	f	5	f
6	s	6	r	6	h
7	l	7	s	7	s
8	g	8	g	8	n
9	f	9	q	9	q
10	h	10	a	10	g
11	q	11	h	11	r
12	m	12	l	12	a
13	t	13	m	13	m
14	p	14	o	14	l
15	r	15	p	15	b
16	k	16	n	16	o
17	o	17	b	17	p
18	a	18	t	18	t
19	b	19	k	19	c
20	c	20	c	20	k
21	u	21	u	21	u

Comparison of CPR Criteria to Criteria from the Four Studies. Most of these criteria (that were determined to be essential for CPR software packages by the AFSC product divisions) can be grouped into one or more of the criteria categories from the four studies that were previously

reviewed. The categories from the four studies that include the CPR software criteria are highlighted in bold characters below. Two of the CPR software criteria cannot be classified into any of the criteria categories from the four studies. They are: a way to determine if data have been inputted correctly (k) and whether the software is available on a personal computer (q). With regard to being able to determine if data have been inputted correctly, the Operations Research study revealed that software must be "user friendly". In this study, it stated that flexibility of the software was an example of "user friendliness" and one way to achieve this was to avoid having the user respond "yes" or "no" as to whether the data entered were correct. Therefore, a method needs to be found that both will identify incorrect data and is also "user friendly" at the same time. As stated above, the highlighted areas in Table 6 below refer to the criteria categories from the four studies previously reviewed which include the criteria determined to be essential for CPR software packages:

TABLE 6
COMPARISON OF CPR SOFTWARE CRITERIA TO
SOFTWARE CRITERIA FOR FOUR DIFFERENT STUDIES

<u>Criteria</u>	<u>Project Management Study</u>	<u>AFSC Software Quality Indicators</u>	<u>Operations Research Study</u>	<u>Word Processor Study</u>
Installation	x			
Tutorial	x		x	
Hands-on Tutorial	x			
Data Entry Flexibility	x		x	
Reporting	x			
Customized Reports	x			
Quality of output	x	x		
Interfacing with other programs and computers	x	x		x
Speed			x	x

TABLE 6

**COMPARISON OF GPR SOFTWARE CRITERIA TO
SOFTWARE CRITERIA FOR FOUR DIFFERENT STUDIES (Continued)**

<u>Criteria</u>	<u>Project Management Study</u>	<u>AFSC Software Quality Indicators</u>	<u>Operations Research Study</u>	<u>Word Processor Study</u>
Understandable				
documentation	x		x	
Usable documentation	x		x	
Easy to learn (become productive quickly)	x	x	x	
Easy to Use - Screen color mix	x			
Easy to Use - Program hierarchy	x	x		
Easy to Use - Command presentations	x	x		
Easy to Use - help function/useful error messages	x		x	
Vendor experience	x			
Vendor technical assistance	x			
Vendor implementation and support	x			
Vendor - training prgms.	x			
Vendor - considers user feedback	x			
Cost	x			
Correctness (satisfies requirements)		x		
Efficient		x		
Flexible (effort to enhance or modify SW)		x		
Integrity (ability to control unauthorized access or modification to software)		x		
Maintainable (effort reqd. to locate and correct errors in software)		x		
Portable		x		
Reliable		x		
Reusable (multiple applications)		x		
Testable (effort reqd. to ensure SW performs intended functions)		x		
Accurateness			x	

Selecting the "Most Important" CPR Software Criteria

In evaluating the three different comparison methods of the CPR analysis software criteria, it was determined that the following criteria consistently ranked as the four most important criteria in evaluating CPR software: user friendly, menu-driven screens; variance analysis; regression analysis; and installation. The criterion that consistently ranked as number one in all three methods was user friendly, menu-driven screens. The results of the three comparison methods regarding the features considered "most important" in CPR software are as follows:

TABLE 7
RANKINGS OF "MOST IMPORTANT" CPR SOFTWARE CRITERIA
DETERMINED FROM THREE COMPARISON METHODS

<u>Criteria</u>	<u>First Method</u>	<u>Second Method</u>	<u>Third Method</u>
(d) User friendly, menu-driven screens	1	1	1
(j) Variance analysis	2	2	4
(i) Regression analysis	3	3	2
(e) Installation	4	4	3
(f) Productivity	9	5	5
(s) Estimate at Completion (EAC)	6	7	7
(n) Ability to modify formulas and update charts	5	16	8
(r) Interactive MIS with contractor	15	6	11
(h) Ability to print graphics or data	10	11	6
(l) Narrative section	7	12	14
(g) Ability to print on plotter or printers	8	8	10
(q) Software is available on personal computer	11	9	9
(a) Help indexes that tutor on the analyses	18	10	12
(m) Documentation	12	13	13

As stated before, studies have shown that most people can only concentrate on seven plus or minus two items at a time before they become overwhelmed. Therefore, the features considered most important in CPR analysis software will be divided into the following seven categories: User Friendliness (Friendly); Tools; Modify/Print Capability (Mod/Prnt);

Interactive MIS Capability (Interact); Personal Computer Capability (PC); Help; and Documentation (Document). The specific features that will be included in each category are:

Friendly:

- (d) User friendly, menu-driven screens
- (e) Installation (ability to load software with no problems)
- (f) Productivity (learn as you use / get to work right away)

Tools:

- (j) Variance analysis
- (i) Regression analysis
- (s) Estimate at Completion (EAC)
- (l) Narrative section

Mod/Prnt:

- (n) Ability to modify formulas and update charts
- (h) Ability to print graphics or data
- (g) Ability to print on plotter or printers

Interact:

- (r) Interactive MIS with contractor

PC:

- (q) Software is available on personal computer

Help:

- (a) Help indexes that tutor on the analyses instead of referring to a manual

Document:

- (m) Documentation - easy to understand and follow

Weights. In determining the importance of each "most important" CPR software criteria, an "average" approach will be used. This approach will be based on how the AFSC product divisions ranked each criterion according to the three comparison methods used previously (see Table 7, RANKINGS OF "MOST IMPORTANT" CPR SOFTWARE CRITERIA DETERMINED FROM THREE COMPARISON METHODS). A ranking of "1" by the product divisions received a rating of 21 points; "2" received a rating of 20 points, etc. down to where a ranking of "21" received a rating of 1 point. The results are provided in Table 8 below:

TABLE 8

ORDER OF IMPORTANCE OF "MOST IMPORTANT" CPR SOFTWARE CRITERIA

<u>Order of Importance</u>	<u>Criteria</u>	<u>Weight</u>	<u>Category</u>
1	(d) User friendly, menu-driven screens	21.0	Friendly
2/3	(j) Variance analysis	19.333	Tools
2/3	(i) Regression analysis	19.333	Tools
4	(e) Installation	18.333	Friendly
5	(f) Productivity	15.667	Friendly
6	(s) Estimate at Completion (EAC)	15.333	Tools
7	(g) Ability to print on plotter or printers	13.333	Mod/Prnt
8	(h) Ability to print graphics or data	13.0	Mod/Prnt
9/10	(n) Ability to modify formulas and update charts	12.333	Mod/Prnt
9/10	(q) Software is available on personal computer	12.333	PC
11	(r) Interactive MIS with contractor	11.333	Interact
12	(l) Narrative section	11.0	Tools
13	(m) Documentation	9.333	Document
14	(a) Help indexes	8.667	Help

Phase IV: Method of Evaluation

Expert Choice, designed for the IBM PC and compatibles, is an analytical hierarchy model and is based on the theory developed by Dr. Thomas L. Saaty, a professor of mathematics at the University of

Pittsburgh. Expert Choice is decision support software that facilitates a variety of decisions ranging from selecting a vacation to deciding whether to build either a hospital or nuclear power plant. Expert Choice supports decision making by considering all of the factors affecting the decision as well as how they affect the decision at the same time. The human mind generally has difficulty doing this. Expert Choice regards the decision making process as an entire system, not as separate parts. It considers both quantitative and qualitative factors in making a decision. Also, Expert Choice can accommodate inconsistencies that are often present in the "real" world. For example, if someone prefers C over D and D over E, logic would say that this person would prefer C over E. In the "real" world this may not necessarily be true because of other factors that enter into a decision. And Expert Choice takes these other factors into consideration when making a final decision. Expert Choice is user friendly in that it allows the user to incorporate new knowledge into the decision-making process as it becomes available.

Expert Choice models its decision making process around an upside-down tree-like structure or hierarchy of the way humans think. A single goal is represented at the top of the structure and everything branches down from it. Quantitative as well as qualitative criteria serve as intermediate levels on this tree. The user decides which criteria to model and makes judgments on those criteria. At the bottom of the tree are the leaves--they represent the alternatives to be chosen. The user makes the final decision on which alternative to select.

Once the goal, criteria and alternatives have been identified, judgments are made on the criteria. A pairwise comparison is conducted

on the main criteria with respect to the goal. A verbal (for qualitative) or numerical (for quantitative) rating may be used. With the verbal rating, the terms "moderately more", "strongly more" and "equally as" important are used. With the numerical rating, numerical values or their reciprocals are used. After the comparison on the main criteria is completed, a pairwise comparison is conducted on the alternatives with respect to each criterion. Three different types of comparison methods are used in Expert Choice. They are importance, preference and likelihood. Importance is used when comparing a certain criterion with another criterion; preference is used when comparing alternatives; and likelihood is used when comparing uncertain events (i.e., the probability of a certain interest rate) (5:2-1 to 2-13).

Expert Choice is unique in that it offers the following three features: an inconsistency ratio, sensitivity analysis and a ratings utility. With regard to the inconsistency ratio, a value of 0.10 or less is considered acceptable. Expert Choice will assist the user in identifying his or her most inconsistent judgment and will suggest an alternative judgment. The user is recommended not to change their judgments in order to be more consistent unless he or she thinks that those judgments were initially inappropriate. Expert Choice also offers sensitivity analysis. By changing judgments about the importance of the criteria, the user can determine how sensitive the final priorities for the alternatives are to those changes. The ratings utility is used when there are a large number of alternatives. "Large" refers to more than seven alternatives and Expert Choice can handle up to a few hundred alternatives. Instead of performing pairwise comparisons with the alternatives, the

ratings utility uses a rating scale approach. First, the main criteria are weighted. Then, ratings "intensities" (i.e., very expensive, expensive, average and cheap may be used to explain the COST criterion) are entered and weighted for each criterion. For example, expensive is 1.5 times as preferable as very expensive whereas cheap is 4 times as preferable as very expensive. After this is accomplished, an incomplete spreadsheet will appear with columns for each criterion. The alternatives are then inserted as the rows of the spreadsheet. Once this is done, the user assigns ratings to each alternative with respect to each criterion using the intensity ratings. Expert Choice will automatically calculate the priorities for the alternatives as the user enters the intensity ratings. Even though the intensity ratings are displayed as words, their numerical values are used to determine the total score of each alternative. The alternatives can then be sorted and ranked in descending order based on the total scores (6:1-11).

As stated above, Expert Choice can be used in a variety of areas of decision making. The general areas of application are as follows: corporate executive decision making, corporate managerial decision making, small business, national policy and public administration. The more specific areas of application contained within the above categories include: marketing, finance, personnel, engineering, purchasing and production. In addition to this, Expert Choice can be used in many areas of personal decision making such as job selection, financial investments, voting and purchases (5:2-6 to 2-8).

Phase V: Software Evaluation and Comparison Using Criteria Established

The four CPR analysis software packages were selected at random in determining the order of evaluation against the criteria. The order of evaluation is as follows: (1) Performance Analyzer (PA); (2) CPR-EZ; (3) Contract Appraisal System (CAPPS); and (4) Contractor Cost Analysis System (CCAS).

Performance Analyzer (PA). Because Version 2.7 of the User Manual was not available, Version 2.6 of PA's User Manual was evaluated while Version 2.7 of PA's software was analyzed.

Criterion (d): User friendly, menu-driven screens. The PA's menu-driven screens are shown in Figure 1, Performance Analyzer Menu Tree, on page 6 of the User Manual. The menu-driven screens are basically very user friendly and easy to work with except for the following observations: 1.) When the PA software is first accessed on the computer screen and the "help" menu (F1) is entered, the software displays "press any key to continue"; however, when "any key" is pressed, the software does not continue; 2.) In the "Automated Data Input Menu," when "*LOTUS" is selected, the cursor moves back to "Text"; 3.) It may be beneficial to the user if the software included "F1, HELP," in the menu at the bottom of the screen; 4.) When conducting Functional Structure Maintenance, the "Ins" (Insert) key allows the user to add more elements. The user must use the Insert function key and cannot perform the task by selecting the "I" key; 5.) Page 33 of the User Manual states that "EAC Inputs" can be entered by pressing the "/" key. However, the menu selection does not include "EAC Inputs" for Work Breakdown Structure

(WBS) Level 1 whereas it is included for some but not all of the WBS Level 2 and Level 3 elements; 6.) With regard to the Manpower chart, after the "Show Baseline" option is selected, the user must exit out of the graphics portion and reselect "Manpwr" before the original Manpower chart is again displayed on the screen; 7.) If any changes are made to data, the user must go to the "Contract Main Menu" and select the "Recalculation" option in order to recalculate--it would be both easier and faster to have a function key perform this operation from any location in the program.

