The Pulse of Performance

Vehicle Unit Cost Reports

Ray Davidson

If a cumulative earned value chart represents the health of a program, the vehicle unit cost report is the program's pulse.

The assault amphibious vehicle's earned value management effort has demonstrated a proven methodology for cost and schedule performance tracking. Cumulative earned value charts with stratification of the actual cost of work performed and its related performance metric plotted against the budgeted cost

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of work scheduled provide, at a glance, an acuity reference of the project's health. Addition of program metrics such as the cost and schedule indices coupled with threshold variances combine to establish a forecasted/recommended estimate to complete. But when it comes to "auribus tenere lupum" [*hold the wolf by the ears*] the structure and data integrity enforced by the vehicle unit costs report is the analyst's choice.

The vehicle cost report and its sister, the vehicle exit unit cost report, enforce a structural, performance, cost, and financial discipline that have proved to be invaluable during the reliability, availability, maintainability/rebuild to standards, and the current inspect and repair only as necessary process.

Enforcing the Structure

Fundamental to performance measurement is the work-breakdown structure (WBS). Thus, it is imperative that a product-oriented family-tree division of hardware, services, and other depot work tasks is succinctly organized to display and define the vehicle/product to be rebuilt and relate the elements of the work to be accomplished to each other and the end product. In addition, to be able to identify anomalies and forecast future performance constraints, the WBS must be reconciled to its lowest unit. For analytical purposes, that is usually at level three and/or four of the WBS.

The WBS provides a formal product-oriented structure, or framework, that identifies all authorized project work. This formalization simplifies the problems of summarizing project-oriented data through both external and internal management reporting, and establishes the reporting structure (as explained in the Marine Corps Logistics Base's *Earned Value Management Systems Description and Procedures*, September 2002). This structure is the framework for reporting of labor costs, labor hours, material costs, program-level costs and vendor/contractor support as shown in the table below.

MIL Handbook 881 states: "The Program WBS provides a framework for specifying program objectives. It defines the program in terms of hierarchically related, product-oriented elements and includes 'other Government' elements (i.e., Program Office Operations, Manpower, Government Furnished Equipment (GFE), Government Testing). Each element provides logical summary levels for assessing technical accomplishments, supporting the required event-based technical reviews, and for measuring cost and schedule performance."

The Accounting Method

The actual cost is used (versus the billed cost of labor) and is the actual labor rate for each employee charging time. The difference between the planned labor rate and the actual labor rate is the true variance we seek. Consequently, the difference between the planned price and the actual price of a material item is the basis of material variances and performance.

A challenge for the Department of Defense has been production expense and general and administrative expense (G&A). Those expenses are allocated to job orders through the use of production and G&A rates. The rates are budgeted and applied to all direct job orders based upon the direct labor hours charged and the cost work center. The production rate is applied to direct labor hours performed in productive cost centers only. The G&A rate is applied to all direct labor hours performed. Those rates are not to be confused with the stabilized billing rates used to price the sale of services. The applied rates are developed by the maintenance centers based on estimated costs within the annual budget and are used for control purposes. The applied rates should periodically be reviewed to see if they should be revised as a result

Figure 1. **Vehicle Unit Cost Report**

WBS	Vehicle 1	Vehicle 2	Vehicle 3	Vehicle 4	Vehicle 5	Vehicle 6	**Estimate**	**Average**	**Variance**
AAVR7		3,480	**562**	**36**		**1,882**	**0**	**993**	**-993**
Vehicle							**0**	0	**0**
Hull/Frame	39,403	36,147	45,451	35,403	42,389	38,731	**32,540**	39,587	**-7,047**
Suspn/Steering	16,007	19,163	10,999	11,762	19,023	15,723	**25,432**	15,446	**9,986**
Power Package	48,044	59,973	71,106	44,636	63,134	47,789	**82,720**	55,780	**26,940**
AuxAutomotive	46,237	42,907	56,561	45,763	40,319	30,288	**53,090**	43,679	**9,411**
Navigation	3,909	4,531	4,697	5,401	3,191	5,959	**6,923**	4,615	**2,308**
Dissassembly	18,079	19,179	18,385	42,627	20,233	14,610	**17,806**	22,185	**-4,379**
Assembly	88,554	95,319	102,247	88,437	93,300	99,322	**63,479**	94,530	**-31,051**
Test	486	221	198		249	9	**10,018**	194	**9,825**
Program Costs	87,157	87,157	87,157	87,157	87,157	87,157	**50,692**	87,157	**-36,465**
Vehicle Cost	260,719	280,920	310,205	274,065	281,837	254,313	**292,008**	277,010	**14,998**
Total Costs	**347,876**	**368,077**	**397,362**	**361,222**	**368,994**	**341,470**	**342,700**	364,167	**-21,467**

