Variance Analysis Within C/SCSC Programs

George J. Chambers

In a 1990 article Christensen highlights the role of analysis in programs subject to the Department of Defense (DOD) Cost/Schedule Control System Criteria (C/SCSC) (Christensen, 1990 & Kerzner, 1984). Variance analysis is performed to determine causes of variances in program cost, schedule or both, and development of proposed resolution of problems indicated by the variances. At Hughes Aircraft Company's Ground Systems Group (GSG), this analysis process typically begins as a qualitative investigation at month-end, even before exact quantitative data is available. Distribution of a C/SCSC Analysis Report adds the missing quantitative data. Narrative analysis of significant variances is provided to the program management office (PMO) for inclusion in the program manager's (PMs) monthly engineering reports. Significant variances are identified by application of "variance thresholds" to the data related to each cost account. This identifies those accounts having significant potential impact on the program on the basis of cost/schedule risk potential. This article describes the variance analysis process used on typical C/SCSC programs (Hughes Aircraft Co., 1992).

Mr. Chambers is president of System Engineering Pathways. He teaches System Engineering and Design to Manufacturability in the Continuing Education Program at the University of California, Irvine. He recently retired from Hughes Aircraft Company's Ground Systems Group where he was a member of the technical staff.

DISCUSSION

A cost account manager (CAM) must meet the technical performance, cost and schedule requirements for an assigned work effort. One tool that assists the CAM in meeting the schedule and cost responsibilities is a periodic variance analysis. This article addresses one area of financial management — variance analysis — and provides some guidance in how CAMs should perform these analyses. Slemaker (1985) identified three characteristics of an effective project control system. Such a system would have: (1) objectives and standards against which accomplishment can be measured, (2) periodic communication of performance status, and (3) a means to affect future performance. At GSG, well-disciplined procedures are followed to monitor and report on cost and schedule performance and planning on C/SCSC programs (Department Of Defense Instruction 5000.2, 1991). These procedures consist of both human (the CAMs) and software analyses as discussed in this article.

The CAMs receive weekly and monthly reports and are responsible for preparing narrative cost/schedule variance analyses as they occur (see Figure 1), or are predicted to occur for the duration of their cost account(s) as planned on Work Package Planning Sheets (WPPS). The Narrative Variance Analysis Report (Figure 1) identifies the variant conditions and is used by the CAM to explain the cause, impact and planned corrective action of each variance. This report is supplied automatically by a Management Control System (MCS). A response is required from the CAM if preset variance thresholds are exceeded.

The preset variance thresholds are used to monitor the status of all cost accounts on the program. Thresholds are used for the current fiscal month and the cumulative planned activity to date.

> Current fiscal month thresholds are typically set at ±5 percent and ≥ $10 K (Slemaker, 1985). In other words, if either the "Cost Variance Percentage" or "Schedule Variance Percentage" or both exceed the threshold and the dollar variance is equal to or greater than $10 K, the variance must be discussed on the Narrative Variance Analysis Report submitted to PMO by the CAM.

