THE DOE/AL COST AND SCHEDULE CONTROL SYSTEM (CS^2) - A USER'S PERSPECTIVE IN ITS USE AS BOTH A REPORTING SYSTEM AND AS A VALUABLE PROJECT MANAGEMENT TOOL*

Richard E. Fate
Warren B. Cox
Sandia National Laboratories

ABSTRACT

Sandia National Laboratories (SNL) Environmental Restoration (ER) Program has recently implemented a highly structured CS^2 required by DOE. It is a complex system which has evolved over a period of a year and a half. During the implementation of this system, problem areas were discovered in cost estimating, allocation of management costs, and integration of the CS^2 system with the Sandia Financial Information System. In addition to problem areas, benefits of the system were found in the areas of schedule adjustment, projecting personnel requirements, budgeting, and responding to audits. Finally, a number of lessons were learned regarding how to successfully implement the system.

INTRODUCTION

The Sandia ER Program is relatively young, having been established several years ago. Its FY92 budget is about $12 million, and over the next fifteen years it will have a total budget of approximately $300 million.

CS^2 was developed in the 1970's to help the DoD monitor and control large, sensitive, technically risky weapons development programs. The requirement was to develop a system which could monitor a program's performance, providing management with information with which to determine if it was progressing adequately or if the program should be modified or curtailed. A rigorous CS^2 effort is now being implemented by Sandia's ER Program.

Is it Necessary to Establish Such a System in an ER Program?

The DOE is requiring SNL ER to establish a rigorous CS^2 because DOE's ER effort is getting very large in terms of both size and funding. Furthermore, it is a program with high visibility and new technologies are being used to deal with some technically difficult problems. These considerations are causing the ER Program to receive Major Systems Acquisition (MSA) status, and DOE Order 4700.1 requires a full CS^2 system on a program with that status.

While it is probably prudent to require CS^2, is such a system good for anything beyond reporting to upper management or one's customer? How is CS^2 actually implemented and are there lessons to be learned from SNL's efforts?

Evolution of SNL ER's System

The SNL ER CS^2 effort began in early FY91 with the development of a "template" for a general assessment activity. This template was then applied to six specific Operable Units (OUs), and modified for each OU where appropriate. The modified template for each OU became the first baseline. From this baseline, monthly reports were produced; see Fig. 1 for a typical monthly report. For these reports, costs were reported, monthly status was updated, and earned value was computed. The various performance indicators of Budgeted Cost of Work Scheduled (BCWS), Budgeted Cost of Work Performed (BCWP), and Actual Cost of Work Performed (ACWP) are calculated. Although variances were calculated and variance reports were written, it is acknowledged that this early effort was a learning stage. This was a time to uncover problem areas in the CS^2 implementation process and procedures.

After four monthly reporting periods had passed, development began on a second generation baseline. This effort centered on improving the quality of the baseline: correcting problems discovered in the first generation, applying more rigor to procedures and estimates, and adding more features to the monthly reports. To accomplish this, several versions of the baseline were submitted, with each version correcting earlier weaknesses. The goal of this effort was to establish a system which would meet the full CS^2 criteria for an MSA as defined by DOE's Albuquerque Operations Office's Cost and Schedule Control System, System Documentation dated June 1991. This goal, including validation, is expected to be reached within the next year.

Problem Areas

In the course of developing the system through two generations, several recurring problem areas were encountered. Because these problem areas are not unique to the SNL ER system and are rather general in nature, they warrant further discussion.

Resource cost estimating had problems in two areas -- defining labor costs and establishing the quality of assessment-related costs. The initial labor cost "estimate" was very much an estimate, with little backup into what it was composed of. Because it was more than four times the average salary, it obviously contained a substantial "overhead" component. This poorly defined component created substantial confusion and was a major problem. It was not until a very tightly defined, average labor cost was supplied by the Sandia Financial Information System (FIS), that the problem was solved.

