Project Management Using Earned Value

Second Edition

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Preface

This book is about project management. It is not about all aspects of project management but it includes some of the most important aspects. This book is about how the planning, control, and management of projects can be improved through the use of the concept called Earned Value.

This book is intended for anyone who desires to know more about project planning and control and how to improve these processes through the use of Earned Value. Intended readers include project and program managers, project control personnel, project technical personnel, procurement activity personnel and the stakeholders and owners of projects. While it is intended for a wide range of readers, each is assumed to have a basic familiarity with the requirements and the disciplines of project management. Readers new to this arena would be well advised to supplement this reading with a basic but general work on Project Management.

The material in this book as been drawn from the collective experiences of the author and many of the professional personnel of Humphreys & Associates, Inc., consultants in project and program management for over forty years. This material has been presented in seminars, workshops and successfully used assisting our clients in the United States and around the world. While introductory theory is explained, time tested samples are provided. Samples are presented from specific industries. Please do not conclude that a sample does not apply to those of you in the construction, software, or other industries.

To facilitate the learning experience, the topics covered are linked together in a process flowchart. This flowchart is displayed at the beginning of each chapter and the elements of the flowchart addressed in that chapter are highlighted. In addition, the chapters have been grouped into Sections. Each Section represents a major activity in the planning and control process, Organization, Scheduling, Estimating, and Earned Value. These are supplemented by a Section on Implementation (of project planning and control) and by a Conclusion and an Appendix.

To further aid the reader, a series of questions about chapter content are found at the conclusion of each chapter. The answers are provided in the Appendix. In addition, at the end of each Section there is a Section Quiz. Again the answers are provided in the Appendix. Finally, the majority of chapters contain one or more Case Studies. These are practical exercises that have been drawn from our consulting experiences and presented in Humphreys & Associates, Inc. seminars and workshops. The Case Studies have been found to reinforce the participants learning. Suggested solutions to these Case Studies can be found on our website at: www.humphreys-assoc.com.

Chapter 1

PROJECT MANAGEMENT USING EARNED VALUE

Objectives of this Chapter:

1. Define "project" and project management.
2. Describe the performance-oriented approach using an Earned Value Management System and explain why it is superior to actual versus budget comparisons.
3. Discuss factors affecting the appropriate level of detail for Earned Value implementation.
4. Introduce the process flowchart for the Earned Value Project Management process.

What is a Project?

Before delving into the intricacies of the Earned Value Management process, projects and Earned Value Management need to be defined first. A project consists of a defined objective to develop or produce a new product, capability, or to expand capacity within a specified time frame and budget. Examples of projects include large capital-intensive efforts such as highway construction, new commercial buildings, power plants and petrochemical plants, water treatment plants, flood control, dams, bridges, hospitals, schools, prisons, and churches. These are the obvious, highly visible projects.

They are not the only types of projects; however, as new product development is also a project. A new automobile, engine, or communication satellite is a project. Other projects include research and development, definition of new information systems, design and installation of communication systems, creation of new software programs, and computer hardware advances.

Projects are so widespread that it is difficult to get through the day without being involved in some way with a project, whether it is sitting in traffic while road work continues, finding a more efficient information flow for office communication, or managing a home improvement.

The Project Management Institute (PMI) defines a project as:

> *A project is a temporary endeavor undertaken to create a unique product, service, or result. The temporary nature of projects indicates a definite beginning and end. The end is reached when the project's objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or the need for the project no longer exists.*[1]

A well conceived project could also be characterized as any endeavor that has a well-defined scope of work and optimistic yet achievable schedule and cost objectives.

The words "project" and "program" are sometimes used interchangeably in industry, resulting in some confusion. A program is made up of individual projects to be accomplished. For example, the inertial guidance system for an aircraft may be a separate project on a program. Because

1. Project Management Institute. *A Guide to the Project Management Body of Knowledge (PMBOK), Fourth Edition.* Newton Square, PA: Project Management Institute, 2008, 5.

projects and programs share the same characteristics they can be treated in a similar manner. For that reason, throughout this text, the term "project" will be used generically to refer to both projects and programs.

Now that project has been defined, what is Earned Value Management? It is the process of defining and controlling the project so that defined objectives are met. The controlling aspect includes scope control, schedule control, and budget control. It also includes the process of identifying and minimizing risk. There are many aspects involved in Earned Value Management, including development of the Earned Value Management System. An Earned Value Management System is a set of processes and tools used to facilitate the management of a project.

Managing Projects

Many projects result in highly successful completions. Successful projects contain many common characteristics: they were well defined and organized, had a closely monitored work scope, had optimistic yet achievable schedule and budget from the time of initiation, and were closely monitored and managed. Many projects have been successful for another reason: they benefited from mistakes on other projects. The primary factor observed on successfully managed projects is managing performance. The common thread throughout all of the topics in this textbook is exactly that.

The approaches and techniques that will be discussed have a performance measurement orientation, because the better something can be measured, the better it can be managed.

In a performance measurement system, cost and schedule targets are assigned to each activity planned in a project and to the project itself; progress (performance) is measured against these targets. Deviations from the activity targets and the causes of the deviations are identified and action is taken to minimize adverse consequences to the project.

Projects require expertise from many disciplines. Close coordination and communication are essential parts of successful execution of a project. To achieve these, a separate "project team" is typically assembled for accomplishing the project's scope of work. This team is organized using individuals from various disciplines such as accounting, purchasing, engineering, manufacturing, testing, operations, finance, contracts, construction, project controls, and may also include subcontractors. Some people provide part time support to a project. These might include any of those mentioned above and others such as the legal department, record retention, financial services, and executive management.