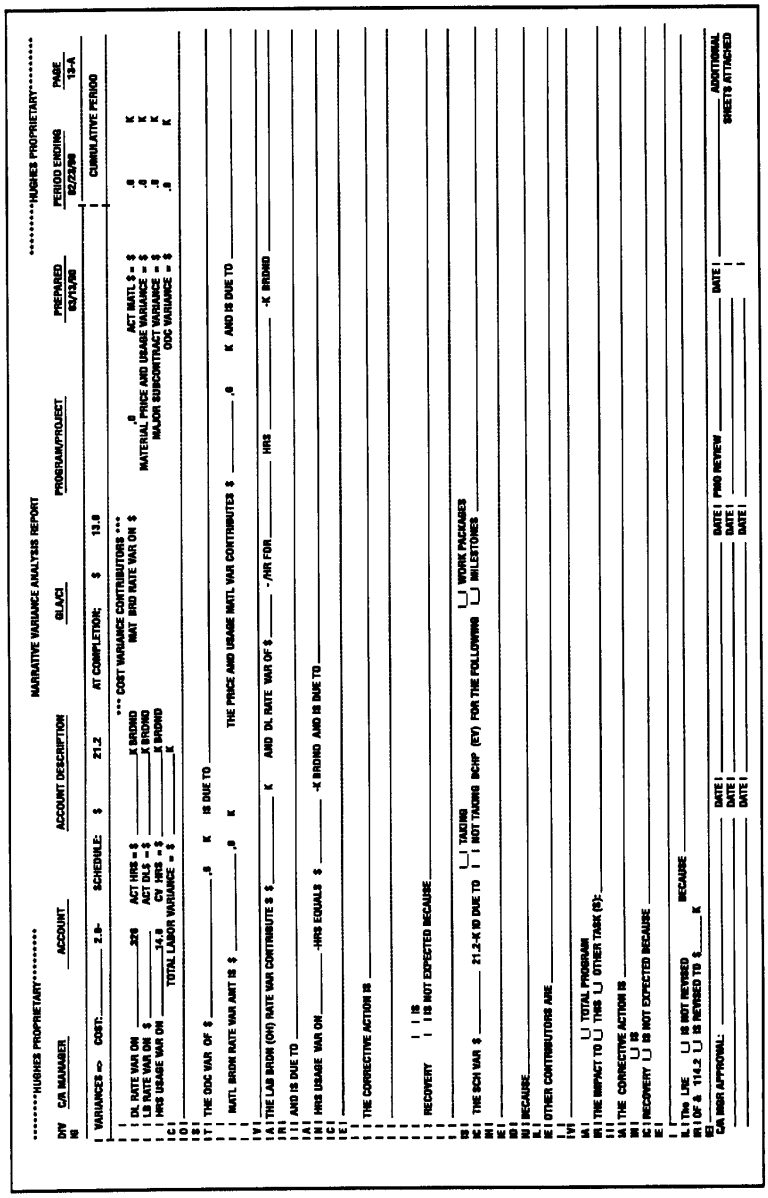
The C/SCSC Analysis Report (Figure 2), generated by the MCS on a monthly basis, contains the following message:

	COST*	YES
VARIANCE EXCEEDS THRESHOLD?	SCHEDULE *	YES
	AT COMPLETION*	YES

* YES or NO, as appropriate

if a Narrative Variance Analysis Report must be completed by the CAM.

Cumulative plan-to-date thresholds are typically set at ≥10 percent and $20K. Opening the dollar "window" to these higher values acknowledges difficulty maintaining tight control over money as a percentage of a large plan and identifying potential problems early in the plan, where start-up



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NARRATIVE VARIANCE ANALYSIS REPORT

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DIV NO C/A MANAGER ACCOUNT ACCOUNT DESCRIPTION GLA/CI PROGRAM/PROJECT PREPARED 03/13/98 PERIOD ENDING 02/23/98 PAGE 13-A

VARIANCES => COST: 2.8- SCHEDULE: $ 21.2 AT COMPLETION: $ 13.0 CUMULATIVE PERIOD

DL RATE VAR ON 326 ACT HRS = $ K BRDND *** COST VARIANCE CONTRIBUTORS *** MAT BRD RATE VAR ON $ .0 ACT MATL $ = $ .0 K
LB RATE VAR ON $ ACT DL $ = $ K BRDND MATERIAL PRICE AND USAGE VARIANCE = $ .0 K
HRS USAGE VAR ON 14.8 CV HRS = $ K BRDND MAJOR SUBCONTRACT VARIANCE = $ .0 K
TOTAL LABOR VARIANCE = $ K ODC VARIANCE = $ .0 K

