LEVEL II

PRESENTATION TO THE
THE SIXTEENTH ANNUAL
DEPARTMENT OF DEFENSE COST ANALYSIS SYMPOSIUM

TITLE: THE SOFTWARE ACQUISITION RESOURCE EXPENDITURE (SARE) METHODOLOGY, DATA REQUIREMENTS, AND DATA UTILIZATION

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SARE reporting is a data collection methodology used to collect software-unique financial data plus technical data that make the financial data meaningful. The data can be used to monitor the progress of software development work on the contract in which the data is collected. Also, the data is to be submitted to a multiproject Air Force Systems Command (AFSC) software data base. The data base will help formulate, calibrate, and validate software cost/schedule estimation methods.

The discussion of SARE reporting consists of five parts:

1. A brief review of the current AFSC financial data collection methods

2. A discussion of the SARE reporting methodology and comments on how the Government contracts for SARE reporting

3. An overview of software data reported and inserted into a project historical file

4. The use of the data collected during a contract to monitor software development during that contract

5. A discussion of the methodology features questioned by reviewers, and the future use of the software data in a multiproject data base

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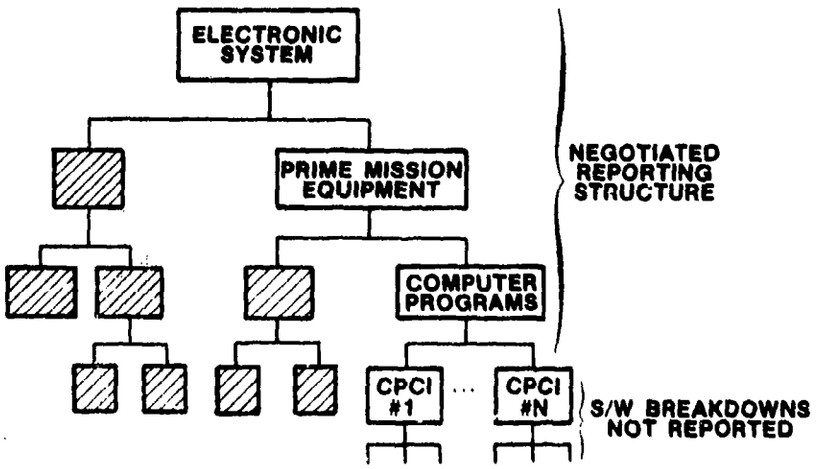
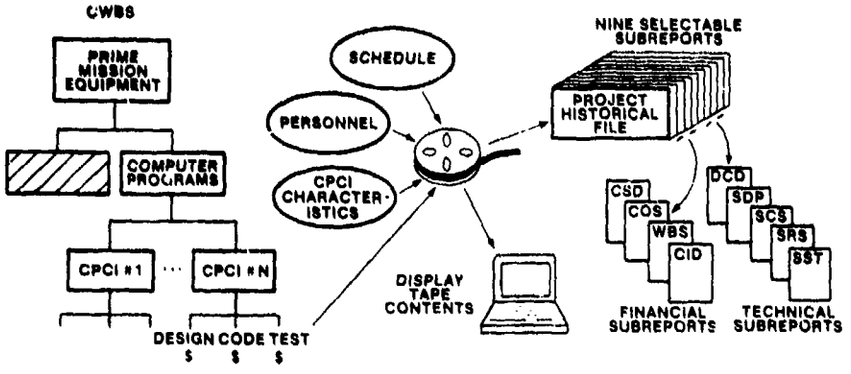
Current Method — C/SCSC Data Reported at Level 3 of CWBS



Typically, standard cost performance data is collected by the AFSC for level 3 contract work breakdown structure (CWBS) elements under the terms of Data Item-F-6000C. This data item is consistent with the Cost/Schedule Control System Criteria (C/SCSC) of DOD Instruction 7000.2. The data is reported on computer cards, is read by a computer, and can be printed out by the computer for system program office (SPO) use. The software package that processes the data is called the "Automated Financial Analysis Program." It is maintained and operated by the Cost Analysis Division, Comptroller, Electronic Systems Division, AFSC at the Hanscom Air Force Base.

