Project Evaluation and Control System
Wail Bokhary
Cost Engineering; Jul 2010; 52, 7; ABI/INFORM Global
pg. 7

CERTIFICATION PAPER

Project Evaluation and Control System

Wail Bokhary

ABSTRACT: This article discuses project cost control, which typically falls under the umbrella of project evaluation and control. For this reason, any discussion of project cost control must begin with a brief overview of the larger framework. This is followed by an examination of the various aspects and approaches to evaluating and controlling project costs, including S-curve analysis of time–cost relationships. The article concludes with an in-depth look at another valuable mechanism for controlling project costs, called earned value management (EVM).

KEY WORDS: Budgets, costs, earned value management, planning, and project evaluation

A project is a temporary set of activities that are planned to start and to end within a specific time to deliver a unique product, service, or result. Planning in a project environment may be described as establishing a predetermined course of action within a forecasted environment.

The project's requirements set the major milestones. Scheduling is the process that converts the project work plan into a roadmap, that if followed, will assure timely project completion. Scheduling is one of the tools used for monitoring and controlling projects to ensure the objectives of cost, quality, and time are met. Schedules provide the baseline against which progress is measured. Schedules are used to assess time impact of changes to the work scope.

A project evaluation and control system measures project progress and performance against a project plan to ensure that the project is completed on time, within budget, and to the satisfaction of the customer.

A good project evaluation and control system should also provide project managers with advance warning of potential problems, before it is too late to correct them.

Without these systems, projects proceed aimlessly with very little oversight, without a clear understanding of status, and without a well-thought-out action plan to bring the project back on track in the event of obvious disruptions.

Designing, implementing, and maintaining an accurate monitoring and control system is perhaps one of the most difficult challenges in project management, and more than a few organizations get it wrong.

There are two reasons for this.

- Very few project managers and project teams have a strong grasp on the essentials of project control. Subsequently, they do not know what warning signals to look for during the development process, or when to look for them.
- They do not have the necessary know-how and training to develop systematic project control that is comprehensive, precise, and timely.

The good news is that this can be easily remedied with some basic knowledge of the processes and procedures involved.

Project Control Process

To correctly and accurately measure and evaluate project performance, four essential elements must be in place. They include setting a baseline plan, measuring progress and performance, comparing actual performance against plan, and taking corrective action—each of which is now examined in detail.

Establishing a Project Baseline Plan—The project baseline plan provides the essential features for measuring performance. It begins with an accurate work breakdown structure (WBS), which establishes all the work packages and tasks associated with the project, assigns the personnel responsible for them, and creates a hierarchical representation of the project from the highest level down.

To create the project baseline plan, the project team lays out each of the discrete tasks from the WBS onto a project network diagram, and time-phases all work, resources, and budgets.

Measuring and Monitoring Progress and Performance—Accurate mechanisms for project measurement are essential prerequisites of effective control systems. The first step in creating them is to establish a control system that measures the ongoing status of various project activities *in real time*, and provides project managers with relevant information as quickly as possible.

The second step is to determine what should be measured. There are both quantitative and qualitative measures for monitoring project progress, and integrating quantitative measures like time and cost into the control system is relatively easy.

On the other hand, qualitative measures like customer satisfaction with product functionality and technical specification can be determined only through on-site inspection or actual use.

When it comes to quantitative measurement, evaluating project performance relative to time can be as simple as answering questions like, "Is the critical path early, late, or still on schedule?" or, "Is there reduction in the slack of noncritical paths?"

Measuring project performance against budget (e.g., dollars, units in place, labor hours) is more difficult. In these cases, a form of project measurement known as earned value management (EVM), can provide a realistic estimate of project performance against a time-phased budget. We will examine EVM later in this article.

Comparing Actual Performance Against Plan—Given that actual project performance is rarely in accordance with the original baseline plan, the next step is to compare the two to measure deviations. This analysis—sometimes referred to as "gap" analysis—is essential for determining current project status. As a rule, the smaller the deviation between the baseline plan and actual performance, the easier it is to take corrective action.

Taking Remedial Action—In cases where the deviations between the plan and actual performance are large and obvious, some form of corrective action is necessary

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

to bring the project back on track. In some cases, the action may be relatively minor; in others, it may require serious and significant remedial steps. In situations where conditions or project scope have changed, the original baseline plan may have to be revised.

Finally, it is important to note that this monitoring and control process is not a one time fix, but is a continuous cycle of goal setting, measuring, correcting, improving, and re-measuring, as illustrated in figure 1.

INTEGRATING COST AND TIME IN MONITORING PROJECT PERFORMANCE: THE S-CURVE

Gantt charts, control charts, and milestones are tools that are often used to monitor project performance. However, these tools track progress only in the dimension of time. The other important dimension of project performance, cost, is virtually ignored.

One of the mechanisms that monitor both dimensions is time–cost analysis. In this method, the project's progress is monitored as a function of the cumulative costs and plotted against time for both budgeted and actual amounts. Time–cost analysis can be illustrated through the simple example of a fictional project, "Project Orion," which consists of four work packages (design, engineering, installation, and testing).

The completion budget is $100,000, and the anticipated duration is 50 weeks. A breakdown of the project's cumulative budget, in terms of both work package and time, appears in table 1

In time–cost analysis, the relationship between time and money is represented graphically with time on the x, or horizontal axis, and money spent on the y, or vertical axis. The typical form of this relationship is S-shaped, where budget expenditures are initially low and increase rapidly during the major project execution stage, before starting to level off again as the project gets nearer to completion.

In figure 2, the cumulative budget projections for Project Orion shown in table 5.1 have been plotted against the project's time duration.

The S-curve figure represents the project budget baseline against which actual budget expenditures will be evaluated.