THE ODC VAR OF $ .0 K IS DUE TO

MATL BRDN RATE VAR AMT IS $ .0 K THE PRICE AND USAGE MATL VAR CONTRIBUTES $ .0 K AND IS DUE TO

THE LAB BRDN (OH) RATE VAR CONTRIBUTE S $ K AND DL RATE VAR OF $ -/HR FOR HRS -K BRDND

AND IS DUE TO

HRS USAGE VAR ON -HRS EQUALS $ -K BRDND AND IS DUE TO

THE CORRECTIVE ACTION IS

RECOVERY IS IS NOT EXPECTED BECAUSE

THE SCH VAR $ 21.2-K ID DUE TO TAKING NOT TAKING BCHP (EV) FOR THE FOLLOWING WORK PACKAGES MILESTONES

BECAUSE

OTHER CONTRIBUTORS ARE

TOTAL PROGRAM
THE IMPACT TO THIS OTHER TASK (S):

THE CORRECTIVE ACTION IS
IS
RECOVERY IS NOT EXPECTED BECAUSE

The LINE IS NOT REVISED BECAUSE
OF & 114.2 IS REVISED TO $ K

C/A MGR APPROVAL: DATE PMO REVIEW DATE ADDITIONAL SHEETS ATTACHED

Figure 1. Narrative Variance Report (Sample)

problems such as staffing requirements, make schedules difficult to meet. Otherwise, cumulative-to-date is treated the same as the current month.

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C/SCSC ANALYSIS REPORT (CS10-V1)

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DIV	C/A MANAGER	ACCOUNT	ACCOUNT DESCRIPTION	GLA/CI	PROGRAM/PROJECT	PREPARED	PERIOD ENDING	PAGE
						03/13/90	02/23/90	13-A

VARIANCE ANALYSIS	CURRENT PERIOD WORK SCHED (BCWS) (1)	WORK PERF'D (BCWP) (2)	ACTUAL COSTS (ACWP) (3)	VARIANCES SCHED (2-1) (4)	VARIANCES COST (2-3) (5)	CUMULATIVE TO DATE WORK SCHED (BCWS) (6)	WORK PERF'D (BCWP) (7)	ACTUAL COSTS (BCWS) (8)	VARIANCES SCHED (7-6) (9)	VARIANCES COST (7-8) (10)	AT COMPLETION TOTAL BUDGET (11)	LATEST REV EST (12)	COMPL VAR (13)
MAN MONTHS	2.9	2.0	2.0	.9-	.0								
HOURS	468	312	326	156-	14-	780	312	326	468-	14-	2,808	2,410	398
DIRECT LABOR $													
TOT LAB BRDN $													
TOT BRDND LAB $													
MATERIAL $	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
MATERIAL BDN $	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOT BRDND MAT $	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
MAJOR SUBCONT $	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
ODC $	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTL MFG COST $													
VARIANCE EXCEEDS THRESHOLD?				NO	NO				YES	NO			NO
RATE VARIANCIES													
DIRECT LABOR $										1.95-	18.87	19.67	.80-
BDND LABOR $										4.17-	45.58	47.39	1.81-
TOT LAB BRDN %										2.7	141.5	140.9	.6
MATERIAL BRDN %	.0	.0	.0		.0	.0	.0	.0		.0	.0	.0	.0
PERFORMANCE INDICES:				.67	.88				.40	.88		1.16	
SCHEDULE CORRELATION:				.48-					1.48				

** PERCENTAGES **

% COMPL (BCWP/TOTAL BUDGET)	11.2
% EXP'ND (ACWP/TOTAL BUDGET)	12.7

** CALENDARIZATION DATES **

	START	COMPL	MTHS
BUDGET :	90/01	90/07	7
LRE:	90/02	90/07	6
ACTUALS:	90/02	90/02	1

** CALCULATED EAC (LRE) **

CPI	SPI	ACWP
145.5	320.0	145.5

VARIANCE ANALYSIS REQUIRED

Figure 2. C/SCSC Analysis Report (Sample)

Latest Revised Estimate (LRE) thresholds also are typically set (Thomsett, 1988) at ±10 percent and ≥ $20K. Variances in this category are treated the same as other types of variances but must be given closer scrutiny by the CAM as the effort nears its end.