Since software costs are lumped together in level 3 CWBS elements, poor software performance may not be revealed by level 3 CWBS financial data collected under the standard cost performance report. For example, a problem revealed by financial data of one Computer Program Configuration Item (CPCI) can be masked by the financial data of a second CPCI. In addition, well-structured technical data is not collected under the standard cost performance report. Technical data is needed to identify and define software components associated with financial data indicating procurement problems; and to explain the problems (e.g., an unexpected large increase in the size of a software component).

SARE Reporting — A Methodology



As stated in the introduction to the briefing, SARE reporting is a data collection methodology. It is used to collect software-unique financial data plus technical data that make the financial data meaningful. In practice, this methodology includes:

1. Inclusion of standard, well-defined, software-related elements in the CWBS, in sufficient detail to account for all software procurement costs

2. Contractor collection of financial data against the lowest level, standard, software-related CWBS elements

3. Contractor collection of technical data that characterize developed computer programs, personnel responsible for the development, and the development process

4. Contractor submission to the Government of software-related financial and technical data on magnetic tape

5. Government computer programs reading the financial and technical data off the magnetic tapes and distributing the data into a project-unique historical file

6. Government-automated generation of well-structured printouts, outputting data selected from the historical file

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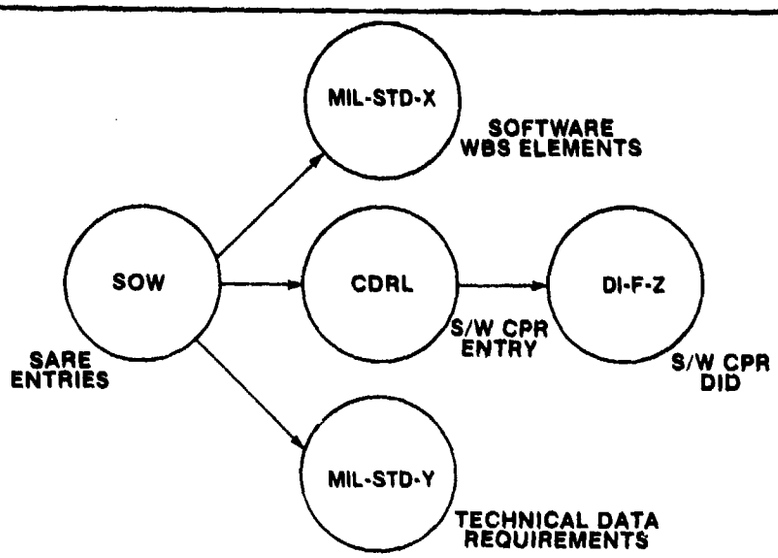
Components Used to Contract for SARE Reporting



To contract for the SARE reporting methodology, one must include:

1. Level 4 and 5 software-related work breakdown structure (WBS) elements in the CWBS

2. The requirement of SARE reporting in the statement of work (SOW)

3. The contract data requirements list (CDRL) specification that data be reported on magnetic tape according to the requirements of the Software Cost Performance Report (S/W CPR) data item

4. SOW references to MIL-STD-X to specify the definitions of the CWBS elements

5. SOW references to MIL-STD-Y to specify the technical data reporting requirements

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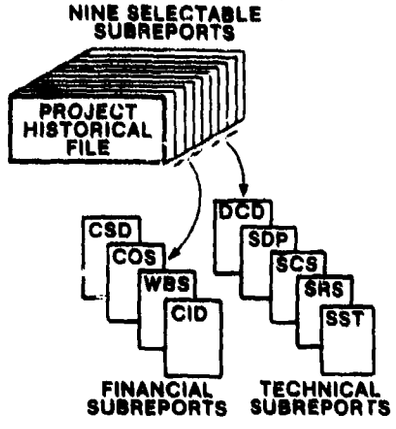
Project Historical File Financial Subreports



The software cost performance data reported each month on magnetic tape is validated, corrected if necessary, and inserted into a project historical file. The historical file consists of nine separate subreports. The data content of each subreport accumulates over the life of the system acquisition. Four of the subreport types are categorized as financial. They include:

1. A contract identification subreport

2. A CWBS subreport

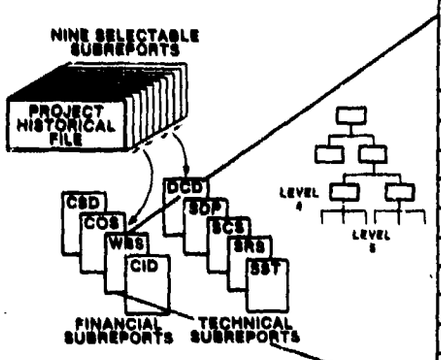
3. A contractor organization structure subreport

4. A cost and schedule financial data subreport

The subreport initials shown in the illustration are ID's used on the magnetic tape to identify the individual subreports

Data is collected to identify the prime contractor and any software subcontractors. This data is stored in Subreport CID. Also, data that defines the organization structure of the prime contractor is collected and stored in Subreport COS.

Work Breakdown Structure Subreport



CWBS ELEMENTS ENCOMPASS	SYSTEM	CPCI	CPC
DEFINITION	X	X	
DESIGN	X	X	X
CODING		X	X
INFORMAL TEST	X	X	
FORMAL TEST	X	X	
INSTALLATION	X		
MANAGEMENT	X	X	
TRAINING	X	X	
DEVELOPMENT FACILITIES	X		
DOCUMENTATION	X	X	
DATA ITEM REPORTS	X		

Data is collected to define the CWBS and is stored in Subreport WBS. The CWBS encompasses software activities associated with:

1. Computer program configuration item (CPCI) procurement

2. The system-level, software-related work associated with CPCI's working together in an integrated system

3. Computer program component (CPC) design and coding, where a CPC is a functionally or logically-distinct part of a CPCI

MIL-STD-X defines a standard set of WBS elements used in the CWBS. The WBS subreport includes all CWBS elements for levels 1 to 3, and software-related CWBS elements for levels 4 to 6.

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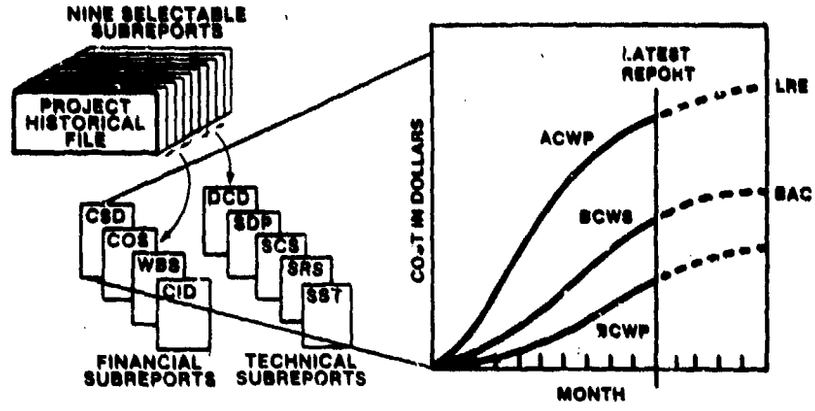
Cost And Schedule Financial Data Subreport

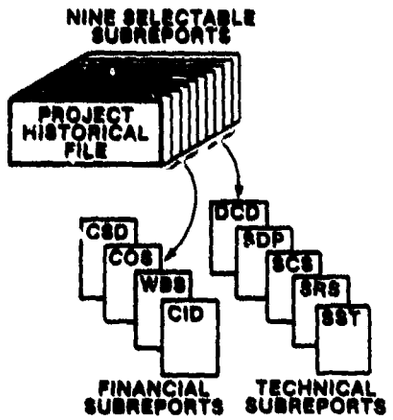


Cost/schedule financial data is collected each month and stored in the historical file under Subreport CSD. This data includes for each lowest level CWBS element:

1. Budgeted Cost of Work Scheduled (BCWS)
2. Budgeted Cost of Work Performed (BCWP)
3. Actual Cost of Work Performed (ACWP)
4. Budget at Completion (BAC)
5. Latest Revised Estimate at Completion (LRE)

In addition, the data includes actual man-hours, budgeted man-hours, and the latest revised estimate of total man-hours at completion. This data is defined by the C/SCSC in DOD Instruction 7000.2 and is required by DI-F-6000C, the standard cost performance report.