	Duration in Weeks										
Work package	5	10	15	20	25	30	35	40	45	50	Total
Prototype design	6	2	4								12
Engineering		4	8	8	8	6					34
Assembly				4	20	6	6				36
Test						2	6	4	2	4	18
Total	6	6	12	12	28	14	12	4	2	4	100
Cumulative	6	12	24	36	64	78	90	94	96	100	100

Table 1— Budgeted Costs (in $000) for Project Orion

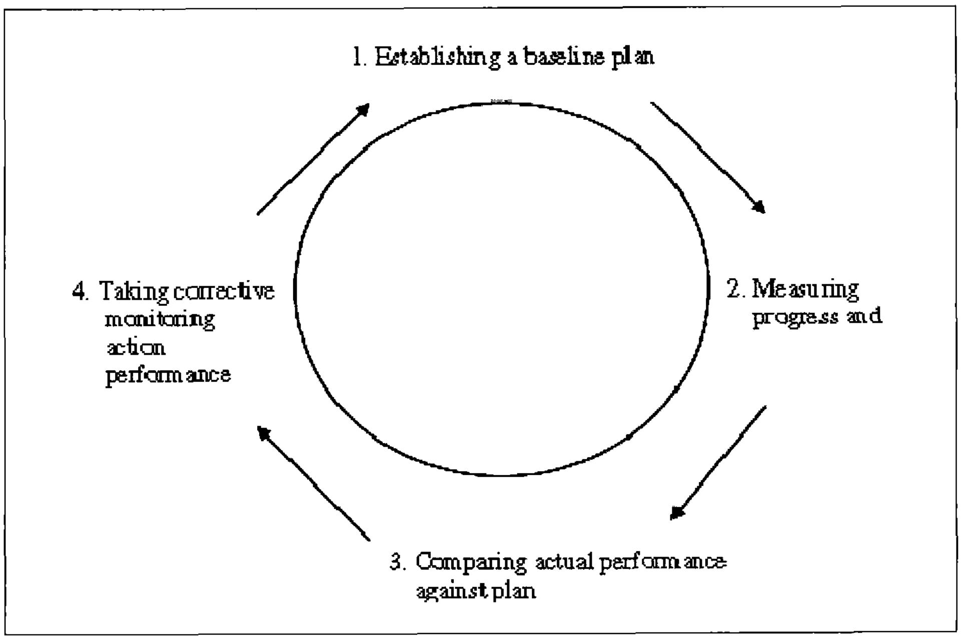


Figure 1— The Project Control Process

To monitor the status of a project using an S-curve, the cumulative project budget expenditures to date are compared with the actual spending patterns at the end of each time period of interest. Any significant deviations between actual and planned budget expenditures constitute a potential problem area that must be investigated.

S-curves were an early attempt to illustrate the nature of the important relationship between time and money. They help project managers understand the correlation between project duration and budget expenditures, and give them a good sense of where the highest levels of budget spending are likely to occur.

Using S-curves to monitor the status of a project involves the following: At the end of each time period of interest, the cumulative project budget expenditures to date are compared with the actual spending patterns. Any significant deviations between actual and planned budget expenditures would constitute a potential problem area that must be investigated.

The biggest advantage of S-curve analysis is that it is simple to use, and data can be created and presented without much difficulty. Furthermore, the S-curve provides the most current information on the project status as budget expenditures can be constantly revised and the new value plotted on the graph.

The S-curve is a more proactive control mechanism, as information can be represented immediately and updated continuously. Consequently, the S-curves provide a clear visual picture of the project's status that is available in a timely manner and easy to read.

To illustrate S-curve analysis using the example in table 1, we'll assume that as of week 27, the original projected expenditure is $75,000. However, the actual project expenditures totaled only $65,000. The net effect is that there is a $10,000 budget shortfall, or negative variance between the cumulative budgeted cost of the project and its cumulative actual cost. Figure 3 shows this comparison of budget versus actual costs, along with the negative variance as of week 27.

While S-curves provide project teams with many benefits, the greatest is that S-curve analysis is simple to use, and data can

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

be created and presented without much difficulty. In addition, S-curves have the following advantages.

- Help project managers understand the correlation between project duration and budget expenditures, and provide a good sense of where the highest levels of spending are likely to occur.
- Provide the most current information on project status, because budget expenditures can be constantly revised and new values plotted on the graph.
- Serve as a more proactive control mechanism, because information can be immediately represented and continuously updated.

Despite these advantages, S-curves have a number of significant shortcomings that must be taken into account when project teams contemplate their use. For example, while S-curves can identify deviations between actual and budgeted expenditures (both positive and negative variances), the cause of these deviations cannot easily be determined.

In the S-curve shown in figure 3, it is clear that the budgeted amount, as of week 27, has not been expended. However, what we do not know and cannot conclude from this graph is the reason for the negative variance. Is it an indication that the project is behind schedule, or that the project team has come up with more efficient methods of completing the tasks? In either case, there is potential for misusing S-curves as a project-monitoring tool.

In the final analysis, simply evaluating a project's status vis- `a-vis its performance on time versus budget expenditures can easily lead to erroneous conclusions about project performance.

This disadvantage created significant problems for several high-profile US aircraft development projects in the early 1960s, and ultimately led to the adoption of the more popular analytical approach of earned value management.

EARNED VALUE MANAGEMENT

The remainder of this article focuses on earned value management, a mechanism that can determine how much work was accomplished for the money spent. The earned value system uses the data from the work breakdown structure, the project network, and the schedule to compare time-phased costs with scheduled activities. In the process, it enables meaningful comparisons to be made between actual and planned schedules and costs.

