

EVLA Project Performance Metrics through March 2007

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Summary

WBS group leaders made earned value estimates for the EVLA project in March 2007. When compared to the first earned value (EV) analysis made in June 2006, the cost performance index for the project increased to $CPI = 0.92$, while the schedule performance index remained essentially constant at $SPI = 0.82$. The improved CPI most likely reflects the excellent progress made in retrofitting antennas, and the constant SPI suggests that the project is still behind schedule, but not losing ground. The cost estimates to complete the project, as calculated with EV, are much less than the estimates from the June 2006 EV analysis, but continue to differ from the estimate determined from the WBS updates. The discrepancy between methods should improve as good progress continues and as the organization becomes more familiar with the EV methodology. The front end and M&C WBS groups continue to warrant additional management attention. The next EV analysis will occur simultaneously with the WBS updates in July 2007.

I. Introduction

EVLA WBS group leaders completed their second attempt at estimating EV for their groups in March 2007. The EV estimates were compared to project financial data compiled through February 2007 to compute performance metrics for the project. The detailed results of the analysis are in the attached Excel spreadsheets. The spreadsheet entries are described in the Appendix, and the results of the analysis are described below.

The EV analysis and our semi-annual WBS updates are different methods for determining how much money is needed to complete the project. The fundamental difference between the methods is the EV analysis makes a budget projection based upon our past performance (e.g. in one case it assumes that our past performance is a good indicator of our future performance), while our WBS updates are based upon our group leaders' re-evaluation of the budget needed to complete the project.

II. Results.

A. Performance Indices.

The CPI for the project improved from CPI = 0.84 in June 2006 to CPI = 0.92 in March 2007. The improved performance is almost certainly due to the implementation of antenna retrofits at the rate of about six per year in September 2006. Given the good progress on the retrofits, the CPI should continue to improve in future EV analyses. The SPI for the project remained essentially constant at SPI = 0.82, indicating that the project is still behind schedule. At this stage of the project, progress is proceeding at about the same rate as what was originally planned. Thus, SPI values determined in the near future should be comparable with the present one. Significant increases in the SPI probably won't occur until the antenna retrofits start to catch up with original plans in about January 2008. The good news is there are no negative trends in CPI or SPI.

From the financial data alone, I do not find evidence for over-spending. The ratio of planned value (PV) to actual cost (AC) is independent of EV estimates, and thus any personal bias, and is equal to $PV/AC = CPI/SPI = 1.12$ in March 2007, up from 1.01 in June 2006. This favorable ratio means that actual costs have not exceeded the planned value, so that money is still available to complete the work. If the PV/AC ratio was less than one, we would have spent more money than we had planned. All WBS elements in the project have a PV/AC ratio that is greater than 1.0, and significantly so in some cases.

As with the overall project, the CPIs for the individual WBS elements generally improved and their SPIs remained relatively constant when compared to the June 2006 results. The performance indices for the front end and M&C WBS groups continue to lag those of the other groups. The lower performance indices in front end reflect the delay in production of OMTs and new receivers along with staffing shortages in the group. The recent addition of new staff to the group and the possible addition of more resources from an upcoming change board action should improve front end group performance. The lower performance indices in M&C may be an artificial result caused by a budget allocation that is too large for the work to be performed.

B. Percent Complete and Percent Spent

The project's percent complete improved from 50.8% in June 2006 to 58.6% in March 2007. Over the same period, the project's percent spent (not shown on the current spread sheet), which is calculated from the ratio of actual cost (AC) to budget at completion (BAC), only increased from 60.2% to 63.9%. A positive trend for the project is the incremental change in percent complete (7.8%) exceeds the incremental change in percent spent (3.7%). Another positive trend is the difference between percent spent and percent

complete in March 2007 is only 4.3%, while the difference in June 2006 is 9.4%.

C. Cost Estimate at Completion (EAC)

As described in the Appendix, two methods were used to estimate the cost to complete the project. With the first method (henceforth method 1, which is based on CPI, top table of the Excel spreadsheet), the EAC of the project is \$80.2M, or about \$7.7M over the budgeted amount (which does not include contingency). The EAC computed from the second method (henceforth method 2, bottom table of the spreadsheet) is \$76.3M, or \$3.8M over the budgeted amount. As we found in the June 2006 EV analysis, these results are very different from the results we get from the semi-annual update of the WBS, which currently gives an EAC of \$73.3M (based on all approved change orders through May 24, 2007). The current funding for the project, including NSF funds, Mexican funds, and contributed effort, is estimated at \$76.8M, which is enough to cover the EAC predicted by either the WBS update or method 2.