Calculations of variances are made using the following formula:

$$\text{Schedule Variance} = \frac{\text{BCWP - BCWS}}{\text{BCWS}} = \%$$

$$\text{Cost Variance} = \frac{\text{BCWP - ACWP}}{\text{BCWP}} = \%$$

where:
BCWP = Budgeted Cost of Work Performed
BCWS = Budgeted Cost of Work Scheduled
ACWP = Actual Cost of Work Performed

Variances exceeding established thresholds are analyzed in detail by the CAM and a narrative explanation written for inclusion in the internal Variance Analysis Reports and external Problem Analysis Reports. Such analyses are also initiated for nonsignificant variances for internal or external reporting purposes if the variances represent unexpected problems or have potential impact because of exhibited trends. To assist in detecting such trends, CAMs are provided with a Weekly Responsibility Summary Report. Each account exceeding established thresholds is identified by an asterisk (*). When these are received, each CAM reviews individual account status to identify variant trends or potential problems. Unfavorable variances generally are caused by a combination of (1) erroneous basic assumptions or (2) control problems.

Reports.
When variance thresholds are exceeded, CAMs must explain to management (line, program or both) exactly what went wrong with their accounts during the prior period and why. Explanations must identify the underlying causes of the variances and not repeat the obvious as identified on the computer-generated reports. Explanations must be complete and include plans for corrective action ("get-well" or "recovery" plans), when warranted. When preparing these reports, the CAM should not expect management to interpret the CAM's variance explanations and independently determine corrective actions, but should write the reports in clear and unambiguous language. In general, there are three common explanations and corrective actions possible for variances:

1. Variances caused by timing differences which will be self-correcting in future reporting periods. No action is required.

2. Variances caused by incorrect the account was first planned. In this case the LRE must be modified by the CAM.

3. Variances caused by expenditures or work not being controlled. Corrective action by the CAM is needed to eliminate the unfavorable trends.

Cost and schedule variance analyses are performed by the CAM at the level of detail and cost elements necessary for a complete explanation of the variance. Specific areas to be addressed are listed below:

Cause.
Contributors to cost variances include:

- Changes in labor rates
- Changes in burden rates
- Changes in planned manpower level/mix (senior vs. less senior)
- Attrition in labor force
- Material price
- Minimum buy quantity variances
- More accurate definition of the scope of work, and
- Other direct costs such as computer time, reproduction, travel, etc., being greater than anticipated.

Resolution (Corrective Action).
Planned resolutions include a detailed explanation of what corrective action is being taken or will be taken within the current estimate at completion (EAC) for the account, how that action is anticipated to impact the cost variance, and when that corrective action will be implemented and effective. Corrective action also should include an analysis and narrative report of the impact on interfaces with other organizations and the total project and should evidence coordination of the proposed resolution, when warranted.

Analysis
Analyses are made for each element of cost in an overrun or underrun situation, with attention to direct labor wage rates and burden labor rate variance impacts, and price and usage variance for separately identified high-dollar material items, etc.

Schedule Slippages
Specific mention should be made of significant slippages in schedule or work around plans, identifying current and projected impact.

Schedule Problem Areas
Major current or potential problem areas should be commented on for possible corrective action by either line or program management or both. A Corrective Action Log should be established by individual CAMs to ensure follow-up action is being taken.

Schedule Variance Analysis
Causes, impact on other activities, corrective actions taken or to be taken, prognosis, recovery dates, status of recovery plans, etc., should be addressed. Schedule variances are always related to work package problems: late start, late completion, etc. In addition, the Narrative Variance Analysis Report must address the potential impact on cost that may be caused by the schedule variance.