Criterion (j): Variance analysis. The PA provides variance analysis for color or monochrome computer systems. The color computer system uses both arrows and colors in the boxes to perform variance analysis. Unless the user either reads the User Manual (page 30) or the Help screen (select F1 for Help but this is not indicated on the menu), he/she may find it difficult to distinguish between what the arrows and colors symbolize. For the monochrome computer system, the difference between "normal" and "inverse" is confusing. "Inverse" refers to a highlighted box whereas "normal" refers to a blank box. Because the variance analysis boxes for cost, schedule and variance at completion are difficult to understand without referencing the Help menu, it may be easier for the user to perform the analysis if a performance indicator key (such as Table 3 on page 30 of the User Manual) is included on the same screen as the variance analysis boxes. Analysis features of PA are described on pages 30-32 and 37-38 of the User-Manual. PA allows the user to sort WBS and Functional levels by cost, schedule or variance at

completion in order to identify the major problem areas affecting each situation.

Criterion (i): Regression analysis. Linear regression is used to forecast EAC. Regression analysis can be referenced on pages 42 and 88 of the User Manual.

Criterion (e): Installation. Installation procedures are on page 2 of the User Manual. The documentation states that the user needs to ensure that the config.sys file contains certain commands but does not give step-by-step instructions on how to do this. Also, when loading PA onto the computer, the software displays an error message if there is not enough memory on the computer. When this occurs, the user will have to delete another program from the computer so that PA can then be loaded onto the computer system.

Criterion (f): Productivity. With PA, the user can get to work right away and is able to learn as he/she uses the software. The menus are designed so that the software is very easy to use and understand. As mentioned above in the "user friendly, menu-driven screens" criterion, a "Recalculation" function key may be more productive than accessing the "Contract Main Menu" screen to select the "Recalculation" option.

Criterion (s): Estimate at Completion (EAC). The PA includes several different EAC calculations but does not include a guide to determine which EAC calculation to use for a given program and/or situation. The System Program Office (SPO) analyst is able to input his/her own EAC along with the method used and a narrative rationale. As mentioned above in the "user friendly, menu-driven screens" option, "EAC Inputs" can be entered by pressing the "/" key. However, the menu

selection does not include "EAC Inputs" for WBS Level 1 but does include "EAC Inputs" for some but not all of WBS Level 2 and Level 3 elements. The User Manual references EAC on pages 32, 35, 41-42 and 85-88.

Criterion (g): Ability to print on plotter or printers. Page i of the PA User Manual states: "The Performance Analyzer can display, print, and plot graphs such as analysis level trend data and briefing class Program Management Review (PMR) charts, required by the Space Division Commander" (10:i). Because a plotter was not available to analyze whether graphics could be plotted, this criterion could not be evaluated. However, the ability to print on printers could be evaluated and reports were easily printed by using the "F7" key.

Criterion (h): Ability to print graphics or data. Page 36 of the PA User Manual states: "Graphs are displayed on the screen and can be output to a printer or plotter. Use the 'F7' key to print a graph and the 'ESC' key to abort a print routine" (10:36). This is consistent with what was discovered when the software was evaluated; however, the "Graphs" option only offers the following selections: Screen Plotter Exit. To print a graph, the user must first select the "Screen" option and then press the "F7" key. This is not obvious from viewing the menu selections. In addition to this, printouts of the graphs are difficult to read because there are white lines running through the typed print.

Page 33 of the User Manual states: "Reports are displayed on the screen and can be output to a printer. Use the 'F7' key to print the report and the 'ESC' key to abort a print routine" (10:33). This was consistent with what was found when the software was evaluated--reports were printed using the "F7" key, which was very easy to accomplish. PA

offers numerous reports and graphs--the reports are discussed on pages 33-35 of the User Manual and the graphs are described on pages 36-39. Page 35 of the User Manual states that to print the CPR report, "a wide carriage IBM printer set to the condensed mode is required" (10:35). Condensed print is also required to print the "PM Sum" report but this is not stated in the description of the Program Manager Summary report on page 34 of the User Manual.

Criterion (n): Ability to modify formulas and update charts.

The user is not given the opportunity to modify formulas but as mentioned previously, the SPO analyst is able to input his/her own EAC along with the method used and a narrative rationale. With regard to updating charts, the user is only able to change the range for some graphs. When changing the range, it is not easy to input data and the software does not save the changes--it defaults back to the previous data. Monthly data input can be changed either manually or via automation. Updating WBS/Functional elements is also easy to perform due to the visual tree-like structure approach which PA uses (10:17-22).

Criterion (q): Software is available on personal computer.

The software packages were evaluated on personal computers (PC) with an MS-DOS operating system. Performance Analyzer, as well as the other three CPR software packages being evaluated, is available on personal computer (PC).

Criterion (r): Interactive MIS with contractor. Page i of the

User Manual states the following:

The system supports automated data transfer from contractors and incorporates automated interfaces to the Space Division ACCI Business Management Review (BMR) System, the Defense Acquisition

Executive System (DAES) and the Air Force Systems Command (AFSC)
Executive Information Systems (EIS). (10:i)

With regard to this criterion, page 23 of the User Manual states that PA performs error checks and creates an error report on the contractor's imported file.

Criterion (1): Narrative section. A WBS Narrative report is available for each WBS element and includes the following information: cumulative performance, cumulative cost/schedule chart, cost performance indices chart and status of element. PA also generates a Program Manager Summary report (see pages 34 and 65 of User Manual) and an Executive Summary report (see pages 34 and 55 of User Manual).

Criterion (m): Documentation. The PA User Manual is easy to understand and follow with the following exceptions: 1.) The User Manual does not include an index but does include a Table of Contents; 2.) "Thresholds and Forecasting Factors" on page 15 is not listed in the Table of Contents; 3.) On page iii of the Table of Contents, "Plotter Set-up" and "Exit" under the "Utilities Menu" option are not aligned correctly; 4.) The Table of Contents lists the heading for "Contract & WBS/Functional Maintenance" on page iii and the subheadings on page iv-- this is not very easy to read; 5.) The PA User Manual does not spell out the following acronyms: PM Sum, MR, Exec Sum, BMR, CPR, EAC (page v of Table of Contents), OPR (page 20), G&A (pages 17 and 20), S/L VAC (pages 37 and 39) and CAO (page 40); 6.) The following reports and figures are difficult to read: CPR Formats 1-5 (pages 57-60), Appendix 2 Formulas (pages 81-90) and Figure 1 Performance Analyzer Menu Tree (page 6); 7.) Under "Plot Summary PMR Chart" on page 7 of the User Manual, it states "See Contract Information to change the contract abbreviation"--

this needs to be more specific since "Initial Contract Information" is discussed on page 13 and "Monthly Contract Information" is discussed on page 24 of the User Manual; 8.) The PA User Manual contains the following misspelled words: "Figure 2 Contract Informantion" (on page 13) instead of Information; the first sentence of "Contract Information" on page 13 states: "Most of the entries on Figure 2" rather than "Most of the entries in Figure 2"; "Table 2 Initail Contract Data" (on page 14) instead of Initial Contract Data; 9.) The PA User Manual lists the operation of different "Function Keys" separately on pages 3, 31-32 and 42--a comprehensive table listing all of the function keys and their respective operations may also be helpful to the user. In addition to this, the User Manual for Version 2.6 and the "Foreword" on the software for Version 2.7 list different operations for certain function keys. Therefore, the function keys were updated from Version 2.6 to Version 2.7 of the Performance Analyzer. Examples of the difference in the function keys for Version 2.6 and Version 2.7 are as follows:

User Manual (Version 2.6)

Ctrl + F4 Weighted Cost/Schedule
Ctrl + F5 Linear Regression
Ctrl + F6 User Performance Factor
Ctrl + F7 Budget at Completion
Ctrl + F8 Latest Revised Estimate
Ctrl + F9 SPO EAC (ICA Input Only)

CPR Software (Version 2.7)--"Foreword"

Ctrl + F4 Copy Cur CPI
Ctrl + F5 Copy COST & SCH
Ctrl + F6 Copy LINEAR REG - Copies the Linear
Regression EAC to the SPO EAC or
ICA EAC.
Ctrl + F7 Copy PERF FACTOR
Ctrl + F8 Copy SPO EAC - Copies the SPO EAC to
the ICA EAC.

Ctrl + F9 Copy NAVSEA EAC - Copies the NAVSEA EAC
to the SPO EAC or ICA EAC.
Ctrl + F10 Copy BAC - Copies the Budget at
Completion to the SPO EAC or ICA EAC.
Alt + F10 Copy LRE - Copies Latest Revised
Estimate to the SPO EAC or ICA EAC.

Criterion (a): Help indexes. PA's help indexes tutor on the analysis and can be accessed by pressing F1 at any location. The help indexes provide thorough, detailed explanations and contain basically the same information as the User Manual.

Other Comments. Pages 2 and 3 of the User Manual states that PA will eventually provide two types of passwords in the network version: one type of password will allow performance data to be changed while the other type of password will allow read only authorization. PA also contains a Validity Report (see page 34 of User Manual) which "produces a list of analysis comments concerning the data validity and the contractor's LRE for each WBS and Functional element" (10:34). Both of these features may also enhance the productivity of the user by providing additional security and analysis techniques.

CPR-EZ. CPR-EZ is "a LOTUS 1-2-3 Application" and Version 1.0 of this CPR analysis software model was evaluated.

Criterion (d): User friendly, menu-driven screens. CPR-EZ uses menu-driven screens which are not very user friendly overall. Some examples of these difficult-to-use screens are as follows: 1.) In CPR-EZ, the Escape (ESC) key is used to transfer control to the user by cancelling the menu-driven feature. Because analysts normally use the "ESC" key to cancel information or return to the previous screen and/or menu, using the "ESC" key for some other function may frustrate the user.

This may occur if the user either forgets that the "ESC" key transfers control to the user or is unaware of this feature (i.e., does not read Sections 4.0 or 7.0 of the documentation). A function key that is not frequently used should be selected to transfer control to the user. Therefore, using a function key to perform this operation would be preferable to using the "ESC" key; 2.) A major frustration with CPR-EZ's menu-driven screens is that for whatever location of the program the user is in, if he/she presses "ESC" and then "Alt-M" to restore the applicable menu options for the operations being performed, the main menu option (DATA MAINTENANCE OUTPUT INSTRUCTIONS END) appears. Therefore, the user must start all over again from the main menu screen and try to find where he/she was previously located in order to complete the task that he/she was performing; 3.) Another example of how CPR-EZ's menu-driven screens are not user friendly is that a myriad of screens must be accessed before the user is finally able to print the Summary Report. After the user is able to view the Summary Report, the next menu option is: SUMMARY REPORT ALL OTHER DETAILS BACK; the menu option following this is: CONTINUE RECALCULATE; and, finally, the next menu option is: SCREEN PRINTER BACK. This is frustrating to the user if he/she wants to print the report immediately after viewing it; 4.) While in the "Instructions" section of the CPR-EZ or CPR-DEMO files, if the user selects the "Home" key, the program does not return to the beginning of the information displayed when the user first entered this option (description of model). Instead, the program returns to cell A1 where a spreadsheet is displayed. This also occurs when the user is in location BL through BR, where information about printing graphs is located.

Following the information about how to print graphs is the instruction "press RETURN to continue"; however, when this is accomplished, the program returns to cell A1.

Criterion (j): Variance analysis. CPR-EZ computes the cost and schedule variances for all months. This software package calculates CUM, 6-MO, 3-MO and CURR information for each of the following: CV, CV%, CPI, SV, SV% and SPI. However, the software program does not provide indicators of major problem areas. The following example is an indicator of a major problem area and is available in the CAPPS program: "Monthly actuals are running at \$17107K. This effort has an unfavorable cost variance of 4 percent. There are indications that you've got problems developing!"

Criterion (i): Regression analysis. CPR-EZ does not use regression analysis to predict trends.

Criterion (e): Installation. CPR-EZ is a LOTUS 1-2-3 spreadsheet. It is easy to load the CPR-EZ files if the user already has the LOTUS program and knows how to use it. Otherwise, the user must buy either the LOTUS program or a program that is compatible with LOTUS in order to use this spreadsheet. QUATTRO and ENABLE are two software programs that are compatible with LOTUS. QUATTRO was able to load the CPR-EZ program; however, ENABLE would not load the CPR-EZ program and displayed the following message: "Invalid Spreadsheet File."

Criterion (f): Productivity. With CPR-EZ, the user is not able to get to work right away. Section 2.0 of the documentation instructs the user to retrieve the "INSTRUCTIONS" option of the CPR-EZ file when using this model for the first time. CPR-EZ is referred to as

the CPR model's "shell"; the "INSTRUCTIONS" option contains general information about how the model works and is not a spreadsheet. Therefore, the user is unable to get to work right away.

Criterion (s): Estimate at Completion (EAC). Section 5.1 of the documentation lists the five different EAC calculations used by CPR-EZ (BASIC, CAPPS, WEIGHTED, APMC and LOLLAR). However, there is no guidance as to which EAC formula to use for a particular program and/or situation. Range BL186 through BR197 provides information on the Weighted EAC; range BL123 through BR138 provides information on selecting an EAC method based on management reserve (MR).

Criterion (g): Ability to print on plotter or printers. The CPR-EZ program does not print on a plotter. It is, however, able to print on a printer. With CPR-EZ, data can be printed using either the "PRINTER" menu option or the "Print Screen" function key.