The job of managing all of these organizations and people is typically assigned to a full time senior individual who is designated as the project manager. A project manager should meet several specific qualifications: many years of experience in the type of project being managed to be technically qualified; a degree to be academically qualified; and stamina to be physically qualified. In addition, project managers must have good processes and tools to effectively manage the people and the project.

The project manager must orchestrate the entire project to achieve the technical, schedule, and cost objectives. If a project is an internal endeavor, then a project manager's role is to manage the internal departmental interfaces and contractors, and possibly other owners and customers, in addition to all of the internal staff.

Unlike normal functional organizations, a project has a specific duration. Even as a project is initiated, its purpose is to accomplish defined objectives and disband. A project team's job is to quickly accomplish the technical scope of work, resource as efficiently as possible, and then move on to the next project. The project manager's job is, therefore, inherently complex and challenging. Besides the interfaces that must be managed on a daily basis, he or she must often be a motivational expert since the many players involved may have different goals. For many reasons, a project manager has a great need for accurate status information. Only with reliable indication of project status can concerns be surfaced early enough to allow corrective action, preventing potential concerns from becoming real concerns that adversely impact technical, schedule, and cost objectives.

Examples used throughout this text are extracted from actual experiences. Frequently it is easier to illustrate a concept by showing what can or will happen if certain fundamentals are ignored than what happens if they are followed. If the principles in this text are followed, there is a good probability of executing a well-managed project. If they are ignored, unpleasant, career-limiting, unsuccessful experiences can occur.

Depending on project risk, project duration, and cost, (technical, schedule, and cost), certain aspects may be implemented less stringently. The principles do not change. It is still necessary to define the scope of work, have a plan for accomplishing the work, and to manage the plan. However, the level of detail of the implementation can vary. Unsuccessful applications of these principles have also happened when organizations went overboard on the level of detail of implementation. If common sense is forgotten, it is possible to create a management system that requires so much effort that it requires and extensive staff just to provide the production and distribution of data. The cost of the management system is then not worth the additional insight received regarding project status.

The Earned Value Management tools that are recommended in this book have been effectively used to improve management on numerous projects. By selectively employing tools, the practitioner will improve management on current and future projects and thus, the prospects for project success.

There are several other topics related to Earned Value Management that are not directly covered. These include contract administration, project administration, and material and subcontract management. These are, however, incorporated within the discussions of related subjects generally performed by these functions.

The contract type has an impact on the extent of Earned Value Management implementation, but all of the basic information is still necessary to ascertain project status regardless of the contracting arrangement. Experience shows that too much attention is placed on the type of contract rather than incorporating all of the information, but at a different level of detail.

The human aspects of Earned Value Management must not be forgotten either. As mentioned before, the project manager needs to be a motivational expert. The project manager also needs a strong supporting staff. No single person can successfully perform all of the work involved in a major project. He or she must rely on the support of many others. This makes the project a team effort. Even the best systems will be less effective in the hands of individuals who do not cooperate with each other and do not work towards a common goal. An underlying assumption is that effective management tools will facilitate better management of a project and minimize the confusion that results from a project that is not well defined and planned.

Background

In the past few decades, many large projects in numerous industries experienced significant schedule delays and cost overruns. Nuclear power projects stretched for years beyond their original schedule and more than tripled in cost. Software development projects in most companies required so much lead-time that the intended users had to find alternative ways of accomplishing their goals. In other cases, competitors beat software development firms to the marketplace and millions of dollars were wasted. Water treatment and sewer treatment plants soared in cost, with immediate impact on the consumer's water bill. Research and development projects and military projects were cancelled because of continually escalating schedule and cost projections. The U.S. auto industry suffered from a perceived lack of quality and unit prices increased. Many of these cases became highly visible to a large number of people.

For the project managers, the owners, and customers of these projects, this was not the objective envisioned in the project plan. How did this happen?

Causes were both internal and external. Scope changes occurred without being recognized and incorporated into a revised plan for accomplishing the work. Customer needs changed, sometimes because of a delay in finishing a product, thus resulting in obsolescence. Delays in mate-

rial delivery occurred without properly reflecting the impact to other work activities. Regulations changed, frequently affecting the time needed to acquire permits or authority to proceed. Lack of coordination between contributing groups meant delays because of missing information, design or otherwise. When these and other disruptions occurred, resulting schedule slippage had large cost impacts because of high rates of escalation. Every delay was penalized with a significant negative economic consequence.

Typically a domino effect is observed. First, a technical problem occurs. This is followed by a negative schedule variance and ultimately a negative cost variance. Sometimes the dominos fall very fast, but problems could evolve over months.

Regardless of the source of difficulty, the underlying problem was that impacts were not recognized quickly enough when conditions changed. In some cases, project managers were ignoring variances from the plan and failing to take action because they did not believe the variances were real. In others, they were not informed well enough about the variances. The situation was much like that shown in Figure 1-1.

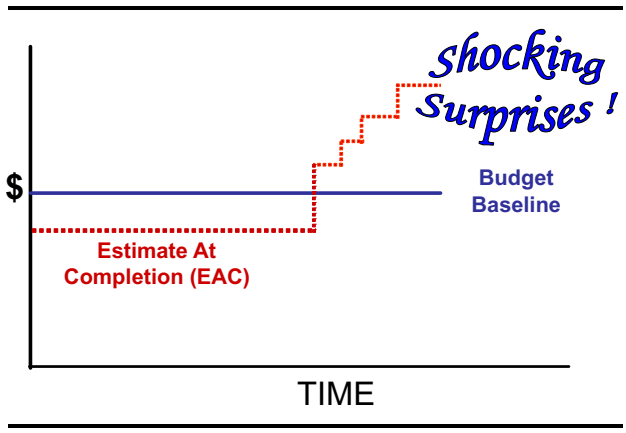

Figure 1-1 Shocking Surprises

In Figure 1-1, the Estimate at Completion (EAC) is below budget throughout most of the life of the project. While challenges were faced daily in the management process, there was no way to quantitatively assess the impact in a timely manner. By the time a schedule slip or an overrun was forecast, it was too late to do anything to minimize its impact. The result was shocking surprises.