ANALYSIS CASES

Thirteen cases for comparing planned vs. actual performance have been identified. These are shown in the Table 1 and each case is described using the relationships:

- Cost Variance (CV) = Budgeted Cost of Work Performed—BCWP (or actual earned value) - Actual Costs [incurred for] Work Performed (ACWP)

- Schedule Variances (SV) = BCWP - Budgeted Cost of Work Scheduled — BCWS (or planned work) where BCWP, BCWS and ACWP are defined.

- For each case, a positive (+) CV means the effort is underspent and a positive (+) SV means the effort is ahead of schedule.

Variance Analysis Case Studies

CASE	BCWS[a]	BCWP[b]	ACWP[c]	SV[d]	CV[e]
1	$X	$=X	$=X	0	0
2	X	0.50X	0.75X	-0.50X	-0.25X
3	X	0.75X	0.50X	-0.25X	-0.50X
4	X	0.75X	0.75X	-0.25X	-0.25X
5	X	0.75X	X	-0.25X	0

CASE	BCWS[a]	BCWP[b]	ACWP[c]	SV[d]	CV[e]
6	X	1.25X	X	0.25X	0
7	X	1.25X	1.25X	+0.25X	+0.25X
8	X	X	0.75X	0	-0.25X
9	X	X	1.25X	0	+0.25X
10	X	0.75X	1.25X	-0.25X	0.25X
11	X	1.25X	0.75X	+0.25X	-0.25X
12	X	1.25X	1.50X	+0.25X	+0.50X
13	X	1.50X	1.50X	+0.50X	+0.50X

a: Budgeted Cost of Work Scheduled (Planned Work)

b: Budgeted Cost of Work Performed (Actual Earned Value)

c: Actual Cost of Work Performed

e: Schedule Variance

f: Cost Variance

Cases:
In each of these cases, the concept of "earned value" was used to predict trends in cost and variance analysis.

1. This case shows that planned work is being performed on schedule (ACWP = BCWP = BCWS).

2. Costs are behind schedule and the cost account appears to be underrunning. Work is being accomplished at less than 100 percent efficiency since ACWP exceeds BCWP. This indicates a cost overrun can be anticipated. This situation is even worse, as the cost account is also 50 percent

behind the schedule defined on the WPPS. This is one of the worst possible cases.

3. In this case, there is good news and bad news. The good news is that work is being performed efficiently. The bad news is that the work is behind schedule, as defined on the WPPS. The "good news" could tend to obscure the bad news giving a false sense of security!

4. The work is not being accomplished according to the WPPS schedule (i. e., it is behind schedule) but costs are being maintained for what has been accomplished. This could indicate a staffing problem.

5. Costs are on target with the schedule as defined on the WPPS, but the work is 25 percent behind schedule because it is being performed at 75 percent efficiency.

6. The cost account team is operating at 125 percent efficiency, work is ahead of schedule by 25 percent but within scheduled costs. The team is performing at a more favorable position on the learning curve, as compared to Case 5.

7. The team is operating at 100 percent efficiency and work is being accomplished ahead of schedule. Costs are being maintained according to budget.

8. Work is being accomplished properly and costs are being underrun. Normally this would be a good situation: however, further analysis of the amount of the underrun would be beneficial to the program.

9. Work is being accomplished properly: however costs are being overrun.

10. Costs are being overrun while the plan is being underaccomplished. Work is also being accomplished inefficiently. This situation is bad and requires that the CAM provide an explanation in greater detailed.

11. Performance is ahead of schedule, and costs are lower than planned. This situation results in a large profit or money being reallocated, depending on the contract.

12. Work is being done inefficiently and a cost overrun could possibly occur. However, performance is ahead of schedule The overall result may be either a cost overrun or complete ahead of schedule.

13. Although actual costs are greater than budgeted, performance is ahead of schedule and work is being accomplished efficiently. This is a good situation and a Narrative Variance Analysis Report is not required.

SUMMARY

This article has reviewed some concepts applicable to performing a cost or schedule variance analysis. Examples were given of several report formats in use at GSG. It was shown that the data provided in these reports can be analyzed and compared to 13 "cases" identified by Kerzner.

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