The use of EVM as a project monitoring and control mechanism began in the 1960s, when it was championed by the US government as a viable system for its agencies and contractors to track project performance. The focus was to track the "value" performance of projects, in addition to cost and other traditional measures.

In the 30 years since its origin, EVM has been used worldwide in a wide variety of settings, ranging from governmental

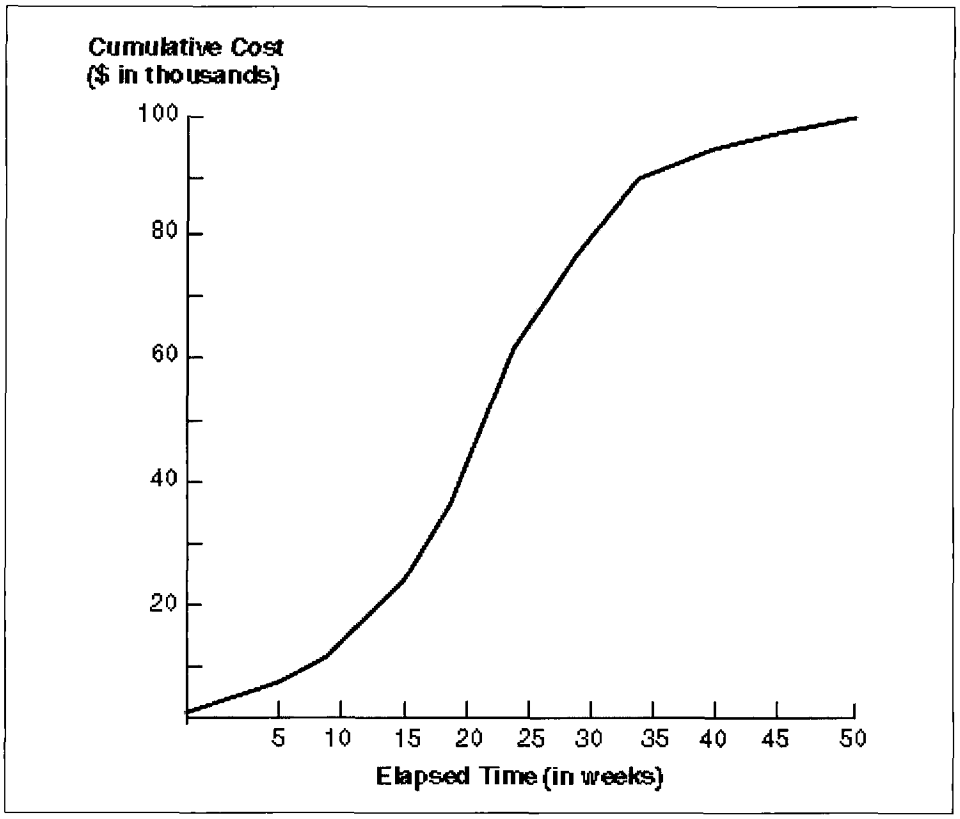


Figure 2— Project S-Curve

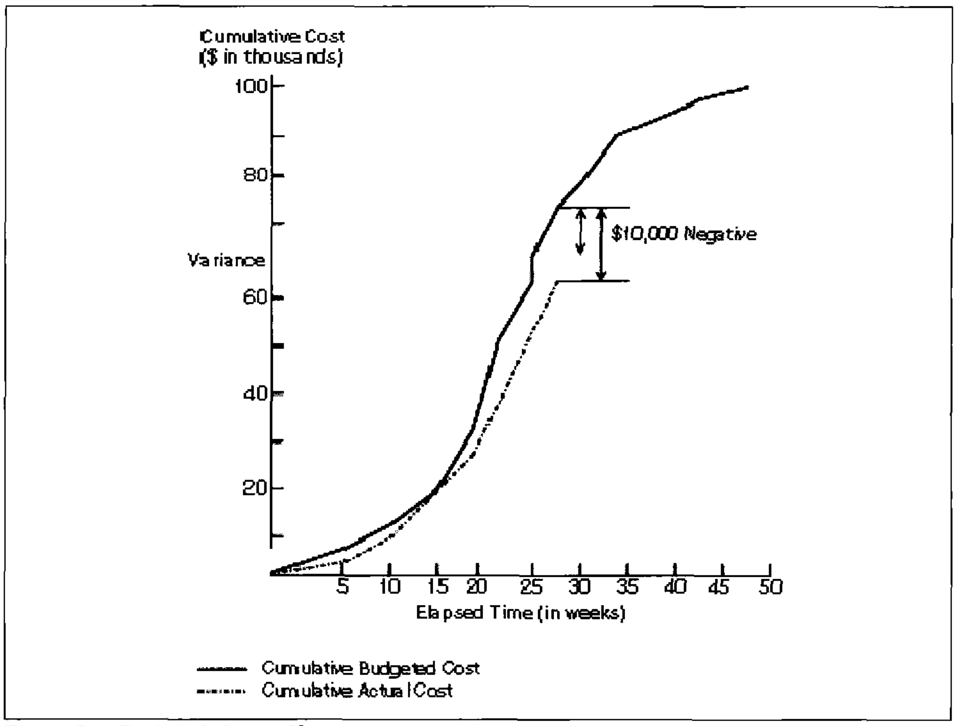


Figure 3— Project S-Curve Showing Negative Variance

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

agencies to a host of project-based organizations in numerous industries.

Unlike Gantt charts and S-curves, EVM evaluates a project by integrating the criteria of time, cost, and value. In other words, in addition to comparing actual and budgeted costs, EVM integrates the important element of time in determining what was accomplished (value realized) to draw conclusions about current project status.