This scenario occurred often enough that there was a heightened awareness of the technical, schedule and cost risk associated with projects. Because of this risk, many organizations reacted by creating better management systems. These systems provided the capability of integrating all of the available data into a cohesive form so that better visibility would result. One of the greatest challenges for these systems was timeliness. If information were not available until after the fact, all that would be accomplished from its use was a well documented history of what went wrong rather than an effective tool for management during the life of the project. This improved visibility must allow for earlier identification of trends so that situations like the one pictured in Figure 1-1 can be prevented.

Most projects develop a time phased plan to accomplish the work. This resembles an S-curve shape. In the early stages, staffing and progress may be slow. In the middle part of the curve, both staffing and progress should be at their peak. At the end of the curve, progress slows while actual staffing may still be at peak or near-peak levels. The implications are obvious: identify and address the problems earlier in the project life and there is a much greater chance of avoiding schedule slips and large cost overruns. Early in the project, it takes very few additional resources to accelerate and resolve variant conditions. At the peak of the project activity, it takes enormous resources just to stay even with the progress curve, making catch-up very difficult. Even worse, at the end of a project, even great cost expenditures may do little to accelerate technical and schedule progress. Improved early visibility is a primary objective of any project management system.

The Performance-Oriented Approach

Every company has some sort of tracking system to indicate how it is performing. Unfortunately, in many cases, the tracking may have been no more sophisticated than what is shown in Figure 1-2, Budget Plan versus Actual Cost. This was

the traditional approach used for many years in companies and is still used in too many organizations.

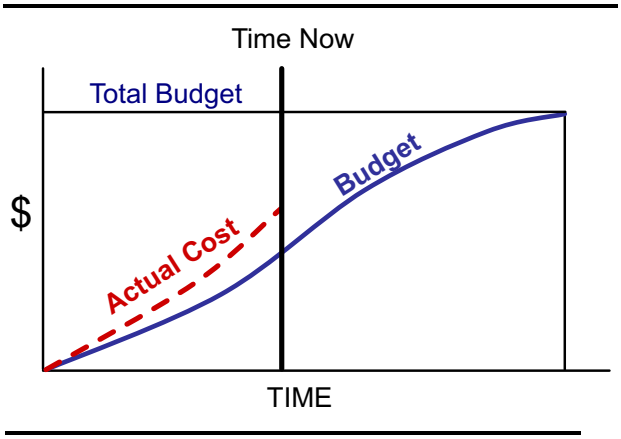

Figure 1-2 Budget Plan vs. Actual Cost

Actual costs are collected and compared with budgeted costs. This is done in the only common denominator available for resources - dollars in the U.S., Canada, and Australia, or the corresponding local currency in other countries. Does this approach provide improved visibility?

A good system must provide status and, therefore, the necessary visibility into progress. The graph shown in Figure 1-2 at least allows comparison of expenditures with what was planned to be spent. However, there is no assurance that project status is known. Actual cost to date is higher than planned, but does that indicate a cost overrun or is the project ahead of schedule? This situation is shown in Figure 1-3.

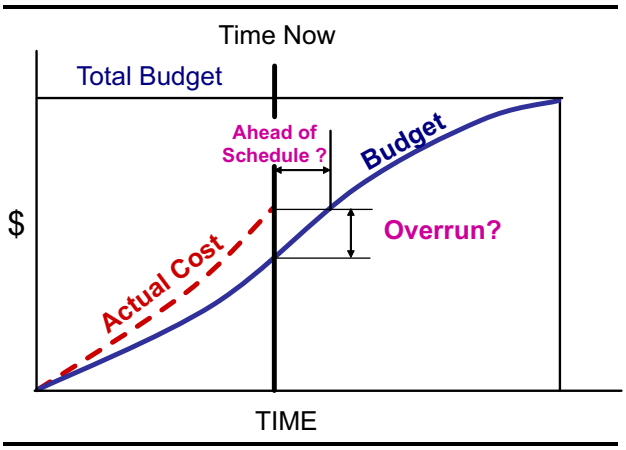

Figure 1-3 Overrun or Ahead of Schedule?

A budget versus actual comparison is shown in Figure 1-4. This may appear to indicate that a cost underrun is occurring. However, there is no basis for projecting what status will be at project completion. It may be that the project is incurring a cost underrun, but it may also be that the project is behind schedule and future expenditures will accelerate significantly. This is shown in Figure 1-5.

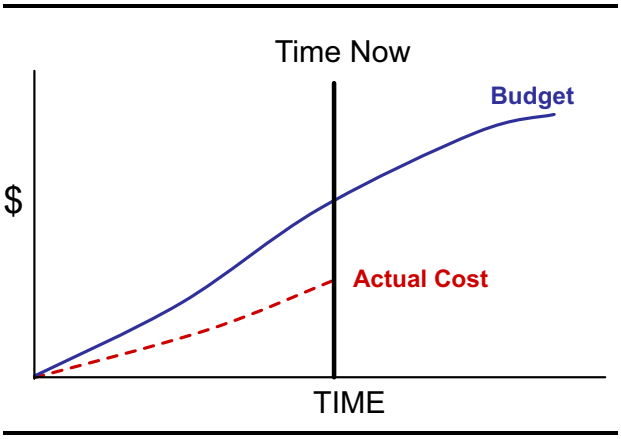

Figure 1-4 Underrun or Behind Schedule?