Another resource cost estimating concern was the quality of the assessment/remediation estimate, given the fact that "qualified" (certified, with construction or ER experience) cost estimators were not used. The argument was successfully

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NOTES: COLUMNS CONTAIN DATA FOR OCTOBER 1 TO SEPTEMBER 30.
DUE TO A LABELING CONVENTION IN TIMELINE THE COLUMN

Start Status	Pct Achvd	Task Name	Start Date	Duration	End Date	Mathemat-ical EAC	Total BL $ (BAC)	Elpsd BL $ (BCWS)	Achieved $ (BCWP)	Spent $ (ACWP)	CstVar Pct	SchVar Pct
Started	15	13068 LIQUID WASTE DISPOSAL	1-Oct-90	1,364.0 days	8-Mar-96	2,673,158.48	2,723,172.12	402,146.29	419,768.43	369,754.80	12	4
			1-Oct-90	1,364.0 days	8-Mar-96	2,723,172.12						
Started	29	+ ADS MANAGEMENT	1-Oct-90	1,122.0 days	22-Mar-95	580,711.95	701,140.49	196,219.35	203,330.74	82,902.20	59	4
			1-Oct-90	1,122.0 days	22-Mar-95	701,140.49						
Started	84	+ PREPARE RFI WORKPLAN	1-Oct-90	359.0 days	6-Mar-92	67,765.80	68,231.74	62,567.42	57,268.54	56,802.60	0	-8
			1-Oct-90	329.0 days	23-Jan-92	68,231.74						
Started	12	+ RFI FIELDWORK	1-Jul-91	417.0 days	26-Feb-93	1,413,861.42	1,369,280.57	143,359.51	159,169.15	203,750.00	-28	11
			1-Jul-91	417.0 days	26-Feb-93	1,369,280.57						
Future	0	+ AMENDED RFI WORKPLAN DEVELO	1-Mar-93	30.0 days	9-Apr-93	3,837.12	3,837.12	0.00	0.00	0.00	100	100
			1-Mar-93	30.0 days	9-Apr-93	3,837.12						
Future	0	+ AMENDED RFI FIELDWORK	12-Apr-93	80.0 days	3-Aug-93	154,926.32	154,926.32	0.00	0.00	0.00	100	100
			12-Apr-93	80.0 days	3-Aug-93	154,926.32						
Future	0	+ RFI REPORT	4-Aug-93	345.0 days	19-Dec-94	152,470.70	152,470.70	0.00	0.00	0.00	100	100
			4-Aug-93	345.0 days	19-Dec-94	152,470.70						
Future	0	+ CMS REPORT	4-Aug-93	650.0 days	8-Mar-96	273,285.17	273,285.17	0.00	0.00	0.00	100	100
			4-Aug-93	650.0 days	8-Mar-96	273,285.17						

Fig. 1. Typical monthly report.

made that, because of the uncertainty in the assessment phase, the actual remediation technique was poorly defined. Further, because both the assessment and remediation often required new technologies, traditional cost estimating methods in these cases were not appropriate. The solution to this dilemma was to carefully document all assumptions made for remediation estimates and to break the assessment phase into very small, easily estimated, tasks.

The proper allocation of management costs created problems. One perspective was to put all management costs in one Activity Data Sheet (ADS), Project Management, in order to easily locate these costs. Another perspective was to distribute most management costs among the various OUs, thereby minimizing the costs in the Project Management ADS. A third perspective was to distribute management costs according to how the program was actually organized, with project-level costs contained in the Project Management ADS and OU level management costs contained in the various ADSs. The third perspective was chosen by SNL because it conformed most closely to how the organization actually worked and facilitated accurate reporting. This issue, however, is not finalized and a DOE mandated change may be required.

A major problem area was that of integrating the Sandia FIS into the SNL ER CS^2 system. Because of the quantity and type of input required by CS^2, the Sandia FIS occasionally cannot meet the requirements. The general solution for this effort was to bring the Sandia FIS managers into the CS^2, so that they understood the specific problems and needs, and a joint effort was made to resolve issues.

Further, the customer was educated regarding the limitations of the Sandia FIS, allowing solutions negotiated among all the participants to evolve. In this way, changes that were possible to be made to the Sandia FIS were made, and where not possible, a negotiated resolution was made.

Advantages of CS^2

Clearly, the implementation of CS^2 is a major administrative undertaking, with significant problems to solve. In addition to the inherent benefits of CS^2, it was discovered that the system served a number of excellent, non-reporting uses.

A. The software and task structure facilitated the "sliding" of the schedule (adjustment of start dates), to conform to budgeting requirements. This ability is not insignificant when funding changes, particularly in the early part of a fiscal year, are routinely required.