In essence, the earned value method measures the value of the work actually accomplished at the cost rates set out in the original budget. This quantity is known as earned value (EV). Furthermore, as EVM provides information about the efficiency with which budgeted money is used relative to the value realized, forecasts about the estimated cost and schedule to project completion can be made.

EARNED VALUE MANAGEMENT MODEL

Earned value management shows the relationship among all three of the primary project success criteria: cost, schedule, and performance. Figures 4, 5, and 6 illustrate the superiority of EVM in comparison with the other project-tracking mechanisms, such as Gantt charts and S-curves.

Essentially, S-curves establish a linkage directly and solely between cost and schedule (figure 4). Tracking mechanisms, such as tracking Gantt charts, employ links between schedule and project (or activity) performance (figure 5). It is only through earned value that the full nature of the association between the three success metrics of schedule, cost, and performance can be understood in relation to each other (figure 6).

FUNDAMENTALS OF EARNED VALUE

The two key elements involved in developing an earned value analysis are:

- **The work breakdown structure**—This provides, in a hierarchical structure, information regarding the individual tasks that need to be performed on the project and individual work packages. The WBS makes it possible to allocate necessary human resources that match task requirements. Subsequently, the project network derived from this information enables the correct sequencing of tasks to be identified, and provides the basis for developing a time-phased budget.
- **A time-phased budget for each work package**—With a time phased budget in place, the project team can determine the timing of budget expenditures required to complete individual tasks. More importantly, the time-phased budget enables the project team to determine the points in the project when budget money is likely to be spent in pursuit of those tasks. As an example, let's assume that the design activity for a project has a budgeted amount of $100,000 and requires four months to complete. Let's further assume that the major portion of the design work will be completed in the first three months. A time-phased budget for this activity may look like table 2. Now that we have the task and work package information from the WBS and have applied a time-phased budget breakdown, the project baseline can be developed.

Activity	Jan	Feb	Mar	Apr	May-Dec	Total
Design	$20,000	$40,000	$35,000	$5000	0	$100,000

Table 2 — Time-Phased Budget for Design Activity

EVM TERMINOLOGY

The standard EVM terminology, currently in use (with some minor variations), was first devised by the US Department of Defense, and is as follows:

- **PV, planned value**—Comprises of all the relevant costs in the project, or any given part of the project, up to the reporting date.
- **EV, earned value**—The cost of all progress achieved on the project, or part of the project, up to the reporting date, expressed in terms of the costs originally set out in the initial estimate. It represents what has been earned, not simply what has been spent.
- **AC, actual cost of work performed**—The cumulative expenditures on the project, or part of the project, up to the reporting date.
- **CV, cost variance**—Given by (EV – AC).
- **SV, schedule variance**—Given by (EV – PV).
- **CPI, cost performance index**—Given by (EV/AC).
- **SPI, schedule performance index**—Given by (EV/PV).
- **OD, original duration**.
- **ETC, expected time to completion**—Given by (OD/SPI).

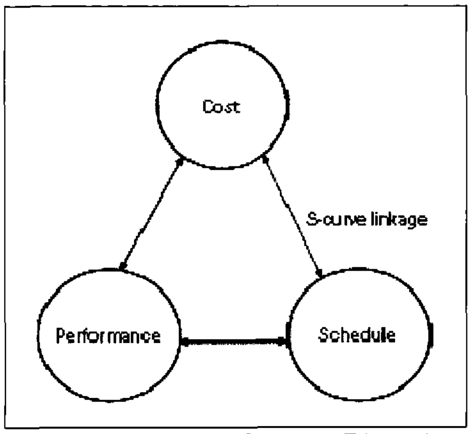


Figure 4 — Project Performance Dimensions Linkage in S-Curve Analysis

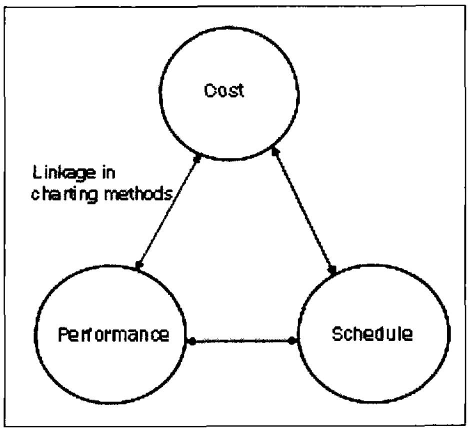


Figure 5 — Project Performance Dimensions Linkage in Charting Methods

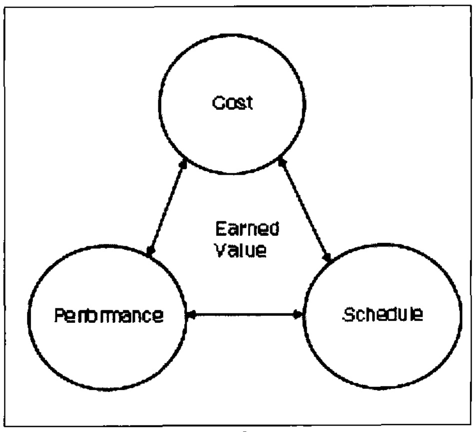


Figure 6 — Project Performance Dimensions Linkage Linkage in EVA

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

- **BAC, budgeted cost at completion**—Represents the total budgeted cost of the project baseline.
- **EAC, estimated cost at completion**—Represents the sum of the costs incurred to date and the revised estimated costs for the work remaining, given by (BAC/CPI).
- **FAC, computed forecasted costs at completion**.
- **VAC, variance at completion**—Given by (BAC – EAC) or (BAC – FAC), indicates expected positive or negative deviation at completion.

RELEVANCY OF EARNED VALUE MANAGEMENT

To illustrate the relevancy of earned value, we'll return to the Project Orion example.