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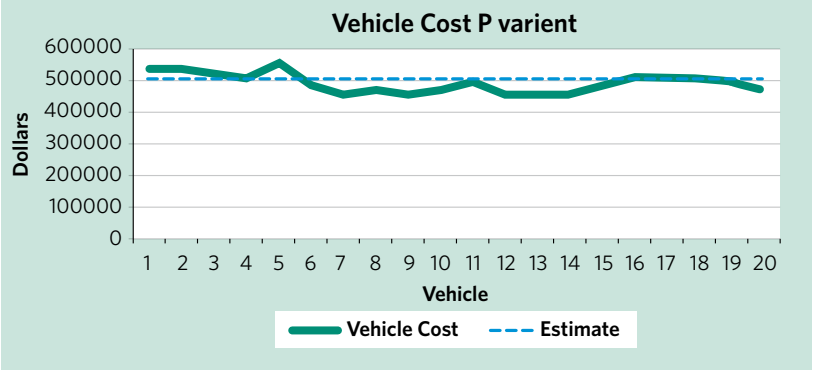
of actual results or revised forecasts, according to the "5.0 Accounting" section in the *Earned Value Management Systems Description and Procedures* referenced earlier.

The Importance of Analysis

The vehicle unit cost report tracks the cost of each individual vehicle as well as hours expended, material consumed, and program-level costs, (i.e., labor, material costs, and hours). Performance and variance analysis are available from both WBS and cost work center (CWC) views. The data can, therefore, be used to review cost and estimate at completion (EAC) variances in order to:

- Identify and isolate vehicle-, WBS-, and CWC-level problems causing unfavorable cost performance
- Evaluate the impact of process changes, variances, workarounds, etc.
- Evaluate the performance of performing CWC
- Identify potential vehicle overruns and underruns as early as possible.

Figure 2. **Vehicle Unit Cost Chart**



Short of re-estimating the remaining work, computing the cost performance index and percent of trend, a projected estimate to complete (ETC) can be made as well as a final average vehicle cost. These numbers are usually triangulated:

- Sunk vehicle cost + cost performance index (CPI) x budgeted cost to complete + percent of trend (to give the most pessimistic cost)
- Sunk vehicle cost + CPI x budgeted cost to complete (this flatlines the performance)
- Sunk vehicle cost + CPI x budgeted cost to complete – percent of trend (to give the most optimistic cost).

Those methods should always be balanced by the analyst's and program manager's assessment. That will conceivably provide a fourth ETC, but to use that projected estimate, there must be a sufficient degree of confidence in the analyst's judgment (usually based on history and past performance) and the program manager's ability to effect change either in shop floor processes or business flows.

According to Ruthanne Schulte in "What is the Health of My Project?" (*Project Management Professional*, April 2002), statistical forecasts (forecasts that are created using such indices as the cost performance index) can give early warning signs of project overruns and can be used to evaluate the accuracy of a manually entered estimate at complete.

David S. Christensen, Defense Acquisition University professor of accounting, expanded on this by saying, "Results show that the average EAC based on the cumulative CPI was the lower end of the average cost at completion. Other common index-based EACs that are found to be higher are more accurate. In particular, studies show EACs based on both the CPI and the schedule performance index (SPI) tend to be significantly higher and are generally more accurate" (quoted from Christiansen's e-mail to the author).