Project Historical File Technical Subreports



Five of the project historical file subreport types are categorized as technical. They include:

1. A software structure subreport
2. A schedule subreport
3. A software components characteristics subreport
4. A software development personnel subreport
5. A change and deviation subreport

The data required by each subreport is defined in MIL-STD-Y.

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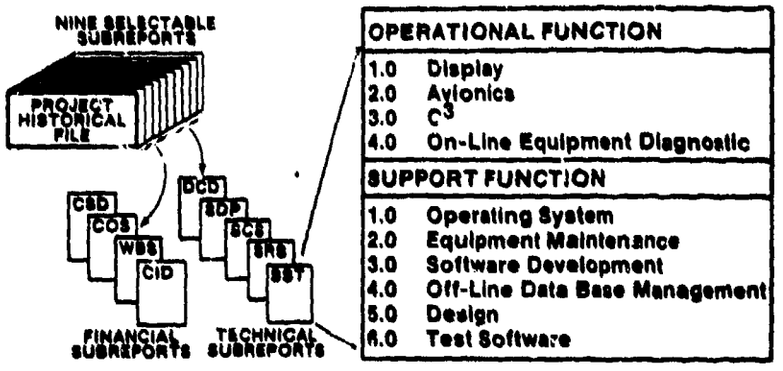
Software Structure Subreport



Data is collected to define each CPCI to be procured and is stored in the historical file under Subreport SST. For each CPCI, the functions implemented must be selected from a table. The table index of each selected function must be reported on magnetic tape. For example, for on-line equipment diagnostics, one or more of the following indexes must be selected:

1. 4.1 for System Readiness Test
2. 4.2 for Computer Diagnostic
3. 4.3 for Memory Diagnostic
4. 4.4 for Display Diagnostic
5. 4.5 for Switch/Indicator Panel Diagnostics
6. 4.6 for I/O Diagnostic
7. 4.7 for Mode Diagnostic
8. 4.8 for Other

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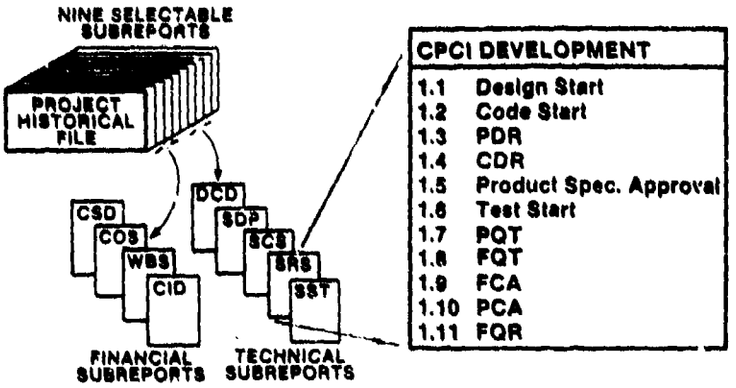
Software-Related Schedule Subreport



The software schedule subreport (Subreport SRS) provides estimates of CPCI development milestones at contract award. Also, the actual completion date of each event is reported after it occurs. In addition, estimates and actual values associated with system development test and evaluation (DT&E) procedures start; system DT&E test report delivery; installation start; and program management responsibility transfer are reported and inserted into the project historical file under Subreport SRS.