Criterion (h): Ability to print graphics or data. Section 1.2 of the documentation states: "A graphics board is necessary for viewing and printing graphs." Additional information on printing graphs is available by accessing the "Function Keys" option of the "Help Index" (F1) as well as by reading the information provided in range CD23 through CJ38 and range BL3 through BR21. Saving and printing graphs is not easy to accomplish. Range BL3 through BR21 tells the user how to print graphs but does not give instructions on how to get to the LOTUS main menu in order to choose the "PRINTGRAPH" option (assumes the user knows how to use LOTUS). Once the LOTUS "PRINTGRAPH" option is set up correctly, graphs can be printed on the printer. With regard to being able to print data, the data for individual WBS elements could not be printed. The

"OUTPUT" option stated that the user would be able to "View or print the output"; however, the user is only allowed to view, not print, data for each WBS element. In contrast to this, the software program is capable of printing the Summary Report in condensed print (15 pitch) so that it can be printed on 8 1/2" x 11" paper.

Criterion (n): Ability to modify formulas and update charts.

Section 3.3 of the documentation states that there are five major inputs (BCWS, BCWP, ACWP, BAC and LRE) for this software. There is no limit to the number of characters that can be entered in each cell but only eight digits will be displayed for each input. The documentation also states that decimals may be entered but will not be displayed. Also, during "INPUT," the cursor is confined to the input area. When the user tries to edit data, the software is set up so that range J through N is frozen. This presents a problem when the user wants to view data in range O1 through AE120--as the cursor is moved to the right, the data in this range disappears behind the frozen range (range J through N). Therefore, it is difficult for the user to compare and/or view the data when this occurs. Also, the user is unable to modify formulas because the cells that contain the formulas are protected. With regard to updating graphs, the user is able to enter ranges for values to be graphed and can also change the labels to appear on the graphs.

Criterion (q): Software is available on personal computer.

CPR-EZ Version 1.0 is available on PC.

Criterion (r): Interactive MIS with contractor. The CPR-EZ

"Contract Analysis Workshop" handout dated 5-6 April 1988 states that

there is only "manual entry of data - for now" available with the CPR-EZ software.

Criterion (1): Narrative section. CPR-EZ generates a Summary Report which includes % COMPL (percent complete), BCWS, BCWP, ACWP, COST VAR %, SCHED VAR %, BAC, LRE, EAC1 (cum basic EAC) and EAC2 (6-month weighted EAC) for each WBS element number. However, the software program does not indicate variance problem areas or provide suggestions for further research. As stated above, the Summary Report calculates dollar amounts for each WBS element number, including WBS level 1.0. Contrary to this, the "INSTRUCTIONS" option of the CPR-EZ file states the following: "This model does not calculate dollar amounts at summary levels (e.g., WBS number 1.0) based upon other inputs. In other words, it doesn't sum the sub-elements."

Criterion (m): Documentation. The pages of the CPR-EZ documentation are not numbered. The documentation also contains the following typographical errors: 1.) In Section 3.2, the first word of the last sentence of the first paragraph, "do," is not capitalized; 2.) In Section 3.4, the second line of the column labeled "ITEM" includes a misspelled word, "NUMNER." In addition to this, the documentation does not include a Table of Contents. In Section 5.1, the documentation does not explain the theories behind the CAPPS, APMC, LOLLAR, BASIC and WEIGHTED EACs. The CPR-EZ documentation is easy to understand but not easy to follow. For example, the documentation does not include all features of the program. The CPR-EZ software contains three files: CPR-DEMO, CPR-DOC and CPR-EZ. However, only the CPR-EZ file is mentioned in the documentation. The CPR-EZ and CPR-DEMO files are basically the same

and include menu options of DATA MAINTENANCE, OUTPUT, INSTRUCTIONS and END. The CPR-DOC file contains the same information as the documentation hardcopy and includes the following menu options: VIEW, PRINT and END. One major disadvantage of the documentation is that it does not include instructions for all operations that the software can perform. As mentioned above, range CD23 through CJ38 and range BL3 through BR21 contain instructions on how to print graphs. Likewise, range BL123 through BR139 and range BL186 through BR197 contain information on the EAC; however, none of this information is included in the documentation. Also, the "Help Index" includes extensive information on how to operate LOTUS 1-2-3. Referencing this information in the documentation may also help the analyst to learn how to use the software program.

Criterion (a): Help indexes. CPR-EZ's help facility does not tutor on the analyses. However, it does contain very thorough explanations of LOTUS 1-2-3 features such as entering, changing, adding and deleting data. The F1 function key is the "help" key--this information is not included in the documentation or menu screens. The software program also refers the user to the documentation. For example, "FORMULAE" is a menu option in the "OUTPUT" section of the software (select OUTPUT, ALL OTHER DETAILS, SELECT WBS, SCREEN, FORMULAE). When the "FORMULAE" option is selected, the software displays the following message: "SEE DOCUMENTATION."

Other Comments. WBS information is entered in the program sequentially; therefore, the relationships between the WBS elements are difficult to visualize. In addition to this, Section 6.0 includes instructions on how to locate certain information in the software program. The

{Home} {End} {Right} and {GoTo} CQ4 {RETURN} instructions are not accurate. {Home} {End} {Right} locates the cursor in cell DT1, where an "x" is located. The documentation states that performing these functions will locate the cursor on MENUSTOP. From cell DT1, performing {End} {Right} locates the cursor in cell HI1, where MENUSTOP is located. Performing {End} {Right} again locates the cursor in cell II1, where MACROSTOP is located. Performing the {GoTo} CQ4 {RETURN} operation locates the cursor in cell CQ4 which is the upper left edge of the "CPR-EZ DETAIL REPORT." The documentation states that performing this operation will locate the cursor in the upper left edge of the summary report. However, cell DK4 is the upper left edge of the "CPR-EZ SUMMARY REPORT."

Contract Appraisal System (CAPPS). Version 2.10 of the CAPPS software from Defense Systems Management College (DSMC) was the third CPR analysis software package to be evaluated.

Criterion (d): User friendly, menu-driven screens. Overall, the menu-driven screens for the CAPPS software are user friendly, with the following exceptions: 1.) Entering the Contract Completion Date and changing the Contract Start Date require a more complicated process than necessary. The user should be able to access and change this information without having to either perform a variety of tasks or select numerous menu options. Section 5.4.4 on page 5-7 of the User's Manual refers to entering the "Contract Completion Date" and Section 5.4.8 on page 5-8 refers to "Changing the Contract Start Date"; 2.) If the user selects the [Previous Screen] option while in the "Help" mode, a message stating "can't go back any further" is displayed on the screen. However, when

the [RETURN] option was selected, the software returned to the previous screen; 3.) The user can only access certain graphs from specific menu options. An example of this is that [EAC's] can only be accessed while in the Cost Performance Indices graph and [Indices] can be accessed only from the Variance Trends graph option. An ideal situation would be if the user could access either [EAC's] or [Indices], etc. from any graphics location. CAPPS tries to compensate for this inability to easily access certain information by providing a "FAST TRACK THROUGH CAPPS" chart on page 7-2 of the User's Manual. Section 7. FAST TRACK on page 7-1 of the User's Manual states the following:

. . . You can get anywhere in CAPPS by starting at the Overview Screen or at one of the element Status Screens. From any element Status Screen, the graphics path is always available (for that element) by pressing the space bar once to [Cum Performance] and pressing the Return key. (1:7-1)

Criterion (j): Variance analysis. CAPPS performs very thorough variance analysis which includes indicators of major problem areas. Major problem areas for each WBS element are highlighted in the "Status of Element" screen. This information is very easy to read and understand and contains a thorough analysis of each WBS element. Section 6.4 KEY ELEMENT STATUS on pages 6-8 and 6-9 of the User's Manual states the following:

The first section of the screen states what percent this element is of the total contract based on the resources devoted to it. This gives you an idea of how significant a problem the element might be in terms of its impact on the total contract.

The comments related to cost, schedule, and projected status in the remaining three windows result from a compilation of numerous analysis techniques applied to the data elements in the file for that key element. These comments [Appendix A of the CAPPS User's Manual contains the "Rules for Status Screen Comments."] flag alarming or unusual trends using special highlighting techniques as illustrated by the shading in Figure 6-7.

The cost status section provides the bottom line analysis based on cost, schedule and technical performance. Typical comments for the cost window warn you when problems are apparent and identify significant decreases (increases) in the rate of expenditures.

In the schedule window you are likely to see comments on whether work in process is behind or ahead of schedule, what percent of the total effort has been completed to date, and projections of schedule slip in weeks if current performance trends continue.

The projected status window usually deals with the feasibility of meeting the cost goals set for the contract. Typical comments include an evaluation of the feasibility of the contractor's current projections. (1:6-8 to 6-9)

As stated above, the "Key Elements" selection provides the user with a summary of the six WBS or Functional elements which are causing the most problems within a program based on cost variance percentages. A more detailed explanation on any specific element is provided by graphic presentations. For example, there is a "Variance Trends Graph - Key Element," "Variance Trends Graph - Total Contract" and a "Cost Performance Indices Graph." The "Variance Trends Graph - Key Element" graphs the cost variance, schedule variance and variance at completion against time (horizontal scale) and dollars (vertical scale). The "Variance Trends Graph - Total Contract" includes management reserve (MR) as well as the cost, schedule and completion variances for the contract. The "Cost Performance Indices Graph" graphs the current and cumulative cost performance indices as well as predicted cost performance. With regard to predicting cost performance, page 6-21 of the User's Manual states:

The cost performance Index To Go . . . is a measure of the cost efficiency which would be required to complete the work within the cost stated in the Latest Revised Estimate. It compares the planned cost of the work remaining (BAC-BCWP) to the estimate to complete (LRE-ACWP). (1:6-21)

Criterion (i): Regression analysis. The CAPPS software does not use regression analysis to predict trends.

Criterion (e): Installation. While installing CAPPS onto the computer hard disk, a message may appear stating that there may be a memory resident file conflict and that the user must remove any memory resident programs from the computer before running CAPPS. Section 5.3 of the User's Manual contains "Installation Instructions" for IBM and Zenith computers and Section 5.6 contains instructions for "Starting the Program." Section 5.6 contains incomplete instructions--for an IBM version using an EGA board, it states that the user must type "CAPPSE" (at the system prompt for the drive that the CAPPS program is in) to bring up the Introductory/Welcome screen for CAPPS; however, the user must type "CAPPSE.BAT" to access the screen. In addition to this, instructions in Section 5.3 for how to create and/or modify the CONFIG.SYS, GRAPHICS.COM AND SCDMP.COM files are not easy to understand and follow.

Criterion (f): Productivity. With CAPPS, the user is able to learn how to use the software as he/she works on the software program. However, if a novice user needs to access a certain screen and/or graph immediately, it may be difficult for him/her to locate it within a reasonable amount of time without using Section 7 of the User's Manual, "Fast Track."

Criterion (s): Estimate at Completion (EAC). CAPPS compares the contractor's Budget at Completion (BAC) and Latest Revised Estimate (LRE) to the following four Estimate at Completion (EAC) values: cumulative cost performance (CUM), the last three months of cost

performance (3MO or REC), the most recent month of cost performance (CUR) and cumulative cost and schedule performance (C&S). Section 6.12, "Projected Completion Status - EAC's," of the User's Manual includes a description of how the EAC values should be evaluated against BAC and LRE. The "EAC formulas" are listed on the computer under the "Explain" option but are not included in the User's Manual. "EAC Techniques" can also be accessed under the "Explain" option--this screen very briefly defines each type of EAC. The User's Manual refers to the last three months of cost performance as "3MO" while the computer labels it as "REC EAC." CAPPS does not provide a guide to determine which EAC is most applicable for a given program and/or application.

Criterion (g): Ability to print on plotter or printers. The CAPPS software was designed to print on printers but not on the plotter. CAPPS data and graphics can be printed only by using the "Print Screen" function key.

Criterion (h): Ability to print graphics or data. As stated above, CAPPS data and graphics can be printed only by using the "Print Screen" function key. With regard to printing graphs, pages 5-3 and 5-4 of the User's Manual states that "the GRAPHICS.COM file allows the contents of a graphics display screen to be printed on a compatible graphics printer when using a color monitor and standard color graphics card" (1:5-3 to 5-4). Page 8-1 of the User's Manual states that "an alternative method of printing the screen is provided through the PRTSCRN.COM file provided with CAPPS" (1:8-1). The documentation also states that the screen can be printed out with the PRTSCRN.COM file by pressing the CONTROL G key combination. However, the file contained on

the CAPPS computer disk is PRTSCRN.EXE, not PRTSCRN.COM. In addition to this, graphs cannot be printed using either the "CTRL G" or the "Print Screen" key options. Page 3-2 of the User's Manual states that CAPPS prepares the following four graphic analyses: cumulative performance, variance trends, indices and projected completion status, or EAC. The user is able to either focus on the most current trends or view the entire period of performance of the contract and/or a certain element using the "Zoom" and "Expand" options (1:6-12 to 6-14).

With regard to printing data, Section 8, "Program Outputs," states that the "PrtSc" key on the IBM PC and the F12 key on the Zenith 110 or 120 will print the information displayed on the screen. As mentioned above, section 8 also states that the PRTSCRN.COM file provided with CAPPS is an alternative method of printing the screen. Data can be printed using either the "CTRL G" or the "Print Screen" key options. CAPPS also allows the user to print a listing of the information in the database--this is discussed in Section 9.6 of the User's Manual.

Criterion (n): Ability to modify formulas and update charts.