Recall that this project consists of four work packages (prototype design, engineering, assembly, and testing), a budget to completion of $100,000, and an anticipated duration of 50 weeks. (For more information, please refer to table 1, and the associated S-curve in figure 2.)

Assuming that the projected project costs and actual expenditures are the same, we can determine that the project budget is being expended within the stipulated timeframe, as of week 30. However, with some revised information, table 3 shows the actual status of the hypothetical Project Orion. An examination of this table reveals that as of week 30, work packages related to prototype design and engineering have been fully completed, assembly is 50 percent done, and testing hasn't begun. (Percentage values, like those in table 3, can be obtained from the project team or a knowledgeable individual's assessment of the current status of work package completion.)

At this point, the earned value of the project work completed thus far is the critical question that needs to be answered. In other words, from the perspectives of budget, schedule, and performance, what is the status Project Orion, as of week 30?

Based on the information in table 2, the earned value for these work packages can be easily calculated by totaling the product of the planned budget for each work package and its respective percentage completed.

The resulting sum is the earned value to date, for both the work packages and the overall project. For the Project Orion example, earned value (as shown in table 4) at the end of 30 weeks, is $64,000.

The earned value calculated above can now be compared with the planned budget, using the original project budget baseline. The results are shown in figure 7, which provides a more realistic assessment of project status than the S-curve shown in figure 3.

According to the original budget projections, $68,000 should have been spent as of week 30. The earned value analysis, however, is projecting a shortfall of $17,000. In other words, there is a negative variance not only in terms of money spent on the project, but also in terms of the extent of value created (performance) in the project to date.

Specifically, while the $10,000 negative variance shown in figure 3 may or may not be of serious consequence, a $17,000 shortfall in value earned on the project to date, is certainly a cause for concern.

CONDUCTING AN EARNED VALUE ANALYSIS

There are several important steps to be considered when conducting an earned value management analysis, including the following:

Work package	Duration in Weeks: 5	10	15	20	25	30	35	40	45	50	Total	% Completed
Prototype design	6	2	4								12	100
Engineering		4	8	8	8	6					34	100
Assembly				4	20	6	6				36	50
Testing						2	6	4	2	4	18	
Total	6	6	12	12	28	14	12	4	2	4	100	
Cumulative	6	12	24	36	64	78	90	94	96	100	100	

Table 3 — Project Orion's Budgeted Costs (in $000) and Percentage Completed

Work package	Planned budget	Percentage completed	Earned value
Prototype design	12	100	12 * 1 = 12
Engineering	34	100	34 * 1 = 34
Assembly	36	50	36 * 0.5 = 18
Testing	18	0	18 * 0 = 0
Cumulative earned value			64

Table 4— Earned Value Calculations (Values in Thousands $)