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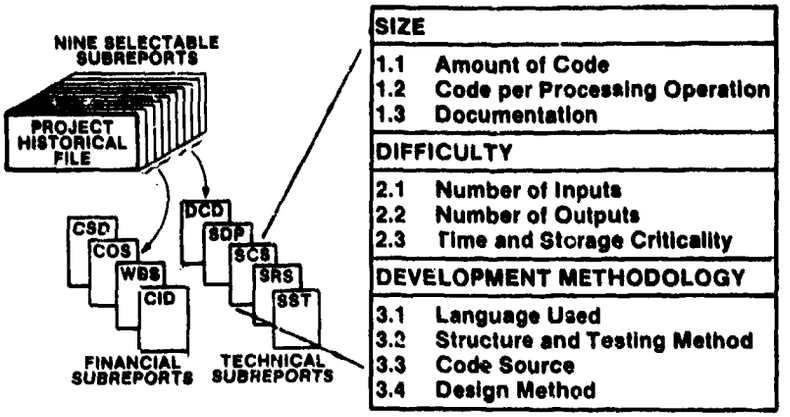
Software Components Characteristics Subreport



The software components characteristics subreport (Subreport SCS) provide estimates of the size, difficulty, and development methodology at contract award. At the end of the contract, actual values are reported and inserted into the project historical file. As an example, a report of the "Amount of Code" for a CPCI must include:

1. The number of source statements

2. The number of source statements written to support the CPCI development.

3. The number of object program words

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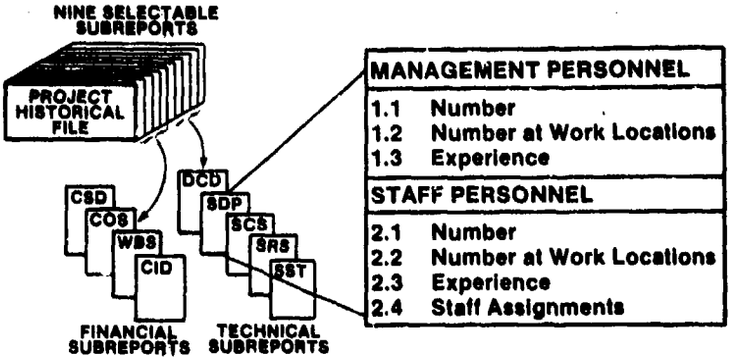
Software Development Personnel Subreport



The software development personnel subreport (Subreport SDP) provides each month actual counts of the number of managers and staff personnel working on the project. As an example of the staff number, each monthly S/W CPR magnetic tape must include:

1. The number of staff full-time personnel

2. The number of staff personnel new to the project since the last monthly report

3. The number of staff part-time personnel

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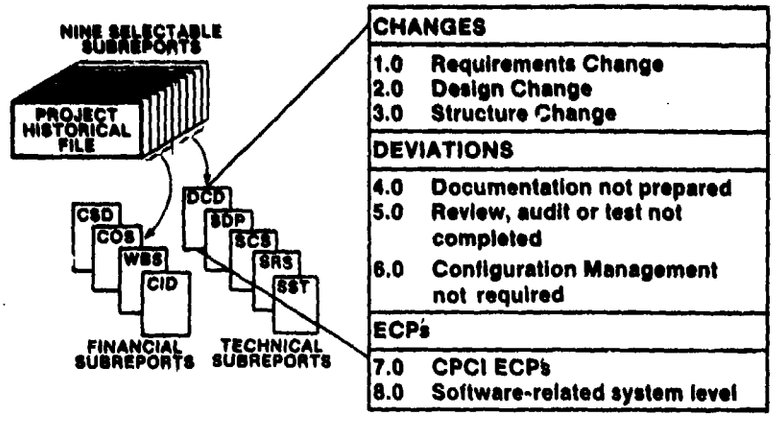
Development Changes and Deviations Subreport



Data is collected under Subreport DCD to record software development changes and deviations, including:

1. Any changes in the original plans

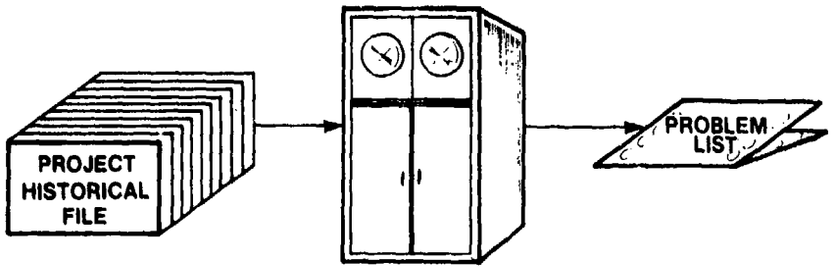
2. Any deviations from common practices (e.g., any documentation and audits of CPCI's waived)

3. The number of engineering change proposals (ECP's) written against each CPCI

4. The number of software-related, system-level ECP's

For example, a structure change could be a CPCI redefinition, a CPCI cancellation, or a redefinition of the CPC's within a CPCI. Examples of deviations include not preparing a CPCI development or product specification, and not preparing a CPCI test procedure or test report.