With CAPPS, the user is unable to modify formulas. With regard to updating graphs, the user is able to adjust the "Variance Trends Graph" (total contract and key elements) for management reserve (MR). MR can be viewed on the graph when the user selects the "Adjust" option. With regard to updating data, Section 5.5.3 of the User's Manual, "Data," states the following: "CAPPS will work correctly only with cumulative monthly data. Also, CAPPS does not roll up the data. You must enter cumulative data for all elements at all levels" (1:5-9).

In addition to this, the user is only able to evaluate one contract at a time with CAPPS. Pages 9-10 through 9-13 of the User's Manual states that when the user creates a new contract database, CAPPS erases the current database. The following screen prompt will also appear: "This will erase the current data base. If you have not copied the data in the data base to a text file using the SAVE function, you will lose the data upon creating a data base" (1:9-10). Therefore, the user must prepare a separate disk for each contract that he/she monitors.

As stated previously in the "user friendly, menu-driven screens" criterion, the Contract Completion Date can only be entered by using the "Modify" option from the "Interactive Update Menu." Also, changing the Contract Start Date requires more effort than it should take to accomplish--this is discussed in Section 5.4.8 of the User's Manual.

Section 9.2 of the User's Manual states that with the "Interactive Update Menu," the user can add the next period of data, correct data for an existing period, remove an existing WBS or Functional element, modify the contract name or completion date and create a new contract database. When the user tries to edit data (select the "Utilities," "Interactive," "Correct," and then "Edit" options), the software will not allow the user to edit and displays the following message: "use the '/' key to display menu selections." Also, when the user tries to add a new element (select the "Utilities," "Interactive," "Correct" and then "Add Element" options), the software did not save the data. When the [Finished] option was selected, the software displayed a message stating that the database was being updated; however, when the database was reentered, the new element had not been added to the database. Section 5.4.5 of the User's

Manual, "Inserting New Elements," states that "when you insert new WBS elements [in]to your data base, CAPPS may occasionally put the element out of sequence, or may duplicate the element" (1:5-7). The User's Manual does give the user instructions on how to correct this problem; however, it is a lengthy process and requires more effort than necessary to perform this function.

Criterion (q): Software is available on personal computer.

The CAPPS software is available on PC.

Criterion (r): Interactive MIS with contractor. CAPPS does not provide an interactive Management Information System (MIS) with the contractor in which CPR data come in electronically and automatically go into a spreadsheet to be analyzed. However, CAPPS does provide for automated data submission from the contractor (see Appendix G of the User's Manual). Figure 9-9, on page 9-13 of the User's Manual, states the following: "In Batch mode, preformatted information is automatically read into CAPPS, element by element. Batch mode was designed for large amounts of data which have been prepared 'off-line' (eg. by the contractor)" (1:9-13). Section 9.4 of the User's Manual, "Batch Update," states that if a bad data message appears while the data are being read in, CAPPS will usually pass on to the next item of data (1:9-16). With regard to this, CAPPS needs to be able to provide the user with the location of the "bad data."

Criterion (l): Narrative section. CAPPS does not provide a narrative section which sums all data, trends and variance problems and does not provide suggestions for further research. Page 2-2 of the User's Manual states: "The narrative explanations are not part of CAPPS'

analysis; neither are CPR Formats 3 and 4. These Formats should not be ignored, however, since they provide important information for program management" (1:2-2).

Criterion (m): Documentation. The CAPPS User's Manual is basically easy to understand and follow; however, there are several areas of the User's Manual which do not include step-by-step instructions on how to accomplish certain tasks. Some of these areas include the following: 1.) Section 5.3, "Installation Instructions"; 2.) Section 5.4.8, "Changing the Contract Start Date"; 3.) Section 5.4.5, "Inserting New Elements"; 4.) Section 9.4, "Batch Update"; and 5.) Section 9.3, "Discussion of Interactive versus Batch Update." Other observations about the CAPPS User's Manual include: 6.) Figures 9-5 and 9-6 (on pages 9-5 and 9-6) are difficult to read; 7.) Page 6-22 refers to the last three months of cost performance as "3MO" while the software labels it as "REC EAC"; 8.) The User's Manual does not list the formulas for the calculations performed by the CAPPS software; 9.) The computer software lists "Commands" for the function keys in the "MAIN HELP MENU"; however, this information was not available in the User's Manual; and 10.) The User's Manual and the computer software contain conflicting information in describing the line type and color of the various performance measurement data elements for the following graphs: "Cumulative Performance," "Cost Performance Indices" and "Variance Trends." Table 9 below shows a comparison of the information in the User's Manual and on the computer software.

TABLE 9

**COMPARISON OF PERFORMANCE MEASUREMENT INFORMATION
IN CAPPS USER'S MANUAL vs COMPUTER SOFTWARE**

Cumulative Performance Graph

<u>User's Manual</u> <u>(Page 6-11)</u>	<u>CAPPS</u> <u>Software</u>
BCWP is a white dotted line	BCWP is a long dashed white line -- --
BCWS is a long dashed red line	BCWS is a short dashed red line - - - -
ACWP is a solid blue line	ACWP is a solid blue line
BAC is a dotted blue line	BAC is a long dashed/short dashed white line -- -
LRE is a short dashed red line (Zenith) or blue line (IBM)	LRE is a long dashed/short dashed/long dashed red line on the IBM -- - --

Cost Performance Indices Graph

<u>User's Manual</u> <u>(Page 6-21)</u>	<u>CAPPS</u> <u>Software</u>
Cum CPI is a solid blue line	Cum CPI is a solid blue line
Cur CPI is a dotted white line	Cur CPI is a long dashed white line -- -- --
Cost performance Index To Go is a dashed red line	TCPI is a short dashed red line - - - -

Variance Trends - Total Contract Graph **

<u>User's Manual</u> <u>(Page 6-18)</u>	<u>CAPPS</u> <u>Software</u>
Management Reserve (MR) is a blue dotted line	MR is a long dashed/short dashed white line -- -

** The Variance Trends - Total Contract Graph is very difficult to read-- there is a solid white line on this graph but no caption to identify this line.

TABLE 9

COMPARISON OF PERFORMANCE MEASUREMENT INFORMATION
IN CAPPS USER'S MANUAL vs COMPUTER SOFTWARE
(Continued)

Variance Trends Graph

User's Manual (Page 6-16)	CAPPS Software
CV is a solid blue line	CV is a solid blue line
SV is a dashed red line	SV is a short dashed red line - - - -
VAC is a dotted white line	VAC is a long dashed white line -- -- --

Some positive observations about the CAPPS User's Manual include:

- 1.) Section 2 contains a thorough explanation of "The Performance Measurement Process";
- 2.) Page 7-2 contains a "Fast Track Through CAPPS" chart which is designed to assist the user in going from one screen to another;
- and 3.) The User's Manual is easy to read because it contains high-quality print and the documentation is placed in a notebook.

Criterion (a): Help indexes. CAPPS' contains "Help" and "Explain" indexes which tutor on the analyses so that the user will not have to refer to a manual. However, with CAPPS, the user may have to refer to Section 7 of the User's Manual, "Fast Track," in order to access certain screens and/or graphs quickly. Appendix B of the User's Manual describes the User Assistance function. The User Assistance function is composed of the "Help" and "Explain" options. "Explain" provides the user with information about performance measurement terminology and techniques; "Help" provides information about hardware and software operation. "Help" can be accessed from any location with the "?" key.

The "Explain" screens contain very thorough, detailed definitions of BCWP, BCWS, ACWP, BAC and LRE.

Other Comments. The CAPPS software is available in three versions: a color graphics version, a tabular version and a monochromatic version. CAPPS also performs logic and consistency checks during its analyses of contract performance data. Also, a "DSMC/PMSS Software Modules Update" dated July 1990 states that CAPPS software is currently being enhanced to include VGA display capabilities and to allow use of laser printers. As stated previously, "DSMC" is the acronym for Defense Systems Management College and "PMSS" is Program Manager's Support System.

Contract Cost Analysis System (CCAS). Version 1.1 of the CCAS CPR analysis software package was prepared by Management Consulting & Research, Inc. (MCR) in Falls Church, VA, for the U.S. Air Force Cost Center.

Criterion (d): User friendly, menu-driven screens. CCAS' menu-driven screens are not user friendly. Some examples are as follows: 1.) It is difficult to save information with the CCAS software. When trying to save data that have been added and/or edited in CCAS, the user must either exit and then reenter CCAS or select the "Clean up Files" option from the "Utilities" menu. Calculations may be performed faster and easier if the CCAS software allowed a function key to save updated information; 2.) The program completion date for the program that was developed on the software was "JUN 93." When trying to obtain information for the "PROJECTED BCWS ENTRY or MODIFICATION" prompt, a message stating "Date can't be later than the completion date" was

displayed for the following dates that were entered: JUN81, JUN93 and JUN91; 3.) The CCAS software does not allow the user to access previous screens or menu options from all screens. Also, pressing the "Esc" key enables the user to return to the previous menu for only some of the screens in CCAS; 4.) While in the "Add/Edit Milestones" screen, the cursor must be within the "Add/Edit Milestones" block before pressing "<ESC> to Remove Menu" will be executed; in other words, the cursor must be located in a certain portion of the screen before any operations can be performed; 5.) When the "F1" key is selected to perform the "Help" function, the software displays either one of two messages--the first message may be an error reading and the software asks the user if he/she wants to "QUIT"; the second message states that "Help is currently not available at this point." The "Tutorial" option also displays the following message: "assist is not available at this point"; 6.) When selecting reports to print, the CCAS software allows the user to select "<A> for all reports" and "<C> to clear choices." Pressing "C" will deselect all choices and the user must reenter the number(s) for the report(s) that he/she wants to print. The "<C> to clear choices" option could be more user friendly if it only deselected the report(s) that the user did not want to print instead of deselecting all of the reports; 7.) The CCAS software is inconsistent in using a certain function key to perform the same or similar tasks for various screens. For example, the "BCWS Projections Screen" requires the user to press "<CR> to exit" (14:III-48). However, the "Add/Edit Milestones Menu" requires the user to press "<ESC> to Remove Menu" (14:III-50); 8.) When in the "Historical Performance Data" option for "Add/Edit Data," the software states that

the analyst can use "<Pg Up>/<Pg Dn>/<Arrows> to position." However, the "<Pg Dn>" key does not perform this operation; 9.) When the "Perform Calculations" option is selected from the "Utilities" menu, the software states that there is a "Database error numeric overflow" and asks the user if he/she wants to "QUIT"; and 10.) The CCAS software is inconsistent in labelling menu screens and the reports associated with those menu screens. Following is a comparison of the "Report Options" menu screen (14:III-12) and the actual titles of those reports (14:III-16 to III-21):

<u>"REPORT OPTIONS"</u> <u>Menu Screen</u>		<u>Actual Title</u> <u>of Report</u>
Contract Status Summary	:	Contract Status Summary
Dollar Variances	:	Dollar Variance
Percents and Indices	:	Percentage Variance
Incremental Status	:	Current Period Data
Estimates at Completion	:	Projected Status
Milestones	:	Milestones

Criterion (j): Variance analysis. The CCAS CPR analysis software performs variance analysis but does not provide indicators of major problem areas. Page III-5 of the Users Manual lists the following types of analysis techniques performed on the data and available under the "Screen Displays" option of the "Detailed Analysis" menu: "Cumulative Data," "Variance Percents & Indices," "Incremental Data," "Projected Status" and "Milestone Status."

Criterion (i): Regression analysis. The CCAS software does not use regression analysis to predict trends.

Criterion (e): Installation. CCAS was installed by downloading the CCAS program from the Cost Center Bulletin Board via a

modem. The phone number of the Cost Center Bulletin Board is 1-800-344-3602. In downloading the CCAS program, the user will need to download the ARC522.EXE and the CCAS.ARC files from the Bulletin Board. The user may also want to print out instructions for "How to Use Arc522.EXE" which can be obtained from the "Bulletins" option of the Bulletin Board. The ARC522.EXE and CCAS.ARC files can be accessed under the "Files" option of the Bulletin Board. After the "Files" option is selected, the user then performs the "Download" operation and uses the "Page Down" function key to begin the downloading process. Downloading files from the Cost Center Bulletin Board is not a difficult task. Instructions for dual floppy and hard disk installation can be obtained in Section II.B. of the Users Manual, "Getting Started."

Criterion (f): Productivity. With CCAS, the user is unable to get to work right away. This is due mainly to the following error message displayed on the screen when the user selects the "Detailed Analysis" option: "proc: DBFOPN line:204 DOS error 3, C:\A10\CONTRACT." When this error message is displayed, the user needs to enter "Program Information," "Contract Information" and "Historical Performance Data" under the "Add/Edit Data" option. However, the user may not be able to determine the cause of the problem because he/she is unable to decipher the above error message. Therefore, when using CCAS, productivity may be improved by displaying comprehensible error messages. As mentioned previously, the "Perform Calculations" option of the "Utilities" menu must be accessed in order to perform calculations on updated information. If a function key was used to perform this operation, increased productivity may result (i.e., the user would be able to access the

function key more easily than the "Utilities" menu, resulting in calculations being performed in less time than previously required). Also, with the present version of the CCAS program, the user may assume that the software automatically saves and updates changes made to data. Therefore, the software needs to display a message telling the user how to update and save changes he/she has made to the data.