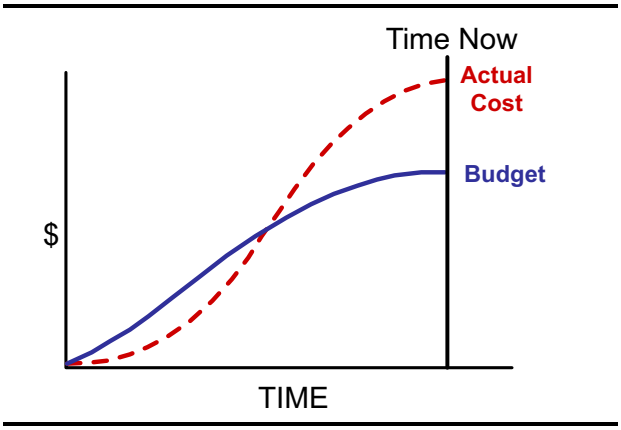

Figure 1-5 Significant Overrun or Accelerated Schedule?

What is missing from the comparison shown in Figures 1-4 and 1-5? There is no measure of what has actually been accomplished for what has been spent. The fact that money was being spent slower than planned could mean that there would be a cost underrun. It could just as easily mean that the project is behind schedule, or both, or neither.

The key to knowing what the true progress and status actually are requires the addition of a third line to the curve that reflects the dollar value for the work that has been completed.

This third line results from a “performance-oriented” approach. This approach shifts the emphasis from expenditures to work accomplishment. The project objective should be to accomplish all of the work rather than to spend all of the money.

When using a performance oriented approach, work scope and associated responsibilities must be defined in the initial planning phase of the project. This is a far better approach than defining responsibility in some form of finger-pointing exercise of guilt determination after a crisis occurs. It allows the person responsible for an emerging variance to take action before it becomes a problem. The entire organization benefits from this approach. If action cannot be taken in time to entirely avoid a problem, at least the impact can be accurately assessed if there were an objective method of measuring progress. By setting variance standards or “thresholds”, the system can be used as a high level Management by Exception indicator. A result is the ability to develop improved forecasts of technical performance, scheduled completion, and final cost earlier in the project. The third line that represents work accomplishment has been added to Figure 1- 6.

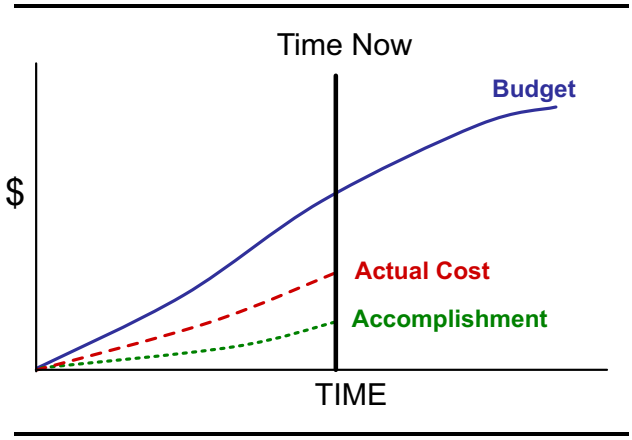

Figure 1-6 A Performance Oriented Approach Provides Better Visibility

Now there is a completely different picture of the project status. This graphic depicts the value of the work scheduled to be accomplished, the value of the work accomplished, and how much the accomplished work actually cost. Actual costs to date are still below the budget line, but the value of work accomplished is even less. In other words, cost is not underrunning, but in fact is overrunning relative to the value of the work accomplished. Similarly, a behind schedule condition is apparent. The various methods for measuring the accomplishment of work will be presented in later chapters of this text, but the important point is that it can be measured and compared with an approved plan.

With this type of information, it is possible to project schedule slippage and cost overrun in early stages of the effort. This early warning feature is one of the most important advantages of including a measure of work accomplished. Figure 1-7 illustrates how these projections might be represented.

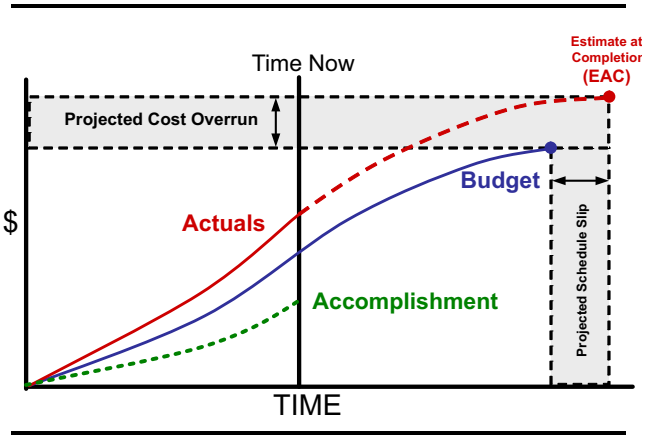

Figure 1-7 Cost and Schedule Impacts

Summary Implementation Concerns

The Earned Value Management process concepts are appropriate in any single project or multi-project environment. On any type of project in any industry, regardless of how small it is, a project must be effectively defined to be effectively accomplished. A project cannot be completed if its scope is not understood. Individuals or organizations must be identified with responsibility for completing the work, and a time frame must be established for accomplishing that work.