The EV-based EAC estimates are significantly different from the June 2006 results (c.f. \$85.9M and \$77.9M from methods 1 and 2, respectively). It is encouraging that the EV EAC estimates appear to be converging rapidly on the WBS EAC estimate. As I mentioned in the summary of the June 2006 EV analysis, method 1 uses CPI to calculate EAC, thereby assuming that past performance is indicative of future performance, which is definitely not true for the project at this time. As I predicted then, the CPI has improved and is a factor leading to the reduction in method 1 EAC between June 2006 and March 2007. The EAC calculated in this way should continue to decrease as CPI improves. Since the EV EACs have decreased significantly over the last year, I'm not convinced that the EV estimates are precisely accurate, and we need more experience with EV before we use its results to make big project decisions. I do remain concerned that the disparity between the EV analysis and WBS updates may indicate that we may not fully understand the work before us, and we should continue to estimate EV so that we can be more confident in what it is telling us.

III. Quarterly Analyses.

To ensure that the results produced by the earned value analysis and the semi-annual WBS updates continue to converge, we will repeat the analysis on a quarterly basis via email. The infrastructure for the analysis is built into the cost data sheets, so it should proceed quickly, and hopefully with minimum interruption. The next analysis will be held concurrently with the WBS updates in July 2007.

Appendix: Explanation of Terms in the Earned Value Analysis

All of the terms for the earned value analysis shown in the Excel spreadsheet have formal definitions given by the Project Management Body of Knowledge (2004, Project Management Institute: Newtown Square, PA). The summary page of the Excel spreadsheet contains two tables. The entries in the columns of the tables are identical, with the exception of the entries in the last two columns. The tables differ in the method used to calculate the project's budget estimate at completion (the next to last column in each table). Both tables show the project performance of each WBS element in the EVLA project.

A. The first column of each table on the summary page identifies the WBS element.

B. The second column of each table identifies the Planned Value (PV), which is also known as the Budgeted Cost of Work Scheduled (BCWS). The PV is the budgeted cost for the work scheduled to be completed on an activity or WBS element up to a given point in time. It is NOT the total budget for the activity/element.

C. The third column in each table is the Earned Value (EV), which is also known as the Budgeted Cost of Work Performed (BCWP). The EV is the budgeted amount for the work actually completed on the scheduled activity or WBS element up to the given point in time. The WBS group leaders made their initial assessments of EV last summer.

D. The fourth column of each table is the Actual Cost (AC) of work performed. The AC is the total cost incurred in accomplishing work in the WBS element during the time period.

E. The fifth column in each table is an estimate of the Percent Complete (PC) for the WBS element. It is the ratio of the EV to the Budget at Completion (BAC) in column 10, expressed as a percentage.

F. Performance Index.

1. The sixth column of each table is the Schedule Performance Index (SPI). The SPI is the ratio of the earned value to the planned value, $SPI = EV/PV$. An SPI equal to one indicates that the WBS element is on schedule. An SPI less than one means the WBS element is behind schedule.

2. The seventh column of each table is the Cost Performance Index (CPI). The CPI is the ratio of the Earned Value to the Actual Cost, $CPI = EV/AC$. A CPI greater than one indicates a cost underrun in the WBS element, and a CPI less than one indicates a cost overrun.

G. Variances.

1. The eighth column of each table lists the Schedule Variance (SV). The SV is the difference between earned value and planned value, $SV = EV - PV$. A positive value of SV is good. A large negative value of SV is bad.
2. The ninth column of each table lists the Cost Variance (CV). The CV is the difference between earned value and actual cost, $CV = EV - AC$. As with SV, a positive value of CV is good, and a large negative value of CV is bad.

H. The tenth column of each table is the baseline budget or the Budget at Completion (BAC). The BAC is the total budgeted cost to complete the WBS element.

I. The next to last column of each table is the projected budget or Estimate at Completion (EAC) of the project. The EAC is the sum of the Actual Cost and the Estimate to Complete (ETC) the project, $EAC = AC + ETC$. The ETC can be computed in three ways:

1. The ETC can be determined from the CPI when the project team believes that current variances are seen as typical for the future. In this case, the ETC is given by the equation $ETC = (BAC - EV)/CPI$. This is the equation used to compute EAC in the next to last column in the table at the top of the summary page. With this definition of ETC, the equation for EAC simplifies to $EAC = BAC * AC / EV = BAC / CPI$.
2. The ETC can be estimated from the BAC and EV if the project team believes that future variances will not be typical of those in the past. In this case, the ETC is simply $ETC = BAC - EV$ (i.e. the CPI is assumed to be equal to one), and $EAC = BAC + AC - EV$. This is the equation used to compute EAC in the next to last column in the table at the bottom of the summary page.
3. Alternatively, the ETC can be determined by the project team by making a complete new cost estimate of the work remaining on the project. This is similar to the approach we adopt in the semi-annual

updates of the WBS.