Criterion (s): Estimate at Completion (EAC). CCAS performs four different EAC calculations but does not include a guide to help the user determine which EAC is most applicable for a given program and/or situation. The four EAC calculations are: Method 1 - Cumulative Performance, Method 2 - Recent (6 Month) Performance, Method 3 - Current Period Performance and Method 4 - Cost & Schedule Performance with Weightings. Exhibit III-22 on page III-28 of the Users Manual, "EAC Selection Grid," lists the following categories that comprise each of the four EAC methods: combination methodology, months of history, cost weighting factor and schedule weighting factor. In addition to this, Appendix A (of the CCAS Users Manual) contains a thorough description of the EAC calculations.

Criterion (g): Ability to print on plotter or printers. As stated previously, because the capability to print on a plotter was not available, this criterion could not be evaluated. However, page III-15 of the Users Manual states that the "Hard-Copy Graphics" option will plot the following graphs: "Cumulative Performance," "Variance Trends," "Performance Indices" and "Estimates at Completion." Page II-1 (of the Users Manual) states that one of the minimum hardware requirements to operate CCAS is a HP7475A or Western Graph-Tech MP02300 plotter. With

regard to being able to print on printers, CCAS has the capability to print its reports in condensed print. The reports are also printed in a professional briefing class format. The menu screens to print the reports are easy to use; however, as mentioned previously, the "<C> to clear choices" option clears all of the choices when selected. The "<C>" option could be more user friendly if it only deselected certain choices instead of deselecting all of the reports to print.

Criterion (h): Ability to print graphics or data. Exhibits III-17 through III-21 on pages III-22 through III-26 of the Users Manual display the graphics options available with CCAS. CCAS does not allow the user to view the graphs on the computer screen before plotting them. The types of reports available with CCAS and the menu screens describing how to print those reports are discussed in the Users Manual on pages III-8 through III-15. Printouts of the various reports are available on pages III-16 through III-21. The CCAS software allows the user to print in condensed print. However, as stated above, the "<C> to clear choices" option when selecting reports to print is not user friendly. As stated on page III-8 of the Users Manual, "there are two Program Reports and six Detailed Reports that can be selected" (14:III-8). There is also a "Contract Status Summary" option under both Program Reports and Detailed Reports. When developing the program and contract information to be analyzed by this software, the user created only one contract for this program. However, conflicting information was generated for each "Contract Status Summary" option under the two types of reports (Program Reports and Detailed Reports). When printing the various reports, the "<A> for all reports" option was selected. In the Program Reports

option, the "Contract Status Summary" report was printed out once whereas the "Contract Indices" report was printed out twice. In the Detailed Reports option, the "Contract Status Summary" report can only be printed using the "Select Specific Contract" option. The remainder of the reports in the Detailed Reports section printed out continuously under the "All Contracts" option.

Criterion (n): Ability to modify formulas and update charts.

Section III.C. of the Users Manual, "Add/Edit Data," describes the various options available in which data can be updated; Exhibit III-23 of the Users Manual, "Add/Edit Menu," displays these options. When trying to insert a report date in the "Historical Performance Data" entry screen (select "Add/Edit Data" and then "Historical Performance Data"), if the user does not either select "<Pg Up> to position" or perform the "Clean up Files" option in the "Utilities" menu prior to inserting the new report date, the software may respond with the following message: "That date already exists! Press RETURN & Enter a new date." As mentioned before, in the "Historical Performance Data" screen the software states that either the "<Arrows>, <Pg Up> or <Pg Dn>" keys can be used "to position"; however, the "<Pg Dn>" function key does not perform this operation.

With respect to the Over Target Baseline (OTB) Adjustment, page III-29 of the Users Manual states that CCAS allows the user to either recalculate the "performance measurements against an overtarget baseline or a baseline measured against contract values" (14:III-29). The Users Manual also states that CCAS indicates which calculations have been performed by positioning either an "A" (for adjusted values) or an "R" (for report

values) "below the contractors name in the header of screen reports and hard copy printed reports" (14:III-29). However, when the values are "adjusted," the software displays a message stating that there is a database error (due to numeric overflow) and asks the user if he/she wants to "QUIT." Also, contrary to the above statement in the Users Manual which stated that either an "A" or an "R" would be printed on hard copy reports below the contractor's name, this was not accomplished.

In evaluating the "EAC Selection Grid," page III-27 of the Users Manual states that the Combination Methodology column is "fixed and cannot be changed by the user" (14:III-27). However, this column can be changed by the user and even though the software will not save the changes made in this column, it will perform calculations based on the updated symbol for EAC 1, 3 and 4. The software does not perform calculations on the updated symbol for EAC 2. The Users Manual states that the Months of History, Cost Weighting Factor and Schedule Weighting Factor columns can be updated by the user--this was found to be accurate.

With regard to being able to update graphs, page III-53 of the Users Manual states that the user is able to rescale the data. "This rescaling provides the vertical scale for the hard copy graphic plots" (14:III-53). However, when the "Autoscale Plot Data" option is selected from the "Utilities" menu, the software does not allow the user to input data.

Criterion (q): Software is available on personal computer.

Version 1.1 of the CCAS CPR analysis software package is available on PC.

Criterion (r): Interactive MIS with contractor. CCAS has the

capability to provide an interactive MIS with the contractor in which CPR data come in electronically and automatically go into a spreadsheet to be

analyzed; however, this capability is available only for Defense Acquisition Executive Summary (DAES) programs. Data can also be updated with CCAS from a DAES transfer disk for Defense Acquisition Executive Summary (DAES) programs and a nonautomated entry process for non-DAES programs. Pages III-30 through III-36 of the Users Manual discuss how DAES information is updated on CCAS.

Criterion (1): Narrative section. CCAS does not include a narrative section which sums all data, trends and variance problems or provides suggestions for further research. The "Top Level, Summary Analysis" option, designed to "provide the user with the ability to quickly focus on a small set of problem programs," will be implemented in later versions of the software (14:III-1).

Criterion (m): Documentation. The CCAS software Users Manual is very easy to understand and follow. A Users Manual for "Version 1.0 of CCAS" was provided; however, the software disks were labeled "CCAS Version 1.1." In addition to this, the subheading titles and their page numbers are not listed in the Table of Contents. The Users Manual contains thorough explanations and includes visual displays of the computer screens, printed reports and graphs. Even though the Users Manual is, for the most part, very easy to understand and follow, the OTB Adjustment explanation (on page III-29) is somewhat difficult to follow. Also, with regard to the "Hard Disk Installation" instructions (on page II-3), step-by-step instructions may be needed to assist the user in determining if the CONFIG.SYS file contains the appropriate operations. The documentation also contains minor typographical errors--an example of this is on page A-2 which states: "The system can develop a variety of

Performance Factors. These can range from Method 1, Cumulative Performance to Method 3, Current Period Performance" (14:A-2). However, there are four instead of three EAC methods. The CCAS Users Manual also omits some information that may be very valuable to the user. For example, in the "Historical Performance Data" screen, the user may need to select the "<Pg Up>" key "to position" before he/she tries to insert a new report date. Otherwise, a message unrelated to the cause of the problem may be displayed (i.e., When the message "That date already exists! Press RETURN & Enter a new date." is displayed, the problem may be that the software has not ordered the dates in a logical sequence rather than the user has entered a date that already exists.). On the positive side, Appendix A of the Users Manual lists all formulas used in CCAS.

Criterion (a): Help indexes. CCAS does not include help indexes that tutor on the analyses. Page I-1 of the Users Manual states the following: "CCAS contains a complete, on-line help function as well as a tutorial function to support the user" (14:I-1). However, when either the help or tutorial functions are accessed, the screen displays the following messages, respectively: "help is not available at this point" or "assist is not available at this point."

The results for evaluating the four PC-based CPR analysis software packages against the fourteen "most important" user-established criteria are listed in Table 10 below. Evaluation of the CPR analysis software packages was based on the descriptions of the user-established criteria. For example, the software packages were evaluated against the documentation criterion of being easy to understand and follow, not that the

software package included documentation. An "x" in Table 10 signifies that the CPR analysis software package includes the specified user-established criterion; however, it does not signify the degree to which the software package meets the criterion. A description of each criterion is available in Phase II of Chapter III.

Chapter III consisted of selecting the criteria used to evaluate the four CPR analysis software packages in this study and then evaluating the software packages against each of the fourteen "most important" user-established criteria. In Chapter IV, "the ideal" CPR analysis software package will be selected using a decision support software program, Expert Choice.

TABLE 10
SUMMARY FOR
EVALUATION OF CPR ANALYSIS SOFTWARE
PROGRAMS AGAINST USER-ESTABLISHED CRITERIA

<u>Criterion</u>		<u>CPR Analysis Software Program</u>			
<u>Symbol</u>	<u>Description</u>	<u>PA</u>	<u>CPR-EZ</u>	<u>CAPPS</u>	<u>CCAS</u>
(d)	User-friendly, menu-driven screens	x		x	
(j)	Variance analysis with indicators of major problem areas	x	x	x	x
(i)	Regression analysis	x		x	
(e)	Installation	x	x	x	x
(f)	Productivity	x		x	
(s)	Estimate at Completion (EAC): Several different EAC calculations	x	x	x	x
	Guide to determine which EAC to use				
(g)	Ability to print on plotter or printers	x	x	x	x
(h)	Ability to print graphics or data: Data on printer	x	x	x	x
	Graphics on printer	x	x		
	Graphics on plotter (unable to evaluate)	x			x
(n)	Ability to modify formulas and update charts: Update data ***	x	x	x	x
	Modify formulas				x
	Update graphs ***		x	x	
(q)	Software is available on personal computer	x	x	x	x
(r)	Interactive MIS with contractor: Data received electronically from contractor ****	x			x
	Data received on disk from contractor	x		x	x
(l)	Narrative section	x	x		
(m)	Documentation	x		x	x
(a)	Help indexes	x		x	

*** It is difficult to update data on CAPPS and CCAS and difficult to update graphs on PA and CCAS.

**** CCAS provides an interactive MIS with the contractor only for DAES programs.

IV. Results, Conclusions and Recommendations

Selection of "the Ideal" CPR Software Package or Features of "the Ideal" Software Package

As stated previously, Expert Choice is a decision support software program and was used in ranking the four CPR analysis software packages against the fourteen "most important" user-established criteria. Expert Choice allows the user to evaluate criteria in either a verbal or numerical mode. Therefore, models were developed and compared for both types of modes. Appendix B contains the detailed analysis for the verbal and numerical modes of selecting "the ideal" CPR analysis software package using Expert Choice. A sensitivity analysis was also performed on both the verbal and numerical modes with regard to the importance of the evaluation criteria in ranking the software packages.

Expert Choice Verbal Mode. The first step in using Expert Choice to evaluate the CPR analysis software packages against the user-established criteria was to evaluate the criteria against each other with regard to order of importance. Then the software packages were evaluated against each other with respect to each criterion. The verbal scale used to compare the criteria are as follows: Equal, Moderate, Strong, Very Strong and Extreme. In addition to this, the user may select a comparison alternative that is in-between the options listed above. For example, "Equal to Moderately More Important" or "Very Strong to Extremely More Important" alternatives may be chosen.

The comparison was conducted in three basic steps. The criteria evaluated against each other first were the seven categories listed in Table 8: FRIENDLY, TOOLS, MOD/PRNT, PC, INTERACT, DOCUMENT and HELP. As

can be seen in Table 8, the FRIENDLY and MOD/PRNT categories consist of three criteria and the TOOLS category consists of four criteria. In determining the overall weight of the FRIENDLY, TOOLS and MOD/PRNT categories, the weights of the respective subcriteria in each category were averaged. The results are as follows: FRIENDLY = 18.333, TOOLS = 16.24975 and MOD/PRNT = 12.888667. The second basic step consisted of evaluating the subcriteria in each of the three general categories (FRIENDLY, TOOLS and MOD/PRNT) against each other. Finally, the third step consisted of evaluating the four CPR analysis software packages against each other with respect to each of the fourteen criteria. The details of the analysis are contained in Appendix B. The results of the verbal mode comparison method are listed in Table 11.

TABLE 11
RANKINGS OF FOUR CPR ANALYSIS SOFTWARE PROGRAMS
USING THE EXPERT CHOICE VERBAL MODE

<u>CPR Analysis Software Program</u>	<u>Ranking</u>
PA	0.479
CAPPS	0.209
CCAS	0.176
CPR-EZ	<u>0.136</u>
	1.000

Sensitivity Analysis of Verbal Mode. A sensitivity analysis was performed with regard to the importance of the evaluation criteria in ranking the software packages. That is, the sensitivity analysis calculated how sensitive the final decision would be to a change in the weightings of the fourteen criteria. When comparing each of the seven general categories (FRIENDLY, TOOLS, MOD/PRNT, PC, INTERACT, DOCUMENT and

HELP) to the goal of selecting the ideal software package, Performance Analyzer (PA) was selected for each category with one exception. The HELP criterion received a weighting in the verbal mode of 0.023 with respect to the other six general categories (see Appendix B). During the sensitivity analysis, Performance Analyzer was chosen as the ideal software package with respect to the HELP criterion weighting of 0.023. However, if the weight for the HELP criterion was approximately 0.45 or greater, the CAPPS software program would have been selected. In addition to this, if the MOD/PRNT criterion had a weighting of 1.00 instead of 0.119, the PA and CCAS software packages would both have been selected as the ideal CPR analysis software package. Also, if the weighting for the PC criterion was 1.00 instead of 0.094, all four of the software packages would have been equally selected.