B. If the individual ADS files are constructed in sufficient detail, CS^2 and associated software can provide an excellent tool for projecting personnel requirements. Thus, if tasks are carefully defined in terms of types and quantities of personnel required, they can be summed over various time intervals to provide valuable information. This type of information can be used, for example, to justify new hiring slots. See Fig. 2 titled "ER Staffing Timeline Projections," for a

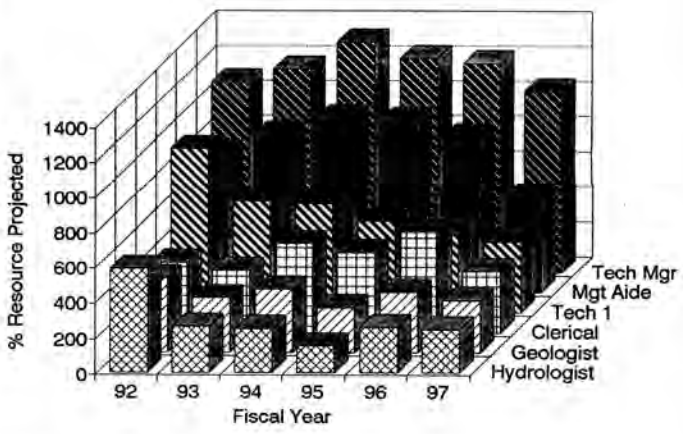

Fig. 2. ER staffing timeline projections as of August 1991.

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	90	91	92	93	94	95	96	Total
13068 LIQUID WASTE DISPOSAL	223,767	1,412,937	496,100	489,906	99,779	683		2,723,172*
ADS MANAGEMENT	156,851	158,100	156,851	156,851	72,489			701,140
PREPARE RFI WORKPLAN	50,033	18,199						68,232
RFI FIELDWORK	16,883	1,236,638	115,759					1,369,281
AMENDED RFI WORKPLAN DEVELOP			3,837					3,837
AMENDED RFI FIELDWORK			154,926					154,926
RFI REPORT			38,947	106,315	7,208			152,471
CMS REPORT			25,780	226,740	20,082	683		273,285
Total	223,767	1,412,937	496,100	489,906	99,779	683		2,723,172*

Fig. 3. Time and task phased budget.

six-year projection of the ER Program's major personnel needs.

This figure shows, for example, that at least five hydrologists (500 + % FTEs) will be required in FY92, with this need declining in the following years. This information gives insight not only into the total number, but also the proper mix of staff versus contractors, by discipline.

C. In addition to providing staffing information, CS^2 is an excellent budgeting tool. Figure 3 illustrates, for an individual ADS, its budget by year, by deliverable level task. This same information can be obtained on a monthly basis and for a more detailed level of tasks. It is a valuable tool for Project Managers to be able to plan and understand their budgets. It can also be used to support the budgeting needs of the accounting system (Sandia FIS) that provides actual costs to CS^2.

D. A final example of a "non-reporting" use of CS^2 is in the validation of a program to outside auditors. It provides a detailed, documented, structured trail that clearly demonstrates the scope, cost, timing, and resources required of a project. In an environment of tight money, hence frequent external audits, such a system can prove invaluable.

Lessons Learned

The evolution of the SNL ER CS^2 effort has been reviewed, along with associated problem areas and benefits. With this background, what lessons have been learned in the implementation process?

A. First, it was found that CS^2 is a useful and legitimate tool. Although a significant administrative effort must be made to implement and maintain it, the effort is not wasted. Therefore, "buy into" the system -- support it actively!

B. In order to get the active support of the individual ADS managers, it is important that they be educated in the development and uses of CS^2. To the extent that they understand it better, they will support it better. It is a very structured system of measuring performance, and technical people should eventually understand and feel comfortable with it.

C. Work closely with your customer (the recipient of the reports) to better understand his needs and to negotiate any changes that he may require. The attitude of this interaction is extremely important; it is all too easy, and nonproductive, to take an adversarial position with such a complex system.

D. Carefully choose the software to be used. The more "user friendly" it can be, the more it will be used and maintained. Also important is the reporting flexibility that the software supports; flexibility will have the same effect as user friendliness.

E. Finally, an important key to maintaining an effective system is to use it -- for more than reporting. The more the system is used, the more it will be embraced and maintained. Active support and maintenance of the system will keep it successful.