Budgets and other resources that are allocated to the project need to be identified. In other words, a plan for accomplishing the work is needed. Then progress must be measured against that plan. When variances are identified, corrective action should be identified, evaluated, and implemented in the most cost effective manner. These are standard techniques that apply in any situation.

Experience shows small, short duration projects are often managed far worse than the large projects that have high visibility. Because small projects are considered less significant towards the overall profit picture, they are sometimes overlooked with very unfavorable results. When small projects ignore basic management concepts, they commonly miss their budgets by 100 to 300 percent. The accumulation of absolute dollars may be more than a large project that misses its budget by 10 percent. The point is that the summation of many poorly managed small projects could exceed the impact of a large project.

A convenient aspect of the performance oriented approach is that it works in all environments including research and development, manufacturing, testing, construction, procurement, software development, and design. It also works on all types of contracts, regardless of whether they are firm fixed price, cost plus, or some other type between these two extremes. However, these factors play an important part in deciding on the level of detailed implementation to be used.

Factors Affecting System Implementation Detail

Among the factors that will impact the selection of project controls for a particular application, are the following:

- Project size and duration.
- Technical, schedule and cost risk.
- Project contract environment.
- Management involvement level.

The size and duration of a project are critical considerations when making key decisions on desired management system characteristics. Because of the complexity of long duration, high cost projects, it is not surprising when it takes six months to develop a detailed plan for accomplishing the project objectives. Smaller projects often do not have a total of six months duration. This does not suggest that the smaller project needs no plan, but rather that it will have a less detailed plan featuring the same general requirements. Similarly, it will not make sense to set up an elaborate monthly reporting scheme with variance analysis reports and corrective action plans since the project will be completed before such a program can even be properly established. Variances still need to be identified and actions taken to correct them, but it will be a far less formal process, probably involving little documentation.

Risk is another important consideration and relates to maturity of the technology involved. If the project were the tenth in a long series of similar products or services, some simple indicators of progress over time may be all that is required. But if it were the development of a new technology, greater detail will be needed for monitoring and managing progress against the goal.

The project contract environment may impact the emphasis of controls. On a firm fixed price contract, cost monitoring and evaluation is typically not emphasized by the customer. However, the contractor will be very cost conscious, since it is responsible for any overruns when this contract type is used. From a customer's perspective, technical and schedule considerations are also very important for firm fixed price contracts with its support contractors, especially on a multiple contractor program as the interfaces between contractors and projects must be managed. Productivity may still be a concern since it will relate to whether the schedule can be met. In a cost reimbursable environment, cost controls are a paramount consideration since the contractor can maximize income by increasing the hours required to complete the work. The level of detail for cost and schedule control systems will vary in detail accordingly.

The level of management involvement is another contributing factor to decisions regarding implementation detail. In many cases, both owner/customer and contractor will have their own systems for determining project status. The contractor

responsible for accomplishing the work will need a detailed system. However, the owner/customer should need a far less involved reporting system and could track progress on a higher level. There are exceptions to this as well. If the owner/customer were hiring the labor for the project and operating in a hands-on management situation, then detailed controls may be needed in the owner's/customer's organization.

Common sense and reason must be used when developing and implementing Earned Value Management Systems. Implementing systems at too low a level of detail and with unnecessary complexity has probably caused nearly as many problems as having no system at all. While that may be a slight exaggeration to make a point, the objective of improved visibility can be clouded just as easily by too much data (and not enough information) as it can by lacking enough input.

Earned Value Management System Recognition

The techniques developed and explained throughout this text were implemented widely only after it became apparent that they were necessary. They have not always been enthusiastically embraced by all project participants for various reasons. Some do not want extra visibility into the status of their work if that same information is in the hands of their boss and/or their customer. Typically, managers prefer to attempt resolution of problems before they are discovered by others. While this is understandable from a human nature standpoint, it is entirely unacceptable from a project manager's viewpoint. If problems are hidden and not satisfactorily resolved, they will later have increasingly substantial impacts to project cost and schedule. It is essential that the project manager has the information and tools to assess status accurately, allowing more rapid, effective management decisions.

The Earned Value Management Process

Successful management of a project involves many concepts and implementation concerns. A project is any endeavor that has a well understood statement of work and optimistic, yet achievable, schedule and cost targets. An Earned Value Management System is a tool set used to facilitate management of a project. There are many considerations in this complex discipline. A series of flowcharts are used throughout the text to exhibit how the various chapters interrelate.

The master flowchart is shown in Figure 1-8, "Earned Value Project Management: The Process". This chart is repeated at the beginning of each chapter to show where that chapter fits in the overall process. Individual blocks will be expanded as necessary into lower level, more detailed flowcharts for the more involved topics. This will help assure that a proper understanding of each concept is achieved.

The fundamental concept of this entire book is that the Earned Value Management process should be logical, well-defined, and integrate all of the pertinent information relating to a project's status into a comprehensive picture. Every organization implements many of the concepts; few of them integrate those concepts into a unified status. That is the primary challenge: to use all of the tools in the tool box in a coordinated manner so that they meet the objective of improved project visibility, allowing earlier management decisions based on accurate information. This provides a project manager the best opportunity to meet project schedule and cost objectives while achieving the technical requirements.

The following is an overview of the process steps in Figure 1-8.