Sensitivity analysis was also performed on the three general categories (FRIENDLY, TOOLS and MOD/PRNT) which contained the following subcriteria:

FRIENDLY:

- Criterion (d): User friendly, menu-driven screens (SCREENS)
- Criterion (e): Installation (INSTALL)
- Criterion (f): Productivity (PRODTVTY)

TOOLS:

- Criterion (j): Variance analysis (VARIANCE)
- Criterion (i): Regression analysis (REGRESS)
- Criterion (s): Estimate at Completion (EAC)
- Criterion (l): Narrative section (NARRATIV)

MOD/PRNT:

Criterion (g): Ability to print on plotter or printers (PRTPLPRN)

Criterion (h): Ability to print graphics or data (PRTGRDTA)

Criterion (n): Ability to modify formulas and update charts (MODIFY)

The results from performing sensitivity analysis on the subcriteria in the FRIENDLY category are that the Performance Analyzer (PA) software package was chosen for all weightings of the PRODTVTY criterion and for all weightings of approximately 0.05 and above for the SCREENS criterion. PA was also chosen as the ideal software package with respect to the INSTALL criterion weighting of 0.258. However, if the weight for the INSTALL criterion was approximately 0.65 or greater, the CPR-EZ software program would have been selected.

The results from performing sensitivity analysis on the subcriteria in the TOOLS category are that the Performance Analyzer (PA) software package was chosen for all weightings with regard to each of the four subcriteria (VARIANCE, REGRESS, EAC and NARRATIV).

The results from performing sensitivity analysis on the subcriteria in the MOD/PRNT category are that Performance Analyzer was chosen for the MODIFY subcriteria at its weighting of 0.124. However, the CCAS software program was selected for the PRTPLPRN and PRTGRDTA subcriteria at the weightings assigned to those criteria (0.517 for PRTPLPRN and 0.359 for PRTGRDTA). Further analysis revealed that the CCAS software program would be selected as the ideal software package for a weighting of approximately 0.120 or less for the MODIFY subcriterion. However, Performance Analyzer (PA) would be selected with a weighting of approx-

imately 0.34 or less for the PRTGRDTA criterion and a weighting of approximately 0.40 or less for the PRTPLPRN criterion.

Expert Choice Numerical Mode. As stated previously, the first step in using Expert Choice to evaluate the CPR analysis software packages was to evaluate the criteria against each other with regard to order of importance. The same approach was taken as in the verbal mode. That is, first the seven general categories (FRIENDLY, TOOLS, MOD/PRNT, PC, INTERACT, DOCUMENT and HELP) listed in Table 8 were compared. Then the subcriteria in the FRIENDLY, TOOLS and MOD/PRNT categories were compared. Finally, the four CPR analysis software packages were evaluated against each other with respect to each of the fourteen criteria.

The seven general categories and the subcriteria in the FRIENDLY, TOOLS and MOD/PRNT categories were evaluated based on the weights in Table 8 for a numerical analysis. The overall weights of the FRIENDLY, TOOLS and MOD/PRNT categories were determined by averaging the weights of the respective subcriteria in each category. The weights used in evaluating the seven general categories as well as the subcriteria in three of those categories (FRIENDLY, TOOLS and MOD/PRNT) are listed below in Table 12. The CPR analysis software packages were evaluated using the same comparisons conducted in the verbal analysis mode.

TABLE 12

WEIGHTS FOR THE GENERAL CRITERIA AND SUBCRITERIA CATEGORIES
IN CONDUCTING A NUMERICAL ANALYSIS OF THE CPR SOFTWARE PACKAGES

<u>Seven General Criteria Categories</u>	<u>Weight</u>	<u>Subcriteria Categories</u>	<u>Weight (Same as Table 8)</u>
FRIENDLY	18.333	SCREENS	21.0
		INSTALL	18.333
		PRODTVTY	15.667
TOOLS	16.24975	VARIANCE	19.333
		REGRESS	19.333
		EAC	15.333
		NARRATIV	11.0
MOD/PRNT	12.888667	PRTPLPRN	13.333
		PRTGRDTA	13.0
		MODIFY	12.333
PC	12.333		
INTERACT	11.333		
DOCUMENT	9.333		
HELP	8.667		

The results of the numerical mode comparison method are listed in Table 13. The details of the analysis are contained in Appendix B.

TABLE 13

RANKINGS OF FOUR CPR ANALYSIS SOFTWARE PROGRAMS
USING THE EXPERT CHOICE NUMERICAL MODE

<u>CPR Analysis Software Program</u>	<u>Ranking</u>
PA	0.460
CAPPS	0.213
CCAS	0.189
CPR-EZ	<u>0.138</u>
	1.000

Sensitivity Analysis of Numerical Mode. A sensitivity analysis was performed on the numerical mode of Expert Choice as well as on the verbal mode. When comparing each of the seven general categories (FRIENDLY, TOOLS, MOD/PRNT, PC, INTERACT, DOCUMENT and HELP) to the GOAL of selecting the ideal CPR analysis software package, Performance Analyzer (PA) was selected for each category with one exception. The HELP criterion received a weighting in the numerical mode of 0.097 with respect to the other six general categories (see Appendix B). During the sensitivity analysis, Performance Analyzer was chosen as the ideal software package with respect to the HELP criterion weighting of 0.097. However, if the weight for HELP was approximately 0.54 or greater, the CAPPS software program would have been selected. In addition to this, if the weighting for the PC criterion was 1.00 instead of 0.139, all four of the software packages would have been equally selected.

Sensitivity analysis was then performed on the subcriteria in each of the general categories of FRIENDLY, TOOLS and MOD/PRNT. The results from performing sensitivity analysis on the subcriteria in the FRIENDLY category are that the Performance Analyzer (PA) software package was chosen for all weightings of the PRODTVTY and SCREENS criteria. PA was also chosen as the ideal software package with regard to the INSTALL criterion weighting of 0.341. However, if the weight for the INSTALL criterion was approximately 0.70 or more, the CPR-EZ software program would have been selected.

The results from performing sensitivity analysis on the subcriteria in the TOOLS category are that the Performance Analyzer (PA) software

package was chosen for all weightings with regard to each of the four subcriteria (VARIANCE, REGRESS, EAC and NARRATIV).

The results from performing sensitivity analysis on the subcriteria in the MOD/PRNT category are that Performance Analyzer was chosen for the MODIFY, PRTGRDTA and PRTPLPRN subcriteria at the weightings assigned to those subcriteria (0.313 for MODIFY and 0.344 for both PRTGRDTA and PRTPLPRN). Further analysis revealed that the CCAS software program would be selected as the ideal software package at a weighting of approximately 0.13 or less for the MODIFY subcriterion, approximately 0.62 or more for the PRTGRDTA criterion and approximately 0.71 or more for the PRTPLPRN criterion.

Conclusions and Recommendations from Comparing the Results of the Verbal and Numerical Modes of Expert Choice. In comparing the results from the verbal and numerical analysis of the CPR software packages using Expert Choice as well as the sensitivity analysis that was performed, Performance Analyzer (PA) is selected as "the most ideal" CPR analysis software package from the four packages that were evaluated. However, Performance Analyzer does not completely fulfill the requirements for "the Ideal" CPR analysis software package established by the AFSC product divisions. For example, PA does not include a guide to determine which Estimate at Completion (EAC) calculation to use for a given program and/or situation. Comments on each CPR analysis software package with respect to the user-established criteria are available in Phase V of Chapter III.

Further Study

In conducting research for this study, a question was raised by Lt Col Thomas Bowman of ASD/ACCM (AV 785-6101) regarding whether the "real" information needs of the user with respect to C/SCSC are being fulfilled. The answer to this question may require a revised format for the CPR and CSSR. Because a survey of this nature was beyond the scope of this thesis, it was not conducted as a part of this project. However, the following questions may assist in determining whether or not the C/SCSC information needs of the program manager and/or cost analyst are currently being fulfilled:

1. What System Program Office (SPO) do you work in and how many years have you been assigned to this SPO?
2. As a manager on this program, what are you looking for in C/SCSC data--what are your real data needs to help make decisions?
3. Does current CPR/CSSR information contain all of the information you need to run the program adequately (if not, what is missing)?
4. If CPR data are not appropriate for subprogram management (ex: avionics) or high risk control, what additional information would assist you in this process?
5. For your purposes, does CPR/CSSR information need to be automated--why or why not (and if yes, what features does the software need to include)?

A Trainee Research Project titled "ASD Standards for Program Analysis of CPR/CSSR" by Charlotte Mathena, dated January 10, 1990, is available in the ASD Cost Library. During this research project, CPR/CSSR experts from Aeronautical Systems Division (ASD), Electronic Systems Division (ESD), Space Systems Division (SSD), Missile Systems Division (MSD), Air Force Institute of Technology (AFIT), Defense Systems Management College (DSMC) and Air Force Systems Command (AFSC) were interviewed with regard to determining what information needs to be included

in conducting an effective CPR and CSSR analysis. The information obtained from this study may assist in determining the "real" C/SCSC information needs of the user.

Appendix A: CPR Analysis Software Packages

The CPR analysis software packages that were analyzed include the following:

Space Systems Division (SSD) Performance Analyzer (PA)

Air Force Cost Center CPR-EZ

Air Force Cost Center Contractor Cost Analysis System (CCAS)

Defense Systems Management College (DSMC) Contract Appraisal
System (CAPPS)

Space Systems Division (SSD) Performance Analyzer (PA):

a. SSD's performance analyzer (PA) was developed [by Thomas/Scifers, Inc. with the assistance of Headquarters Space Division (SD)] to streamline and automate the analysis and reporting processes associated with analyzing the SSD contractor's CPRs and C/SSR.

b. The PA features intuitive menuing, a contract probe module, visual displays of the WBS and functional structure, and graphic displays of the performance data. It is designed to serve the needs of contract financial analysts, engineers, and program managers alike.

(1) The PA is extremely user-friendly, allowing the user to visually define the WBS and functional tree structure and enter and edit data.

(2) The analysis module has been designed to be extremely easy to use. The user may probe down the tree structures using on-screen performance indicators; switch from WBS to functional structures, viewcharts, and reports from each element; or jump from one element to another.

(3) All graphs and reports can be displayed on the screen and printed or plotted to selected hard-copy devices.

c. PA displays, prints, and plots graphs such as analysis-level trend data at the lowest levels and quality briefing charts at the highest levels for program management reviews. It also produces hard-copy reports for internal program office use. It fully supports the automated transfer of data from the contractor to the program office, to the headquarters staffs, to the Executive Management System (EIS), and then to OSD through the Defense Acquisition Executive Summary [DAES] data base.

d. By placing a standardized CDRL [Contract Data Requirements List] on the contracts, the contractor will submit the CPR and/or C/SSR on a network system or a floppy disk in a structured ASCII format to

the program office. It requires little to no investment by the contractors. The program offices will then import the data into their PA systems and do their analysis. Each analyst can input their program office EACs for each lower-level WBS and/or functional element along with narrative text explanations of the EAC methodology they used.

e. PA will make the following computations:

- (1) Mathematical checks for data errors.
- (2) Percent complete by WBS/function.
- (3) Current and cumulative CV and SV.
- (4) CPIs and SPIs for current and cumulative data.
- (5) VAC.
- (6) TCPI.
- (7) SV verification in weeks and days.
- (8) Tolerance bands.
- (9) Three-month moving average calculations.
- (10) EACs using weighted indices.

f. PA [Version 2.6] supports the IBM PC/XT/AT compatible computers (Z-150s, Z-248s, etc.); EGA, Hercules, VGA graphic cards; all Epson compatible printers, most laser-jet printers; DOS (version 2.0 or higher); and the Hewlett-Packard 7550A plotter.

g. The PA software package consists of three floppy diskettes (they are not copy-protected) and a user's manual. It must reside on your computer's hard drive as it will not run on the floppies. The config.sys file on the root directory of your boot disk must contain: buffers=20 and files=20. Without these commands, the system will not work properly.

h. To receive copies of the PA, please write or call SSD/ACCI, Los Angeles AFB, PO Box 92960, Los Angeles, CA 90009-2960, (213)643-1520 or AUTOVON 833-1520. (3:33-34)

Air Force Cost Center CPR-EZ:

a. This model was developed by the Air Force Cost Center to provide a general tool to perform detailed CPR analysis. It allows the analyst to work at any level of the work breakdown.

b. The program will make the following calculations:

- (1) CV.
- (2) SV.
- (3) CPI.
- (4) SPI.
- (5) PMB.
- (6) Percent complete.
- (7) Five EAC calculations with flexibility.

- c. Hardware and software requirements are as follows:
- (1) IBM-compatible, dual floppy or Winchester hard drive.
 - (2) Graphics board within the PC, color monitor not required.
 - (3) No specific printer requirements.
 - (4) MS-DOS.
 - (5) LOTUS 1-2-3 version 2.01.
- d. Contact Department of the Air Force, Attn: SAP/ACC, Pentagon, Room 4D159, Washington, D.C. 20330-1000, AUTOVON 225-4510 for more information. (3:34-35)

Air Force Cost Center Contractor Cost Analysis System (CCAS):

- a. This program allows the analyst to do cost performance analysis directly from the DAES disk using an IBM-compatible PC. It will create and maintain an historical data base using information from several of the pertinent DAES formats. CCAS will also accept keyboard entry of non-DAES data.
- b. The program will make the following current and cumulative calculations:
- (1) CV.
 - (2) SV.
 - (3) SPI.
 - (4) CPI.
 - (5) TCPI.
 - (6) Percent complete.
 - (7) Four EAC calculations with flexibility.
- c. Hardware and software requirements are as follows:
- (1) IBM time-compatible dual floppy or Winchester hard drive.
 - (2) Graphics board within the PC, color monitor not required.
 - (3) Epson or IBM-compatible printer.
 - (4) HP 7475A plotter or compatible.
 - (5) MS-DOS Version 2.0 or later.