J. The last column of each table is the difference between the estimate at completion and the budgeted amount (= EAC - BAC).

The data presented in the remaining pages of the worksheet are identical to what is shown in the summary tables.

Note: All monetary amounts are in \$k dollars

WBS	Level 2 Task	Planned Value (PV)		Earned Value (EV)		Actual Cost (AC)		% Complete		Performance Index		Variances		Budget At Completion (BAC)	
		Scheduled	Work Performed	Value	Value	Cost	Cost	EV / BAC	SPI	CPI	Schedule	Cost	BAC	EAC	Variance
601	Project Management	2,588	2,376	2,310	2,310	59.4%	0.92	1.03	-212	66	4,001	3,890	111		
602	System Integration & Testing	5,233	4,751	4,837	4,837	80.9%	0.91	0.98	-482	-86	5,874	5,980	-106		
603	Civil Construction	2,349	2,087	2,291	2,291	88.2%	0.89	0.91	-262	-204	2,366	2,597	-231		
604	Antennas	3,600	2,973	2,626	2,626	62.7%	0.83	1.13	-627	348	4,740	4,186	554		
605	Front End Systems	10,605	7,649	9,325	9,325	41.1%	0.72	0.82	-2,956	-1,677	18,601	22,679	-4,078		
606	Local Oscillation System	4,555	4,059	4,167	4,167	71.1%	0.89	0.97	-496	-108	5,706	5,858	-152		
607	Fiber Optic System	7,511	6,018	6,662	6,662	65.2%	0.80	0.90	-1,493	-644	9,236	10,224	-988		
608	Intermediate Frequency System	3,730	3,373	3,409	3,409	67.3%	0.90	0.99	-357	-36	5,009	5,063	-54		
609	Correlator, NRAO Interface	18	17	9	9	50.0%	0.94	1.91	-1	8	34	18	16		
610	Monitor & Control System	8,025	5,873	7,320	7,320	53.2%	0.73	0.80	-2,152	-1,446	11,046	13,766	-2,720		
611	Data Management & Computing	3,833	3,368	3,378	3,378	56.8%	0.88	1.00	-465	-10	5,930	5,948	-18		
612	Education & Public Outreach	0	0	0	0	0.0%	0.00	0.00	0	0	0	0	0		
Project Totals		52,048	42,545	46,336	46,336	58.6%	0.82	0.92	-9,503	-3,791	72,542	80,209	-7,667		

WBS	Level 2 Task	Planned Value (PV)		Earned Value (EV)		Actual Cost (AC)		% Complete		Performance Index		Variances		Budget At Completion (BAC)	
		Scheduled	Work Performed	Value	Value	Cost	Cost	EV / BAC	SPI	CPI	Schedule	Cost	BAC	EAC	Variance
601	Project Management	2,588	2,376	2,310	2,310	59.4%	0.92	1.03	-212	66	4,001	3,935	66		
602	System Integration & Testing	5,233	4,751	4,837	4,837	80.9%	0.91	0.98	-482	-86	5,874	5,960	-86		
603	Civil Construction	2,349	2,087	2,291	2,291	88.2%	0.89	0.91	-262	-204	2,366	2,570	-204		
604	Antennas	3,600	2,973	2,626	2,626	62.7%	0.83	1.13	-627	348	4,740	4,392	348		
605	Front End Systems	10,605	7,649	9,325	9,325	41.1%	0.72	0.82	-2,956	-1,677	18,601	20,278	-1,677		
606	Local Oscillation System	4,555	4,059	4,167	4,167	71.1%	0.89	0.97	-496	-108	5,706	5,814	-108		
607	Fiber Optic System	7,511	6,018	6,662	6,662	65.2%	0.80	0.90	-1,493	-644	9,236	9,880	-644		
608	Intermediate Frequency System	3,730	3,373	3,409	3,409	67.3%	0.90	0.99	-357	-36	5,009	5,046	-36		
609	Correlator, NRAO Interface	18	17	9	9	50.0%	0.94	1.91	-1	8	34	26	8		
610	Monitor & Control System	8,025	5,873	7,320	7,320	53.2%	0.73	0.80	-2,152	-1,446	11,046	12,492	-1,446		
611	Data Management & Computing	3,833	3,368	3,378	3,378	56.8%	0.88	1.00	-465	-10	5,930	5,941	-10		
612	Education & Public Outreach	0	0	0	0	0.0%	0.00	0.00	0	0	0	0	0		
Project Totals		52,048	42,545	46,336	46,336	58.6%	0.82	0.92	-9,503	-3,791	72,542	76,332	-3,791		