The Process Steps

Step 1 – Project Objectives

The first step in the process is definition of the project objectives. These objectives include a general description of the technical requirements of the project, its budget, and the time frame for the work to be completed. A targeted starting date and a completion date are included in this description. There may even be some guidance provided as to whether this is a technical, schedule and/or cost critical project. These can be critical pieces of information: as an example, at one

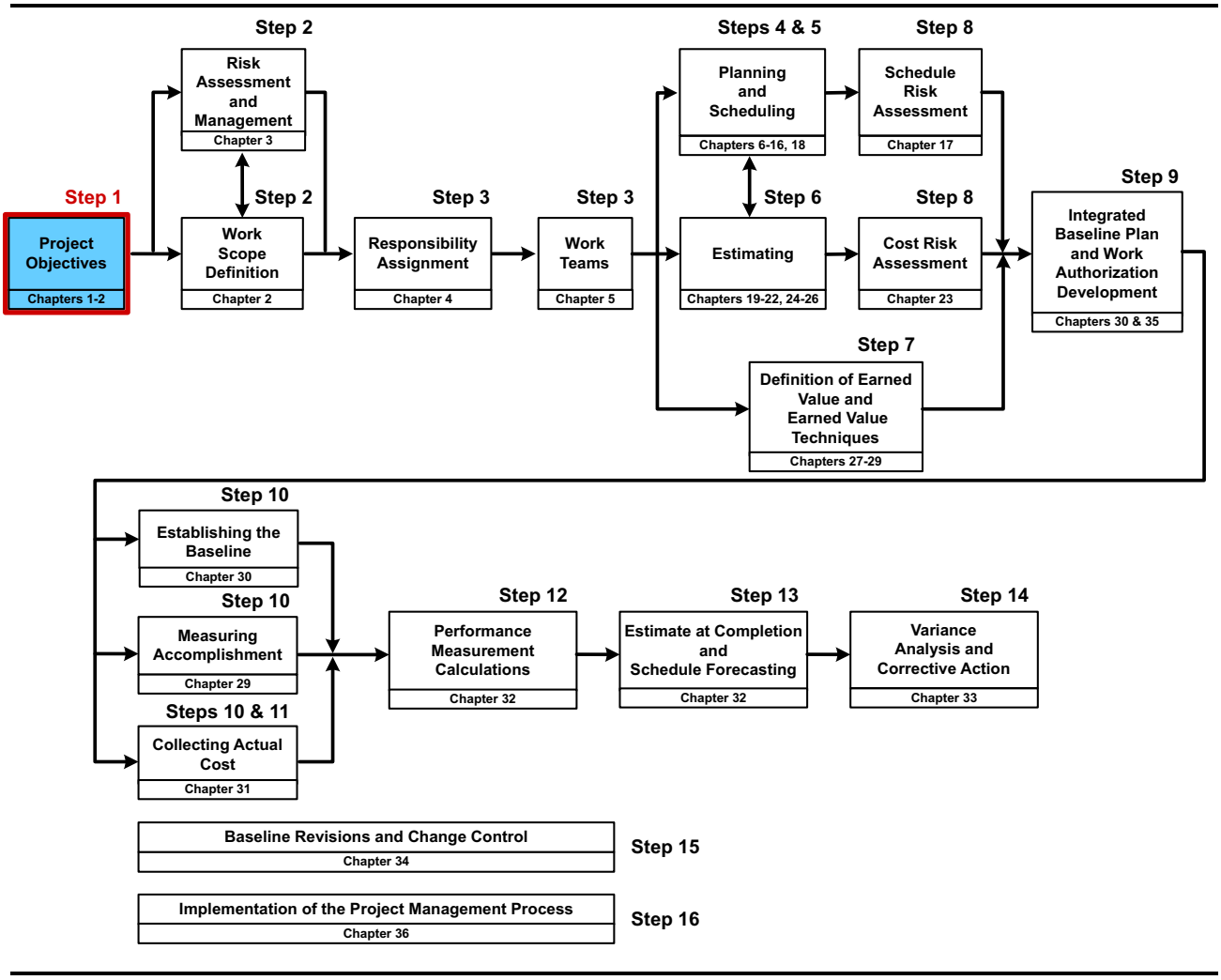

Figure 1-8 Earned Value Project Management: The Process

of the major auto manufacturers a project to design a new bumper system was being initiated. The time for this product to reach the market was critical, with a goal of eight and a half months. However, the contractor's project manager assumed that the project was more cost critical than schedule critical. This resulted in the project plan being stretched to 18 months to lower the peak cost requirements.

When the owners and customers reviewed the contractor's plan, they realized that the primary objectives had not been explained clearly enough. The contractor was sent back to completely redo the plan to support the eight and a half-month requirement. If this project had been managed to the 18-month plan, it would have lost much of its commercial appeal.

The project plan is the set of documentation and directives that formalize the entire management process described in this text, including project objectives, general scope, project organization, desired schedule/cost goals, and a description of management systems and procedures to be used in completing the project. The project plan reflects the project specific internal as well as customer management, reporting, and analysis requirements. The approach used to code and organize the project data is an important up front activity to establish a standard approach to integrate the technical, schedule, cost, and risk data to generate reliable information for effective management, reporting, and analysis for the life of the project.

Step 2 – Work Scope Definition, Risk Assessment and Management

Once the project objectives have been defined, the next function that must be fulfilled is to delineate, capture, and define the entire scope of the project. This is the best opportunity to assure understanding among the various project participants. It also is the best chance to avoid later nightmares with numerous scope changes and possible litigation. The work breakdown structure (WBS) and work breakdown structure dictionary are the tools used to segregate the work into manageable components and to define each component.

A risk assessment of the technical goals is an important part of this process. Risks are identified and mitigation plans are developed. After the organization is assigned in Step 3, additional risks may be identified and the risk plans updated.

Step 3 – Responsibility Assignment, Work Teams

Once the scope is crisply defined, the next step is to document who is responsible for the work. Each component of work defined in the work breakdown structure will have one individual assigned who will be responsible for the scope, schedule and budget for that work.