- d. Contact Department of the Air Force, Attn: SAP/ACC, Pentagon, Room 4D159, Washington, D.C. 20330-1000, AUTOVON 225-4640 for more information. (3:35)

DSMC Contract Appraisal System (CAPPS):

- a. The Defense Systems Management College (DSMC) CAPPS [was developed by DAI, Inc. in Rockville, Maryland and] is a management tool to aid executives and program managers in their understanding of cost and schedule status of their program. This system is designed to support the executive or program manager with high-level, summarized cost and schedule status information. CAPPS will make the following computations:

- (1) CV.
- (2) SV.
- (3) VAC.
- (4) CV percent.
- (5) CPI.
- (6) Index to go.
- (7) EAC techniques.
- (8) EAC formulas.

b. Some of the above computations can be displayed graphically. Hardware requirements to run CAPPs are an IBM PC/XT or a true compatible or a Zenith 110/120; one floppy disk drive; 192KB RAM minimum; PCDOS 2.X operating system for the IBM or an MSDOS 2.X for the Zenith. Further information about the use of this system can be obtained from PMSS Directorate (DRI-S), DSMC, (703)664-4795/5783 or AUTOVON 354-4795/5783. (3:36-37)

Automated Financial Analysis (AFA) Tabular Report Generator:

NAVAIR is currently updating Electronic Systems Division's (ESD) Automated Financial Analysis (AFA) program so that it will be available in a PC version. The point of contact for the Navy is AIR-713 (AFA Project Team) at (202) 433-2653/5038 or AV 288-2653/5038.

Following is a description of the ESD Automated Financial Analysis (AFA) Program that was included in a draft version (dated 1 October 1988) but excluded from the final version of AFSCP 173-4. Cost Analysis: Guide to Analysis of Contractor Cost Data, dated 1 September 1989:

- a. The ESD AFA model was designed to meet the needs of the financial manager in analysis of both the CPR and the C/SSR. In addition to calculating a cost-at-completion discussed below, this model also contains several other routines:
- b. First of all, after the data from the cost report is entered, this data is displayed in two segments - one for current month data; one for cumulative to date data. The mathematics of these two segments are then checked, and errors are pinpointed and flagged in an error listing table.
- c. The schedule variance feature gives an assessment of the completion status of the contract. Schedule Variance Percentages (SVP) are computed using the formula

$$\frac{BCWP_{cum} - BCWS_{cum}}{BCWS_{cum}} \times 100$$

An SVP greater than zero reflects an ahead-of schedule situation; whereas, a SVP of less than zero indicates a behind schedule status. Months behind schedule is also computed by calculating the historical point in time when the currently reported cum BCWP equals previously reported cum BCWS.

d. The Cost Variance Percent (CVP) is calculated using the formula

$$\frac{BCWP - ACWP}{BCWP} \times 100$$

A CVP greater than zero reflects an under-cost situation; whereas a CVP less than zero reflects an over-cost position.

e. The completion status is determined using a series of formulas. It displays what percentage should be done, what percentage actually is done, and what percent of the funds were spent to accomplish the task.

f. G&A rates are also analyzed by the ESD APA model. It displays the historical rates, and calculates the projected rates and rates at completion.

g. A potential price at completion is determined for each cost at completion method discussed below, for the BAC and for the LRE. This includes the Point of Total Assumption (PTA) calculation based upon the contract type and share ratios.

h. Cost At Completion (CAC) can be calculated with six different formulae all of which utilize a Performance Factor (PF). Selection of the most appropriate formula is left to the discretion of the analyst. Each CAC methodology is discussed below:

(1) Method 1 - This method is calculated using a performance factor based on current month cost performance.

(2) Method 2 - This method is calculated using a performance factor based upon a three (3) month moving average of current month cost performance.

(3) Method 3 - This method is calculated using a performance factor based on cumulative cost performance.

(4) Method 4 - This method is calculated using a performance factor provided by program office personnel.

(5) Method 5 - This method is calculated using a performance factor based on the last quarter cost performance.

(6) Method 6 - This method is calculated using a performance factor based on a combination of cost and schedule variance and user chosen performance weightings.

i. The source deck for the AFA is available through ESD. It is compatible with CDC 6600 computer hardware and associated fortran compiler. In addition, other DOD agencies have made the program compatible with the GE time sharing system. To obtain the source deck and to gather further information on how to access the program, contact ESD/ACCI, (617) 377-5223 or AUTOVON 478-5223.

Appendix B: Detailed Analysis of Selecting
"the Ideal" CPR Analysis Software Package Using Expert Choice

Expert Choice Verbal Mode

The verbal scale used to compare the fourteen "most important" user-established criteria and the four CPR analysis software packages is listed below:

Extreme	-----

Very Strong	-----

Strong	-----

Moderate	-----

Equal	-----

The comparison was conducted in three basic steps. The criteria evaluated against each other first were the following seven general categories: FRIENDLY, TOOLS, MOD/PRNT, PC, INTERACT, DOCUMENT and HELP.

FIRST STEP (With Respect to GOAL):

FRIENDLY is Moderately More Important than TOOLS
FRIENDLY is Moderate to Strongly More Important than MOD/PRNT
FRIENDLY is Strong to Very Strongly More Important than INTERACT
FRIENDLY is Strongly More Important than PC
FRIENDLY is Very Strong to Extremely More Important than HELP
FRIENDLY is Very Strongly More Important than DOCUMENT

TOOLS is Moderate to Strongly More Important than MOD/PRNT
TOOLS is Strong to Very Strongly More Important than INTERACT
TOOLS is Strongly More Important than PC
TOOLS is Very Strong to Extremely More Important than HELP
TOOLS is Very Strongly More Important than DOCUMENT

MOD/PRNT is Moderately More Important than INTERACT
MOD/PRNT is Equal to Moderately More Important than PC
MOD/PRNT is Strongly More Important than HELP
MOD/PRNT is Moderate to Strongly More Important than DOCUMENT

PC is Moderately More Important than INTERACT
INTERACT is Moderate to Strongly More Important than HELP

INTERACT is Moderately More Important than DOCUMENT
PC is Strongly More Important than HELP
PC is Moderate to Strongly More Important than DOCUMENT

DOCUMENT is Moderately More Important than HELP

Inconsistency Ratio = 0.079

(An Inconsistency Ratio of 0.1 or more indicates inconsistent judgments.)

RESULTS:

FRIENDLY	0.389
TOOLS	0.281
MOD/PRNT	0.119
INTERACT	0.058
PC	0.094
HELP	0.023
DOCUMENT	<u>0.036</u>
	1.000

The second basic step consisted of evaluating the subcriteria in each of the following three general categories against each other:

FRIENDLY, TOOLS and MOD/PRNT.

SECOND STEP:

With Respect to FRIENDLY (0.389):

SCREENS is Moderately More Important than INSTALL
SCREENS is Strongly More Important than PRODTVY

INSTALL is Moderately More Important than PRODTVY

Inconsistency Ratio = 0.033

RESULTS:

SCREENS	0.637
INSTALL	0.258
PRODTVY	<u>0.105</u>
	1.000

With Respect to TOOLS (0.281):

VARIANCE is Equally as Important as REGRESS
VARIANCE is Moderate to Strongly More Important than EAC
VARIANCE is Strong to Very Strongly More Important than NARRATIV

REGRESS is Moderate to Strongly More Important than EAC
REGRESS is Strong to Very Strongly More Important than NARRATIV

EAC is Moderate to Strongly More Important than NARRATIV

Inconsistency Ratio = 0.045

RESULTS:

VARIANCE	0.406
REGRESS	0.406
EAC	0.134
NARRATIV	<u>0.054</u>
	1.000

With Respect to MOD/PRNT (0.119):

PRTGRDTA is Moderate to Strongly More Important than MODIFY

PRTPLPRN is Moderately More Important than MODIFY
PRTPLPRN is Equal to Moderately More Important than PRTGRDTA

Inconsistency Ratio = 0.093

RESULTS:

PRTPLPRN	0.517
PRTGRDTA	0.359
MODIFY	<u>0.124</u>
	1.000

The third step consisted of evaluating the four CPR analysis software packages against each other with respect to each of the fourteen criteria.

THIRD STEP:

FRIENDLY Category (0.389):

With Respect to SCREENS (0.637):

PA is Extremely More Preferable than CPR-EZ
PA is Moderate to Strongly More Preferable than CAPPS
PA is Very Strongly More Preferable than CCAS

CCAS is Moderate to Strongly More Preferable than CPR-EZ

CAPPS is Very Strongly More Preferable than CPR-EZ
CAPPS is Strongly More Preferable than CCAS

Inconsistency Ratio = 0.113

RESULTS:

PA	0.610
CAPPS	0.262
CCAS	0.089
CPR-EZ	<u>0.039</u>
	1.000

With Respect to INSTALL (0.258):

CPR-EZ is Moderately More Preferable than PA
CCAS is Moderately More Preferable than PA
PA is Equal to Moderately More Preferable than CAPPS

CPR-EZ is Equal to Moderately More Preferable than CCAS
CPR-EZ is Moderately More Preferable than CAPPS

CCAS is Moderately More Preferable than CAPPS

Inconsistency Ratio = 0.045

RESULTS:

PA	0.146
CPR-EZ	0.439
CCAS	0.311
CAPPS	<u>0.104</u>
	1.000

With Respect to PRODTVTY (0.105):

PA is Extremely More Preferable than CPR-EZ
PA is Very Strongly More Preferable than CCAS
PA is Moderate to Strongly More Preferable than CAPPS

CCAS is Moderately More Preferable than CPR-EZ

CAPPS is Very Strong to Extremely More Preferable than CPR-EZ
CAPPS is Strong to Very Strongly More Preferable than CCAS

Inconsistency Ratio = 0.107

RESULTS:

PA	0.607
CPR-EZ	0.039
CCAS	0.076
CAPPS	<u>0.279</u>
	1.000

· TOOLS Category (0.281):

With Respect to VARIANCE (0.406):

PA is Extremely More Preferable than CPR-EZ
PA is Very Strongly More Preferable than CCAS
PA is Equal to Moderately More Preferable than CAPPS

CCAS is Moderately More Preferable than CPR-EZ

CAPPS is Very Strong to Extremely More Preferable than CPR-EZ
CAPPS is Strong to Very Strongly More Preferable than CCAS

Inconsistency Ratio = 0.047

RESULTS:

PA	0.527
CPR-EZ	0.041
CCAS	0.082
CAPPS	<u>0.349</u>
	1.000

With Respect to REGRESS (0.406):

PA is Strongly More Preferable than CPR-EZ
PA is Strongly More Preferable than CCAS
PA is Strongly More Preferable than CAPPS

CPR-EZ is Equally as Preferable as CCAS
CPR-EZ is Equally as Preferable as CAPPS

CCAS is Equally as Preferable as CAPPS

Inconsistency Ratio = 0.000

RESULTS:

PA	0.625
CPR-EZ	0.125
CCAS	0.125
CAPPS	<u>0.125</u>
	1.000

With Respect to EAC (0.134):

PA is Very Strongly More Preferable than CPR-EZ
PA is Strongly More Preferable than CCAS
PA is Strong to Very Strongly More Preferable than CAPPS

CCAS is Moderate to Strongly More Preferable than CPR-EZ
CAPPS is Moderately More Preferable than CPR-EZ

CCAS is Equal to Moderately More Preferable than CAPPS

Inconsistency Ratio = 0.057

RESULTS:

PA	0.641
CPR-EZ	0.056
CCAS	0.186
CAPPS	<u>0.117</u>
	1.000

With Respect to NARRATIV (0.054):

PA is Very Strong to Extremely More Preferable than CPR-EZ
PA is Extremely More Preferable than CCAS
PA is Extremely More Preferable than CAPPS

CPR-EZ is Moderately More Preferable than CCAS
CPR-EZ is Moderately More Preferable than CAPPS

CCAS is Equally as Preferable as CAPPS

Inconsistency Ratio = 0.045

RESULTS:

PA	0.730
CPR-EZ	0.147
CCAS	0.061
CAPPS	<u>0.061</u>
	1.000

MOD/PRNT Category (0.119):

With Respect to PRTPLPRN (0.517):

PA is Equally as Preferable as CPR-EZ
PA is Equally as Preferable as CCAS
PA is Equally as Preferable as CAPPS

CPR-EZ is Equally as Preferable as CCAS
CPR-EZ is Equal to Moderately More Preferable than CAPPS

CCAS is Equal to Moderately More Preferable than CAPPS

Inconsistency Ratio = 0.022

RESULTS:

PA	0.246
CPR-EZ	0.289
CCAS	0.289
CAPPS	<u>0.175</u>
	1.000

With Respect to PRTGRDTA (0.359):

PA is Moderately More Preferable than CPR-EZ
CCAS is Equal to Moderately More Preferable than PA
PA is Very Strongly More Preferable than CAPPS

CCAS is Moderate to Strongly More Preferable than CPR-EZ
CPR-EZ is Strongly More Preferable than CAPPS

CCAS is Very Strong to Extremely More Preferable than CAPPS

Inconsistency Ratio = 0.044

RESULTS:

PA	0.315
CPR-EZ	0.143
CCAS	0.498
CAPPS	<u>0.044</u>
	1.000

With Respect to MODIFY (0.124):