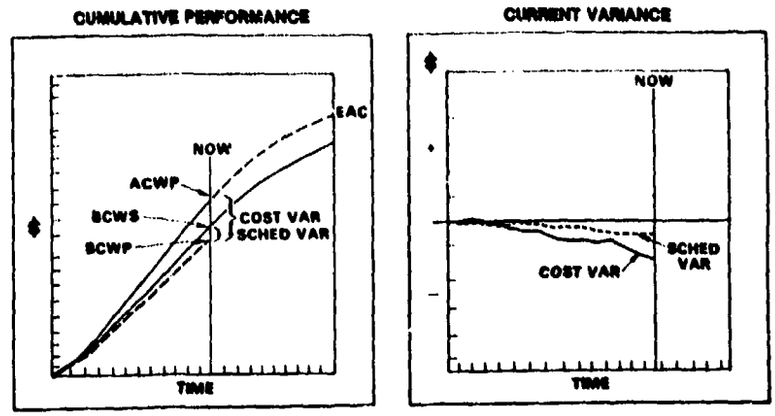
Project Historical File Financial Data Evaluation



The project historical file stores software data collected over the life of the system acquisition. This data can be processed by Government computers to detect software acquisition problems. Such problems will be revealed by a printout listing all software activities overrunning budgeted cost or behind schedule.

The computer program that implements this printout will check the status of software activity, encompassed by each CWBS element; discard the elements encompassing activities on or ahead of schedule; and list the elements associated with cost overruns and schedule slips. This capability significantly reduces the amount of paper a program office must review. In fact, a one or two-page printout should encompass all software-related activities behind schedule and overrunning budgeted cost. Early discovery by an SPO will enable the enforcement of proper corrective action before the software problems lead to large cost overruns and schedule delays in the overall system acquisition.

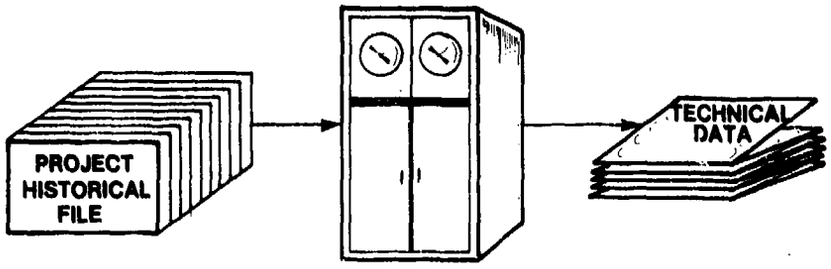
GRAPHIC ANALYSIS



The graphic analysis of financial data associated with a CWBS element included in the problem list, can be made to note cost and schedule element trends. The illustration shows two graphic representations of cost and schedule financial data commonly used with data collected under the standard cost performance report. These graphs also apply to the software cost performance report.

The Cumulative Performance graph plots BCWS, BCWP, and ACWP against time on a cumulative basis from the beginning of the contract. The example shown by the illustration indicates a software activity behind schedule and overrunning budgeted cost, with both cost and schedule trends progressively worsening. This presentation smooths the data to a certain extent to illustrate the performance trend, but does not effectively show short term performance (e.g., over the last two months). The current variance graph, hich plots the monthly variances against time, does a good job depicting short-term performance. These graphs can be generated by Government software.