It takes an entire project team working together to make the project a success, but only a single individual to cause it to fail. This explains some of the reason for the growing popularity of work teams that help break down the traditional barriers between functional work areas (i.e. departments which can also include subcontractors) and encourage a team spirit.

Work teams are composed of the functional elements necessary to develop or produce the end product. This work team structure has advantages in that fewer management accounts are needed, there is improved communication and efficiency, and potential risks often are surfaced earlier.

Step 4 – Planning

Once the work definition and organizational concerns have been addressed, the particulars of the Earned Value Management process must be developed. These include the functions of scheduling, estimating, budgeting, and performance measurement. These elements must all be performed and integrated for the baseline plan to be developed.

Step 5 – Planning and Scheduling

The scheduling process is defined as what must be done, and when it must be done, to accomplish the project objectives on time.

Step 6 – Estimating

The estimating process is defined as a forecast of how much it will cost to perform the work.

Step 7 – Definition of Earned Value and Earned Value Techniques

Determining performance measurement is accomplished through the use of Earned Value techniques, which is the key concept of the entire Earned Value Management process. While this definition has been given earlier, it is important enough to repeat here. It provides a critical element of information when project status is assessed by providing insight to what has actually been accomplished for the money that has been spent. This can also be compared with what was planned to be accomplished to allow an accurate picture of the current cost and schedule position.

Earned Value is determined through numerous techniques. The techniques selected for a project will depend on each application, but objective guidelines are available to help the selection process.

Step 8 – Schedule and Cost Risk Assessment

A topic of growing importance is that of risk assessment. This Earned Value Management process includes three components: technical risk, schedule risk, and cost risk. Each of these has its own considerations and impacts. Like the overall Earned Value Management process, these are also interrelated. There has been some tendency over the years for managers to ignore the possibilities of identifying and especially quantifying risk because the results may be disconcerting. However, ignoring risk does not

lessen its impact, and will most likely increase its effects. As profit margins become slimmer in a highly competitive environment, the topic of risk assessment must be addressed.

Step 9 – Integrated Baseline Plan and Work Authorization Development

Next we come to the center of the flowchart for a concept that is central to the overall process: performance measurement baseline development. The performance measurement baseline is the official, documented plan that shows in detail how the project objectives are to be achieved. All of the activities described thus far and the processes displayed on the Figure 1-8 flowchart are needed to achieve a well-planned performance measurement baseline. At the completion of this step, the technical, schedule, and budget baselines have been established and integrated; the schedule reflects the time frame where all of the detailed work scope is planned to be performed and the budgets are time phased based on the schedule requirements. The work is authorized to the responsible manager and the technical work commences.

Subcontract management is a critical element for many projects. The subcontractor's technical, schedule, and budget baseline must be integrated with the prime contractor baseline. Since the integrated baseline must include this element, a separate chapter on subcontract management (Chapter 35), is included in this step.

Step 10 – Establishing the Baseline Plan, Measuring Progress

At this point, there is a shift from the planning phase of baseline establishment to the control phase of the Earned Value Management process. Once the performance measurement baseline has been established, the main concern from that point on is the determination of progress. Progress is measured using the same earned value techniques that were established as part of the planning process. The techniques used when the performance measurement baseline (PMB) was established must be applied consistently when progress is determined. Progress is compared with the plan, and this comparison, in turn, provides the schedule variance.

Step 11 – Collecting Actual Costs

All projects will have a system for collection of actual costs. Regardless of how unsophisticated a system may be this component must be included. The challenge in this area is to define account structures that can be used for consistently comparing budgets, actuals, and performance. This could mean modification to existing accounting structures. Actual costs are necessary so that they can be compared with progress, and this comparison, in turn, provides the cost variance.

Step 12 – Performance Measurement Calculations

After progress is measured against the plan and the actual cost is entered, the three points necessary for data analyses are available. There are many calculations that aid in assessing the project status and assist the manager in targeting problem areas for corrective action. These calculations also assist in the Estimate at Completion and Variance Analysis reporting.

Step 13 – Estimate at Completion and Schedule Forecasting

Organizations are very concerned with bottom line performance. One of the essential pieces of corollary information needed to evaluate an ongoing project is, "When is it going to finish and what is it finally going to cost?" This answer will be used for many purposes, ranging from reward of project participants with better positions on new projects to project cancellation. The "Estimate at Completion" is so important that it can become a highly political number. A well-defined Earned Value Management System will have objective means of determining and evaluating estimates at completion to improve their accuracy even in the early stages of a project. This can only be achieved with defined performance factors that provide an accurate picture of what has happened to date and what is forecast to happen.

Step 14 – Variance Analysis and Corrective Action

Variance analysis and corrective action are very important to the overall process. Much time and effort are invested in baseline establishment, and

now the baseline information can be used as a basis for determining the course of the project. The tools defined in the previous two Steps directly feed variance analysis and corrective action. By comparing earned value to budget, schedule variances can be determined. By comparing earned value to actual cost, cost variances can be determined. The second element, corrective action, is a critical part of the control phase. At this point in the process, there is a strong basis for determining the project's true position versus the approved plan so that exceptions can be addressed. The carefully defined system will provide immediate feedback as to whether the corrective action was successful.

Step 15 – Baseline Revisions and Change Control

An essential aspect of the Earned Value Management process is managing change. After all of the effort that goes into developing the baseline plan and determining current status, it is always a disruption to change that plan. Nevertheless, changes are a part of every project and must be addressed as to how they will be reviewed, approved, and incorporated into the plan. Procedures are required to manage the change control process or, over time, the project's reports will relate less and less to the current scope, schedule, and budget as well as the true status. One guideline stipulates that as much attention is needed for processing baseline changes as was used in developing the original baseline plan.