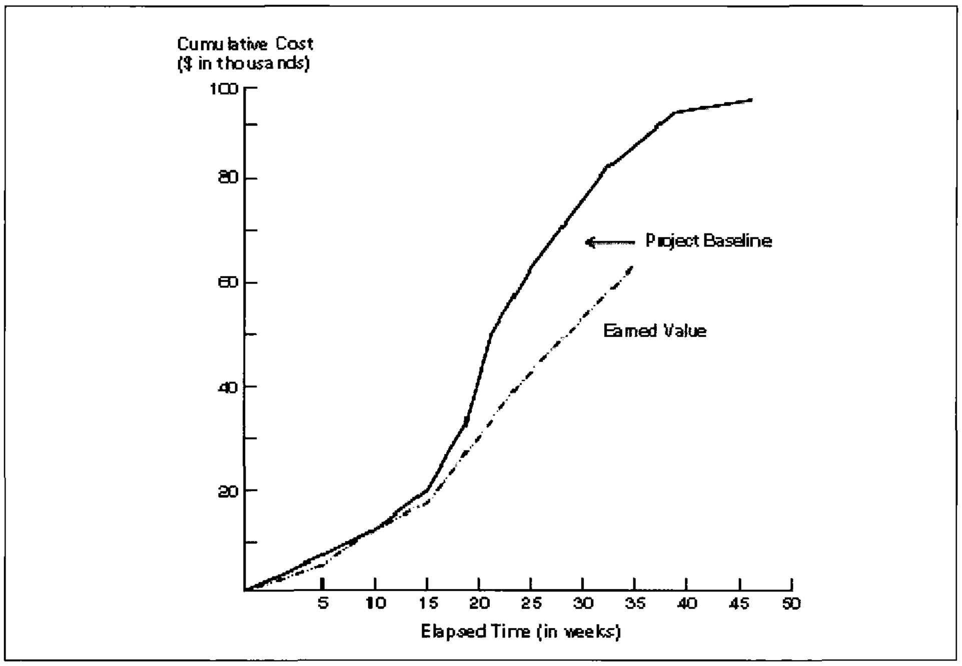


Figure 7— Project Baseline Comparison Using Earned Value

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

- *Clearly define each project activity or task, its resource needs, and a detailed budget for that task*—Using the work breakdown structure, the project team can identify all necessary project tasks and the project resources assigned to that task, including personnel assignments, and costs for equipment and materials. Given these task breakdowns and resource assignments, the budget or cost estimate for each project task can be generated
- *Develop schedules for activity and resource usage*—The purpose of this step is to determine, on a period-by-period basis, the percentage of the total budget allocated to each task throughout the life of the project. The outcome of this process is the establishment of a direct link between the project budget and the project schedule. Specifically, this step provides information on how much of the budget is allocated to each task, along with when the resources will be used during the project development cycle.
- *Develop a "time-phased" budget*—Armed with the information available from the previous step, it is now possible to establish expenditures across the project's life. With this information, we can now determine the planned value, which is the total (cumulative) amount of the budget, and serves as the project baseline. During any stage of the project development cycle, the PV helps to identify the cumulative budget expenditures planned for that stage. The PV in any period is a cumulative value, which is sum of all planned budget expenditures of all preceding time periods.
- *Determine and aggregate the actual costs incurred for each task that is being performed*—The aggregate actual costs of performing a task represent the actual cost of work performed (AC). In addition, we can also calculate the budgeted values for the tasks being performed. This gives us our project's earned value (EV).
- *Compute the cost and schedule variances as the project progresses*—The three key pieces of data collected from the previous steps (PV, AC, and EV) can be used to calculate both the project's cost variance and schedule variance while the project is still in progress. The schedule variance is calculated as the difference between the budgeted cost of the work performed and the budgeted cost of the work scheduled to be performed to date, and is given by SV = EV − PV. The budget, or cost, variance is defined as the difference between the budgeted cost of the work performed and the actual cost of the work performed to date, and is given by CV = EV − AC.

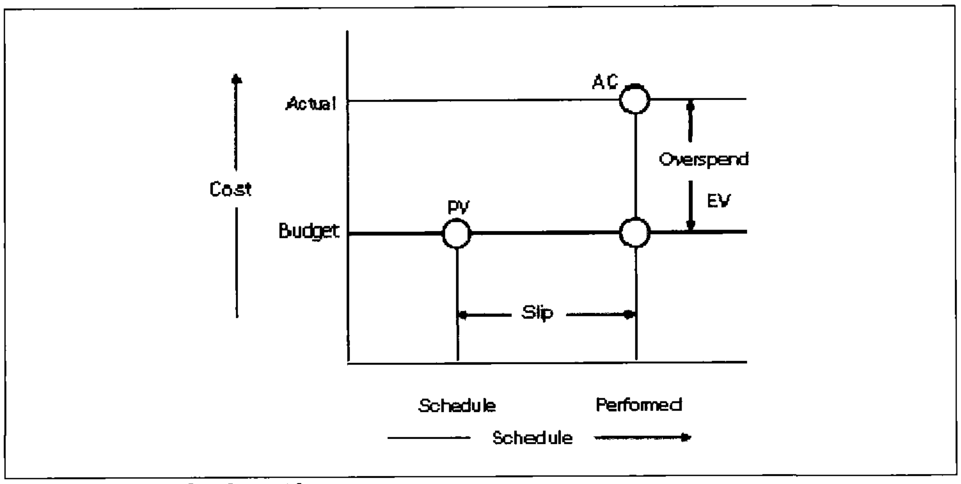


Figure 8— Earned Value Milestones

Figure 8 presents a simple model that integrates the three key components of earned value (PV, AC, and EV).The project baseline (PV), which represents both the schedule and budget for all project tasks, is shown in the bottom left corner of the chart. Any actual schedule deviation from the original PV is attributed to the EV.

Given these earned value figures, which indicate the extent to which project tasks are completed, we can now compute the project's AC, which is the difference between the budgeted and actual costs of the project's activities.

PERFORMING AN EARNED VALUE ASSESSMENT

Table 5 presents the initial components of a calculated EVA on a fictitious project, titled, *"Project Jupiter."* This project, which began in January, has a planned duration of eight months and a $150,000 budget.

We are interested in calculating the earned value of Project Jupiter at the end of July. For purposes of simplicity, we will assume that the project comprises only six work packages. If we know the amount budgeted for each work package and when the work is scheduled for completion, we can begin to construct a budget table like the one shown in Table 5. This table shows that each work package has a fixed budget that runs across several time periods. For example, "Preliminary design" is budgeted to cost $20,000, and will be performed during the months of March and April. "Prototype development" is scheduled to begin in April, has a budgeted amount of $5,000, and concludes in May.

In table 5, we can see the amount budgeted for each work package for each completed month of the project (January through July). In addition, we can see the actual amount spent each month in the bottom four rows.

Although we had planned to spend $40,000 on activities by April, the actual cumulative costs were $45,000. On the surface, it appears that the budget has been overspent—but, as noted earlier, this information is insufficient to arrive at any realistic determination of project status.

What has to be determined is the value earned on the project to date; that is, the number of work packages and the percentage of work completed in each, over the time budgeted to them. The key pieces of information that allow us to identify earned value are included in the three columns at the far right of table 5.

These columns show the planned expenditures for each work package, the percentage of work completed in each, and the calculated "value," which is simply the product of the planned expenditures and the percentage of work completed.

For example, the work package "preliminary design" has a total planned budget of $20,000, across two months. To date, however, only 80 percent of that work package has been completed, resulting in $16,000 in "value."

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

In the same manner, if we sum the numbers in the columns for planned expenditures and actual value (EV), we come up with our project's planned budget ($150,000) and the value realized at the end of July ($65,000).

With the information that we now have in table 5, it is possible to use earned value analysis to determine the project's status. In this table, the planned value (PV) is the cumulative cost at the end of the month of July ($130,000). The earned value (EV) for the project to date, totaling $65,000, is at the bottom of the last right-hand column. The performance measures that are of interest to us are the schedule performance index (SPI) and the estimated time to completion. The SPI is calculated by dividing the EV by the PV, as shown in the calculation appearing in table 6 ($65,000/130,000 = 0.50).

With the SPI, we can now determine the amount of time required to complete the project. Since the SPI is telling us that we are operating at only 50 percent efficiency, we divide the original project duration (OD) by the SPI to determine the projected actual timeframe for completion (8/0.50 = 16 months).

Clearly, as of July, it appears that the project will take an additional nine months; in other words, we are running exactly eight months behind schedule. Now that we have determined that our project is eight months behind schedule, the next step is to use the EVM to make similar projections about the final cost.