The ability of the program manager to effect process change and defy trend was seen at the Maintenance Center Barstow (MCB), Calif., when a holistic risk mitigation approach was used. MCB defined the entire business process as a potential risk, and methodologically reviewed all work for efficiency and effectiveness. That robust risk approach, coupled with support from Marine Corps Logistics Command's Maintenance Management Center's Assault Amphibious Vehicle Team and Lean Six Sigma efforts, exceeded both the analysts' and program managers' optimistic forecasts. At the same time, the risk management approach gave them the ability to use the vehicle unit cost tool to measure and analyze their processes, allowing them to improve, then exercise control over their work.

These results are amazing given that, according to Schulte, "The Department of Defense's experience in more than 400 programs since

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1977 indicates that without exception the cumulative cost performance index (CPI) does not significantly improve during the period between the 15% and the 85% of contract performance; in fact, it tends to decline."

The Vehicle Unit Cost Report versus the Vehicle Exit Unit Cost Report

As seen in the chart on page 46, the vehicle unit cost report tracks the vehicle costs associated with the job order number assigned to the vehicle as it was inducted into the maintenance cycle. Early in the Assault Amphibious Vehicle program, SYSCOM Program and Resources requested that Albany Marine Corps Logistics Base produce the exit cost of a vehicle versus the cost associated with the inducted vehicle. Since all costs were associated with the inducted vehicle, a concept was devised that approximated the cost of the final product. The plan was to track the cost of the hull and all serialized parts (hatch door, plenum, etc.) as direct charges; average the costs of components not succinctly tracked; and allocate the program-level costs. SYSCOM approved that method. Critical to the method was the capturing of all costs at level three of the WBS.

Assessing the Risks

For the vehicle unit cost report to be a viable program document to access costs as well as to provide prognostic value, the data supporting the report must be reconcilable to the third level of the WBS. That can sometimes be a challenge—when the program has un-reconciled costs or data integrity issues, for example. Such a situation does not allow analysis of vehicle unit cost at the component level.

Equally devastating for analysis is the failure to maintain the WBS structure. That was borne out at MCB with the fiscal year 2006 line. The decision to combine WBS elements for disassembly, assembly, and test created too large a "bucket" to drill down to negate cost drivers. Once the elements were broken out again, the major cost drivers were apparent.

Another risk is the costs captured at the program level, which can be viewed in two dimensions.

Program-Level WBS/Job Order Number Not Used

This situation is found when program-level costs are charged to an individual vehicle/product, driving the specific unit cost way beyond average or threshold levels. For example, the cost for Marine Corps Albany's OSMOSIS water purification unit jumped almost $600,000 for one specific unit because there were no job order numbers established for program-level charges and the costs were applied to a single unit.

Unconstrained Line Side Stock (LSS) Costs

This is the case when repairable parts are charged to LSS versus the discrete WBS element. LSS was established for common nuts-and-bolts items—items usually considered pre-expended bin items with a unit cost of less than $500. Occasionally, repairable parts find their way into LSS charges; they must be identified and charged to the correct component WBS element.

The management of applied rates and the frequency of change constitute a minor risk to the program but can be mollified by more frequent rate changes (weekly instead of monthly or quarterly). As stated earlier, the applied rates should be reviewed periodically to see if they should be revised in light of actual results or revised forecasts. As long as they are consistently applied, they do not pose a great risk to performance metrics, but they will pose a manual risk to the vehicle unit cost.

Bottom-Line Value

The vehicle unit cost reports provide a hands-on view of program data that is easily relatable and understandable to both the layman and the analyst. It is a fundamental view of the data that supports cost, schedule, and performance reporting and serves as the analysts hip-pocket guide. Without it, we could not have accomplished the drill downs at MCB as quickly and efficiently as we did.

Performance analysis using such methods as earned value indices, process control charting, run charts, histograms, vehicle cost reports, and other analytical techniques will provide a statistical and empirical foundation for our future management decisions.

Cumulative cost and performance charts and their indices will contribute significantly to the health of our projects. At the same time, the vehicle unit cost reports provide the pulse; if properly used and supported by reliable data, they will enable us to keep our programs off life support, thus proving to be a valuable partner to gain desired outcomes. Our goal must always be to gain efficiency and effectiveness, to monitor our success, and provide the best equipment for the best price to our soldiers of the sea.

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