PA is Strong to Very Strongly More Preferable than CPR-EZ
PA is Extremely More Preferable than CCAS
PA is Extremely More Preferable than CAPPS

CPR-EZ is Strong to Very Strongly More Preferable than CCAS
CPR-EZ is Strong to Very Strongly More Preferable than CAPPS

CCAS is Equally as Preferable as CAPPS

Inconsistency Ratio = 0.092

RESULTS:

PA	0.681
CPR-EZ	0.219
CCAS	0.050
CAPPS	<u>0.050</u>
	1.000

PC Category (0.094):

PA is Equally as Preferable as CPR-EZ
PA is Equally as Preferable as CCAS
PA is Equally as Preferable as CAPPS

CPR-EZ is Equally as Preferable as CCAS
CPR-EZ is Equally as Preferable as CAPPS

CCAS is Equally as Preferable as CAPPS

Inconsistency Ratio = 0.000

RESULTS:

PA	0.250
CPR-EZ	0.250
CCAS	0.250
CAPPS	<u>0.250</u>
	1.000

INTERACT Category (0.058):

PA is Very Strongly More Preferable than CPR-EZ
PA is Equal to Moderately More Preferable than CCAS
PA is Moderate to Strongly More Preferable than CAPPS

CCAS is Strong to Very Strongly More Preferable than CPR-EZ
CAPPS is Moderately More Preferable than CPR-EZ

CCAS is Moderate to Strongly More Preferable than CAPPS

Inconsistency Ratio = 0.036

RESULTS:

PA	0.491
CPR-EZ	0.054
CCAS	0.336
CAPPS	<u>0.119</u>
	1.000

DOCUMENT Category (0.036):

PA is Extremely More Preferable than CPR-EZ
PA is Very Strongly More Preferable than CCAS
PA is Strong to Very Strongly More Preferable than CAPPS

CCAS is Strongly More Preferable than CPR-EZ
CAPPS is Strongly More Preferable than CPR-EZ

CAPPS is Equal to Moderately More Preferable than CCAS

Inconsistency Ratio = 0.097

RESULTS:

PA	0.674
CPR-EZ	0.040
CCAS	0.117
CAPPS	<u>0.168</u>
	1.000

HELP Category (0.023):

PA : Strongly More Preferable than CPR-EZ
PA is Very Strongly More Preferable than CCAS
CAPPS is Moderately More Preferable than PA

CPR-EZ is Moderate to Strongly More Preferable than CCAS
CAPPS is Very Strongly More Preferable than CPR-EZ

CAPPS is Extremely More Preferable than CCAS

Inconsistency Ratio = 0.087

RESULTS:

PA	0.289
CPR-EZ	0.093
CCAS	0.040
CAPPS	<u>0.579</u>
	1.000

THE FINAL RANKINGS OF THE FOUR CPR ANALYSIS SOFTWARE PROGRAMS USING THE EXPERT CHOICE VERBAL MODE (See Table 11) are listed below:

<u>CPR Analysis Software Program</u>	<u>Ranking</u>
PA	0.479
CAPPS	0.209
CCAS	0.176
CPR-EZ	<u>0.136</u>
	1.000

Expert Choice Numerical Mode

As stated previously, the first step in using Expert Choice to evaluate the CPR analysis software packages was to evaluate the criteria against each other with regard to order of importance. The same approach was taken as in the verbal mode. That is, first the seven general categories (FRIENDLY, TOOLS, MOD/PRNT, PC, INTERACT, DOCUMENT and HELP) listed in Table 8 were compared. Then the subcriteria in the FRIENDLY, TOOLS and MOD/PRNT categories were compared. Finally, the four CPR analysis software packages were evaluated against each other with respect to each of the fourteen criteria.

The seven general categories and the subcriteria in the FRIENDLY, TOOLS and MOD/PRNT categories were evaluated based on the weights in Table 8 for a numerical analysis. The overall weights of the FRIENDLY, TOOLS and MOD/PRNT categories were determined by averaging the weights of the respective subcriteria in each category. The weights used in evaluating the seven general categories as well as the subcriteria in the FRIENDLY, TOOLS and MOD/PRNT categories were listed in Table 12. Table 12 is reconstructed below. The four CPR analysis software packages were

evaluated using the same comparisons conducted in the verbal analysis mode.

TABLE 12

**WEIGHTS FOR THE GENERAL CRITERIA AND SUBCRITERIA CATEGORIES
IN CONDUCTING A NUMERICAL ANALYSIS OF THE CPR SOFTWARE PACKAGES**

<u>Seven General Criteria Categories</u>	<u>Weight</u>	<u>Subcriteria Categories</u>	<u>Weight (Same as Table 8)</u>
FRIENDLY	18.333	SCREENS	21.0
		INSTALL	18.333
		PRODTVTY	15.667
TOOLS	16.24975	VARIANCE	19.333
		REGRESS	19.333
		EAC	15.333
		NARRATIV	11.0
MOD/PRNT	12.888667	PRTPLPRN	13.333
		PRTGRDTA	13.0
		MODIFY	12.333
PC	12.333		
INTERACT	11.333		
DOCUMENT	9.333		
HELP	8.667		

As stated previously, the comparison was conducted in three basic steps. The criteria evaluated against each other first were the following seven general categories: FRIENDLY, TOOLS, MOD/PRNT, PC, INTERACT, DOCUMENT and HELP.

FIRST STEP (With Respect to GOAL):

$$\text{FRIENDLY/TOOLS} = 18.333/16.24975 = 1.128202$$

FRIENDLY is 1.1 times (EQUALLY) More Important than TOOLS

$$\text{FRIENDLY/MOD/PRNT} = 18.333/12.888667 = 1.4224124$$

FRIENDLY is 1.4 times (EQUALLY) More Important than MOD/PRNT

$$\text{FRIENDLY/PC} = 18.333/12.333 = 1.4864996$$

FRIENDLY is 1.5 times (EQUAL TO MODERATELY) More Important than PC

$$\text{FRIENDLY/INTERACT} = 18.333/11.333 = 1.6176652$$

FRIENDLY is 1.6 times (EQUAL TO MODERATELY) More Important than INTERACT

$$\text{FRIENDLY/DOCUMENT} = 18.333/9.333 = 1.9643202$$

FRIENDLY is 2.0 times (EQUAL TO MODERATELY) More Important than DOCUMENT

$$\text{FRIENDLY/HELP} = 18.333/8.667 = 2.1152648$$

FRIENDLY is 2.1 times (EQUAL TO MODERATELY) More Important than HELP

$$\text{TOOLS/MOD/PRNT} = 16.24975/12.888667 = 1.2607782$$

TOOLS is 1.3 times (EQUALLY) More Important than MOD/PRNT

$$\text{TOOLS/PC} = 16.24975/12.333 = 1.3175829$$

TOOLS is 1.3 times (EQUALLY) More Important than PC

$$\text{TOOLS/INTERACT} = 16.24975/11.333 = 1.4338436$$

TOOLS is 1.4 times (EQUALLY) More Important than INTERACT

$$\text{TOOLS/DOCUMENT} = 16.24975/9.333 = 1.7411068$$

TOOLS is 1.7 times (EQUAL TO MODERATELY) More Important than DOCUMENT

$$\text{TOOLS/HELP} = 16.24975/8.667 = 1.874899$$

TOOLS is 1.9 times (EQUAL TO MODERATELY) More Important than HELP

$$\text{MOD/PRNT/PC} = 12.888667/12.333 = 1.0450553$$

MOD/PRNT is 1.0 times (EQUALLY) as Important as PC

$$\text{MOD/PRNT/INTERACT} = 12.888667/11.333 = 1.1372688$$

MOD/PRNT is 1.1 times (EQUALLY) More Important than INTERACT

$$\text{MOD/PRNT/DOCUMENT} = 12.888667/9.333 = 1.3809779$$

MOD/PRNT is 1.4 times (EQUALLY) More Important than DOCUMENT

MOD/PRNT/HELP = $12.888667/8.667 = 1.4870967$
MOD/PRNT is 1.5 times (EQUAL TO MODERATELY) More Important
than HELP

PC/INTERACT = $12.333/11.333 = 1.0882379$
PC is 1.1 times (EQUALLY) More Important than INTERACT

PC/DOCUMENT = $12.333/9.333 = 1.3214401$
PC is 1.3 times (EQUALLY) More Important than DOCUMENT

PC/HELP = $12.333/8.667 = 1.4229837$
PC is 1.4 times (EQUALLY) More Important than HELP

INTERACT/DOCUMENT = $11.333/9.333 = 1.2142934$
INTERACT is 1.2 times (EQUALLY) More Important than DOCUMENT

INTERACT/HELP = $11.333/8.667 = 1.3076036$
INTERACT is 1.3 times (EQUALLY) More Important than HELP

DOCUMENT/HELP = $9.333/8.667 = 1.0768432$
DOCUMENT is 1.1 times (EQUALLY) More Important than HELP

Inconsistency Ratio = 0.000

RESULTS:

FRIENDLY	0.205
TOOLS	0.183
MOD/PRNT	0.143
PC	0.139
INTERACT	0.128
DOCUMENT	0.105
HELP	<u>0.097</u>
	1.000

The second basic step consisted of evaluating the subcriteria in each of the following three general categories against each other:
FRIENDLY, TOOLS and MOD/PRNT.

SECOND STEP:

With Respect to FRIENDLY (0.205):

SCREENS/INSTALL = $21/18.333 = 1.1454754$
SCREENS is 1.1 times (EQUALLY) More Important than INSTALL

SCREENS/PRODTVTY = 21/15.667 = 1.340397

SCREENS is 1.3 times (EQUALLY) More Important than PRODTVTY

INSTALL/PRODTVTY = 18.333/15.667 = 1.1701666

INSTALL is 1.2 times (EQUALLY) More Important than PRODTVTY

RESULTS:

SCREENS	0.373
INSTALL	0.341
PRODTVTY	<u>0.286</u>
	1.000

With Respect to TOOLS (0.183):

VARIANCE/REGRESS = 19.333/19.333 = 1.0

VARIANCE is 1.0 times (EQUALLY) as Important as REGRESS

VARIANCE/EAC = 19.333/15.333 = 1.2608752

VARIANCE is 1.3 times (EQUALLY) More Important than EAC

VARIANCE/NARRATIV = 19.333/11.0 = 1.7575455

VARIANCE is 1.8 times (EQUAL TO MODERATELY) More Important
than NARRATIV

REGRESS/EAC = 19.333/15.333 = 1.2608752

REGRESS is 1.3 times (EQUALLY) More Important than EAC

REGRESS/NARRATIV = 19.333/11.0 = 1.7575

REGRESS is 1.8 times (EQUAL TO MODERATELY) More Important
than NARRATIV

EAC/NARRATIV = 15.333/11.0 = 1.3939091

EAC is 1.4 times (EQUALLY) More Important than NARRATIV

RESULTS:

VARIANCE	0.301
REGRESS	0.301
EAC	0.232
NARRATIV	<u>0.167</u>
	1.001

With Respect to MOD/PRNT (0.143):

$$\text{PRTGRDTA/MODIFY} = 13.0/12.333 = 1.0540825$$

PRTGRDTA is 1.1 times (EQUALLY) More Important than MODIFY

$$\text{PRTPLPRN/MODIFY} = 13.333/12.333 = 1.0810833$$

PRTPLPRN is 1.1 times (EQUALLY) More Important than MODIFY

$$\text{PRTPLPRN/PRTGRDTA} = 13.333/13.0 = 1.0256154$$

PRTPLPRN is 1.0 times (EQUALLY) as Important as PRTGRDTA

RESULTS:

MODIFY	0.313
PRTGRDTA	0.344
PRTPLPRN	<u>0.344</u>
	1.001

The third step consisted of evaluating the four CPR analysis software packages against each other with respect to each of the fourteen criteria.

THIRD STEP:

The CPR analysis software packages were evaluated using the same comparisons conducted in the verbal analysis mode (See THIRD STEP of "Expert Choice Verbal Mode"). THE FINAL RANKINGS OF THE FOUR CPR ANALYSIS SOFTWARE PROGRAMS USING THE EXPERT CHOICE NUMERICAL MODE are listed below (See Table 13).

<u>CPR Analysis Software Program</u>	<u>Ranking</u>
PA	0.460
CAPPS	0.213
CCAS	0.189
CPR-EZ	<u>0.138</u>
	1.000

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Vita

Captain Terry V. Smith [REDACTED]

[REDACTED] graduated from Lafayette High School in Ellisville, Missouri in 1978 and was employed as a secretary at Brown Shoe Company in St. Louis, Missouri. She enlisted in the USAF in 1980 as an Aircrew Life Support Specialist and attended the U.S. Air Force Academy in 1981, graduating with a Bachelor of Science in Management in May 1985. Upon graduation, she received a regular commission in the USAF and was assigned to Aeronautical Systems Division (ASD) at Wright-Patterson AFB, Ohio. After serving two years as a Program Analyst on the F-15 program, she was assigned the position of F-15 Cost Analyst, making her responsible for the preparation of the Selected Acquisition Report (SAR), Defense Acquisition Executive Summary (DAES) and Unit Cost Report (UCR) as well as the annual estimate for the F-15E program. Upon completing her tour at ASD, she entered the School of Systems and Logistics, Air Force Institute of Technology, in May 1989. She received her Certified Cost Analyst designation from the Institute of Cost Analysis in May 1990 and her Master of Business Administration degree from the University of Dayton in July 1990.

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