The process for computing cost variances is similar to calculating schedule variances, except that the two important pieces of information we need are the actual cost of work performed (AC) and earned value (EV). We already know the earned value figure ($65,000), and we can determine the AC from table 5. This is the cumulative actual cost incurred at the end of July ($118,000).

The cost performance index (CPI) for this project is obtained by dividing the EV by the AC ($65,000/118,000 =0.55). The projected cost is calculated by dividing the original project budget ($150,000) by CPI (0.55) to arrive at the estimated cost to completion of $272,727 ($150,000/0.55). These calculations are presented in table 7.

The disconcerting news is that this project not only is well behind schedule, but is also projected to incur a significant cost overrun. Figure 9 is a graphical representation of these variance values that shows the differences between earned value (EV) and PV and AC. The intriguing result of this example suggests how misleading simple S-curves can be.

For example, in table 5, the difference of $12,000 between the AC ($118,000) and PV ($130,000) at the end of July seems to indicate that we have marginally under spent our budget. However, when viewed from the perspective of earned value ($65,000), the results were much more serious.

This is because of the fact that when we calculated the percentage of completion for all scheduled tasks, the shortfall in earned value revealed that the schedule and cost variances were much more severe.

This example clearly underscores earned value management's superiority for precisely determining actual status—which, as we've shown, is a function of its three component pieces: schedule, budget, and extent of project completion.

MANAGING A PORTFOLIO OF PROJECTS WITH EARNED VALUE MANAGEMENT

Earned value management methodology can be applied to both individual projects and portfolios of projects. With the latter, all of the earned value measures across the firm's entire portfolio of projects are aggregated, with the aggregate earned value figure serving as a measure of the efficiency with which the company is managing its projects.

Table 8 is an example of a portfolio-level EVM control. It presents both positive and negative cost and schedule variances, and, based on these measures, the projected cost to completion of each current project.

Table 8 includes not only information on the total positive variances for both the budget and schedule, but also the relative schedule and cost variances expressed as a percentage of the total project portfolio. For example, the company's portfolio of projects is showing average cost and schedule variances of 6.84 percent and 7.34 percent, respectively.

It is evident from the above analysis that EVM provides a company's top management with an excellent tracking and control tool for monitoring a portfolio of projects. Not only does it provide a measure of a company's ability to efficiently run projects, but it also provides the mechanism to compare all projects currently in development, and facilitates identification of both the positive and negative variances that are incurred.

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Plan	% complete	Value
Staffing	9	6							15	100	15
Preliminary design			8	12					20	80	16
Prototype development				5	10				15	60	9
Testing					5	5			10	60	6
Final design					2	8	15		25	40	10
Construction						5	40		45	20	9
Transfer								20	20	0	0
Total									150		65
Monthly plan	9	6	8	17	17	18	55	20			
Cumulative	9	15	23	40	57	75	130	150			
Monthly actual	9	11	10	15	15	18	40	0			
Cumulative actual	9	20	30	45	60	78	118				

Table 5— Earned Value Table for Project Jupiter

Planned value (PV)		130
Earned value (EV)		65
Schedule performance index (SPI):	EV / PV = 65/130 =	0.50
Estimated time to completion (ETC)	OD / SPI (8/0.50) =	16 months

Table 6— Schedule Variances for EVM

Actual cost of work performed (AC)		118
Earned value (EV)		65
Cost efficiency index	EV/AC =65/118 =	0.55
Estimated cost to completion	BAC/CPI =($150,000/0.55) =	$272,727

Table 7— Cost Variances for EVM

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

IMPORTANT ISSUES IN THE EFFECTIVE USE OF EARNED VALUE MANAGEMENT

Earned value management's effectiveness as a performance metric depends on some important factors. The first, and most important, is the availability of highly accurate, up-to-date information on the percentage of work packages completed, which is vital for determining the earned value at any point in time. The accuracy of the calculated earned value hinges on an honest reporting system, as well as the integrity of the project team members and managers.

In practice, organizations use simple decision rules for assigning completion percentages. The common methods for determining completion values include the following.

- **0/100 rule**—This rule assigns a value of zero to a project activity until it is completed. Once the activity is fully complete, then a 100 percent completion percentage is assigned. This rule is best suited for work packages that have very short durations, because it provides virtually no information on the status of the work package on an ongoing basis.
- **50/50 rule**—This decision rule assigns a 50 percent completion value for any activity that has been started and carries this value until it is completed, at which time the completion value switches to 100 percent. Like the 0/100 rule, this decision rule is most often used for work packages of very short duration.
- **Percentage complete rule**—With this decision rule, the project manager and team members mutually decide upon a set of completion milestones. For example, these predetermined completion milestones may be 25, 50, 75, and 100 percent, or 33, 67, and 100 percent, or any other set of values. Next, the status of each in-process work package in the project is reviewed and updated. Depending on the extent of completion, the work package may or may not be assigned a new completion value, and, on the basis of this new information, the project's EVM is updated.