Project Historical File Technical Printouts

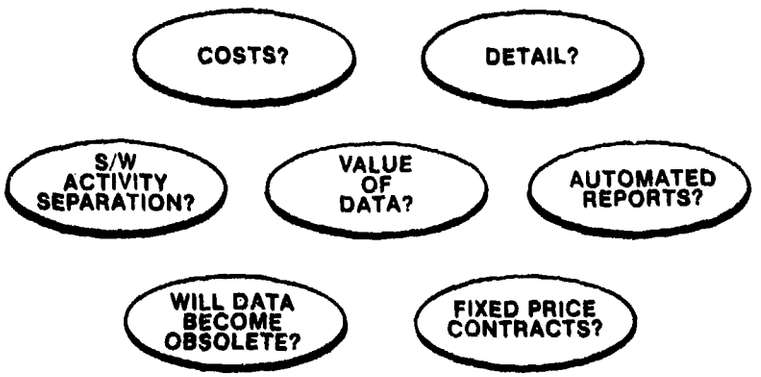


Historical file data can be used to explain software problems, so that proper corrective action can be initiated. The most obvious explanation for cost overruns and schedule delays would be a software CPCI acquisition change in scope. A historical file printout lists changes and deviations associated with a CPCI, including any requirements changes, design changes, and engineering change proposals.

A second obvious explanation for cost/schedule anomalies would be significant growth in the size of a CPCI over its development life cycle, as shown by a historical file printout. If current estimates are significantly greater than the original estimates of implementation code required, then size growth could well account for poor financial data.

A historical file printout of technical data itself could flag potential software problems. For example, a significant change in the number of personnel assigned to a CPCI could indicate a problem. Such a change in staff size could indicate that a contractor has recognized a development problem.

Questions — Pilot Review



The cost for a contractor to report the software cost performance data has been estimated to be about 1 to 2 percent of the software acquisition cost. These estimates were made by carefully considering contractor tasks required to report data, but are unproven. Cost and other questions of the SARE reporting methodology have been raised by reviewers, who have asked the following:

1. Does the methodology encroach on a contractor's method of doing business?

2. Will the contractor's cost to update or modify his accounting system be significant?

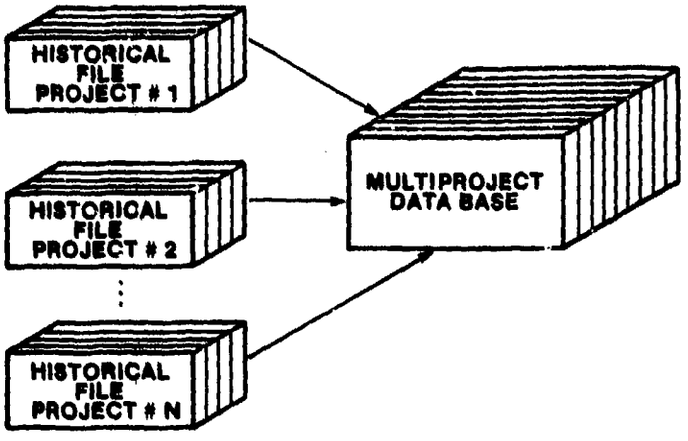
3. Are the CWBS breakouts artificial, causing inaccurate reporting of software costs?

4. Is the S/W CPR data too detailed for program office use?

5. Is automated report generation helpful or unnecessary?

We are aware of these and other issues and believe a pilot application of the SARE reporting methodology should answer many of the questions. A pilot application is planned to start later this year.

MultiProject Data Base — Future Software Data Base Management System



The methodology will be reviewed after the pilot with respect to implementation costs, data collection proficiency, and use as a monitoring tool. Assuming a positive evaluation and efficient revision, the ESD intends to apply the methodology to several acquisitions. In addition, the ESD will incorporate resulting project historical file data into a multiproject ESD software data base, using the most appropriate commercially available data base management system. This data will be used to formulate, calibrate, and validate software cost estimation methods.

Presently, several cost estimation models exist (e.g., PRICE S, SLIM). Also, software acquisition models are under development for use in cost and schedule estimation. Although the models vary greatly in how they approach the software cost estimation problem, they all have one thing in common; the confidence of their predictions is limited without access to a well-structured, comprehensive software data base used for calibration and validation purposes. The multiproject data base would fill this missing link in the estimation process.