Step 16 – Implementation of the Project Management Process

Now that the system design is complete, there are still some ways to streamline the information flow. These include topics such as paperless systems and electronic data integration. There are also programs available for automating much of the data reduction and analysis, with built-in sanity checks to catch obvious errors. These topics are discussed in the final chapter of this book.

Conclusion

A project is any endeavor that has a scope of work and optimistic yet achievable schedule and cost targets. A project is typically managed by a single individual known as a project manager, who must be able to coordinate a multi-functional team towards the achievement of all of the project objectives. One of the greatest needs of the project manager is accurate, reliable, and timely information to enable effective management decisions. The information needs to include a valid assessment of project progress and status. Projects were historically monitored by comparing planned expenditures against actual expenditures.

This approach lacks the most important element of status: a measure of work accomplished. This shortcoming can be overcome by including a third data element that determines an objective value of work completed. This is known as the performance oriented approach. The performance oriented approach allows early identification of trends that indicate if a project's objectives are in jeopardy. This "early warning system" allows a timely response on the part of management to mitigate unfavorable outcomes by making informed decisions.

It is important that the tradeoff between adequate project status visibility and excessive data collection be recognized and addressed. This is accomplished by setting an appropriate level of detail in the implementation process. Factors that affect level of detail include project size and duration, risk (technical, schedule and cost), type of contract, and desired level of management involvement.

The entire process of managing projects must be a logical one. Each of the steps of the Earned Value Management process is illustrated by the flowchart in Figure 1-8 and will be discussed in detail in subsequent chapters.

Chapter 1 Review Questions

1-1. Explain the difference between a project and a program.

1-2. What aspects of a project are managed during the controlling phase of Earned Value Management?

1-3. How is a project organized differently from a functional organization?

1-4. What are some frequent causes of project delays?

1-5. Why is a comparison of actual costs to date versus budgeted costs not adequate from an Earned Value Management standpoint?

1-6. List at least three factors that will affect the level of detail appropriate for implementation of earned value on a project.

True or False

1-7. The Earned Value Management process is only applicable for large projects.

1-8. The fact that more money has been spent at a point in time than was planned to be spent means that an overrun in final cost is indicated.

1-9. A program may be made up of multiple projects.

1-10. Performance measurement can be successfully applied in engineering, construction, manufacturing, and software development applications, among others.

1-11. Using a measure of performance allows earlier indication of potential increases in final cost.

1-12. From the customer's viewpoint, a firm fixed price contract suggests the need for tight cost controls.

The answers to these questions can be found in Section 6, Solutions.

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About the Author

Mr. Gary C. Humphreys has over 35 years of program management experience in both government and commercial environments, specializing in earned value management systems (EVMS) design, development, and implementation. He was the first US Army Team Director to conduct an EVMS Tri-Service Demonstration. As both a Team Member and Team Director, he has assisted, evaluated, and directed review teams leading to successful system acceptance.

He has developed a successful consulting practice operating out of Orange, California. As the premier consultant in this field he has provided assistance in all phases of project management to over 800 clients from aerospace firms to utility companies, England's Inland Revenue Service (IRS), and Shipbuilding companies in North America, Australia, and Europe. Within the industry, no one has performed more on-site earned value cost/schedule performance work.

He was elected to the Nine Man Committee for Increasing the Cost Effectiveness of earned value and led the Fifteen Man Industry Committee to modify traditional documentation and interpretation of earned value to be more compatible with efficient, economical production management control techniques. As a member of the Integrated Program Management Initiative Joint Team, Mr. Humphreys received the DOD's highest acquisition award, the 1998 David Packard Excellence in Acquisition Award. He is also a recipient of the Whitey H. Driessnack Award for Outstanding Contributions to the Advancement of Performance Management.

He has served as Vice-Chair and Chair of the National Defense Industrial Association (NDIA) Program Management Systems Subcommittee (PMSC). As a direct result of his tenure as Chair, he took a fledgling committee and developed it into an influential, policy impacting committee with membership growing to over one hundred people. He was also instrumental in opening the lines of communication between the DOD's Performance Measurement Joint Executive Group (PMJEG) and industry by establishing the first dialogue interchange meetings between the two groups. It was through the NDIA PMSC that he orchestrated the first ever survey on EVMS. As a direct result of this survey's findings, the US Government conducted their own survey. These two independent surveys formed the genesis for subsequent revisions to numerous guides and reference material on EVMS.

Under his leadership, the Performance Management Association (PMA) (now the Project Management Institute's College of Performance Management) achieved importance as a policy-influencing group. He initiated international Chapters in Australia and new US Chapters. He served as leader of the Total Quality Management (TQM) Process Action Team (PAT) for streamlining business system descriptions for performance measurement and management applications.

He has been a guest and keynote speaker on a variety of performance measurement related subjects at the Air Force Institute of Technology (AFIT), Association for the Advancement of Cost Engineering International (AACE International), Certified Public Accountants (CPA) Government Contracts Conference, Defense Acquisition University (DAU), National Computer Conference (NCC) of American Federation of Information Processing Societies (AFIPS), PMI, CPM National and International Chapter meetings, and numerous software user groups.

Mr. Humphreys is a graduate of the University of California at Berkeley, with a Masters Degree in Business Administration from the University of Southern California.

He authored the first edition of *Project Management Using Earned Value* published in 2002. He was a co-author of *Project and Production Scheduling*, published in 1987. He has also written numerous articles on subjects related to project management and earned value.