Project	*PV*	*EV*	*Time var ($)*	*Var (+)*	*AC*	*Cost var ($)*	*Var (+)*	*Plan*	*Est. at completion*
Alpha	91	73	18	18	83	10	10	254	289
Beta	130	135	−5	0	125	−10	0	302	302
Gamma	65	60	5	5	75	15	15	127	159
Delta	25	23	2	2	27	4	4	48	58
Epsilon	84	82	2	2	81	−1	0	180	180
Total	395	373			391				986

Total schedule variance: 27 Total cost variance: 29

Relative schedule variance: 27/395 = 6.84% Relative cost variance: 29/395 = 7.34%

Table 8— Project Portfolio Earned Value (All Figures in Thousands ($))

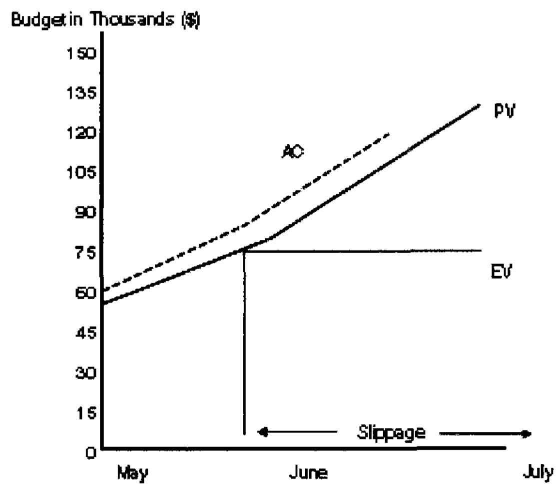


Figure 9— Earned Value Variances

Clearly, the viability and integrity of this process rests on an honest appraisal of the status of ongoing activities in terms of the actual percentage of the activities completed, regardless of the elapsed time or budget spent.

The percentage complete rule can be problematic, primarily because of controversy surrounding the level of detail used in calculating an activity's completion value. The various gradients of completion must be acknowledged and used by all parties; otherwise, using EVM involves the risk of creating misleading information.

In addition, using the percentage completion rule with excessive levels of detail for EVM is essentially meaningless. For example, let's assume that the earned value analysis of a project uses percentage completion values based on five percent increments (e.g., 5, 10, 15, etc.).

From a practical point of view, it is virtually impossible to precisely delineate between five percentage points for most project activities. Consequently, the use of too much detail has the potential to confuse the true status of a project, rather than to clarify it. The only exceptions to this are for projects where there is prior knowledge of the nature of the task, or where it is possible to accurately measure the amount work completed.

In the case of software development projects, for example, where it is possible to judge quite accurately the number of lines of code needed to complete a task, a higher level of detail for task completion percentages can be employed. In these cases, it is also possible to estimate the cost that would be incurred in task completion.

A second issue when establishing accurate or meaningful EVM results is the "human factor" that comes into play when projecting project activity completion. In the interest of looking good for the boss, or because of implicit or even explicit pressure from project managers themselves, the tendency to downplay serious cost problems can arise.

Despite these limitations, EVM is useful for enabling project managers and their teams to gain a better understanding of the "true" nature of project status midstream—specifically from the aspect of cost control.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

The real-time information provided by EVM can be invaluable in gathering the most up-to-date cost information and in developing realistic and meaningful plans for addressing and rectifying any systematic problems associated with project cost management. Ultimately, these cost management benefits stem from disciplined planning and the availability of metrics that show real variances from plan to generate necessary corrective actions.

In the final analysis, project cost control is fraught with many uncertainties. Therefore, it is imperative that top management take the time to periodically review budget and financial information. By using a formal review process, it is possible to prevent projects from going adrift or the escalation of costs without sanctions. A formal financial review process can also mitigate the risk of cost overruns, and ensure that the project stays on course.

At the completion of the project, it is the project manager's responsibility to ensure that all costs are accrued and accounted for, that a financial balance sheet is produced for audit and signature, and that the financial procedures of the company are adhered to.

There are major project management approaches that directly or indirectly aided this article; however the project cost control is a process that cannot be considered as a separate source of knowledge that can be implemented without interfering with other project management processes. ◆

RECOMMENDED READING

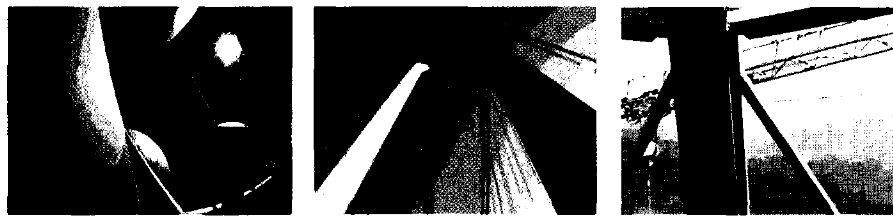
1. **PMBOK: Project Management Body of Knowledge**, PMI.
2. **Skills & Knowledge of Cost Engineering**, AACE International.
3. **Cost Management Terminology and Concepts.**
4. **Project Management - A Systems Approach to Planning, Scheduling, and Controlling**, 8th Edition.
5. **Cost and Value Management in Projects.**

ABOUT THE AUTHOR

Wail Elamin Ahmed Bokhary is with the KFO Company of Abu Dhabi in the United Arab Emirates. He can be contacted by sending e-mail to: wail007@email.com.

SERIOUS ABOUT SURVIVAL?

Whether you call it **COST ESTIMATING** or **PRECONSTRUCTION** - you have to get it right.



If you are a

CONTRACTOR

you can't just rely on the subs, not even the good ones, to deliver a bid. You have to know your costs if you want to survive.

PROPOSAL TEAM

still working with spreadsheets, you're on thin ice. Your competition is using sophisticated parametric tools and up-to-the-minute cost databases.

FACILITY OWNER

'in the ballpark' is no longer good enough. Your forecasts have to be right on target right from the start. The people with the money are not smiling.

For more than 15 years, Eos Group has been partnering with leading contractors, engineering firms, and facility owners to dramatically improve their processes.

Eos Group Solutions Deliver

Higher Efficiency
Lower Variability
Higher Win/Loss Ratio
Lower Risk

www.eosgroup.com

9 of the top 10 ENR Contractors and Designers are Eos Group clients. It's all we do and we're the best in the business.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.