Project Management in Government: An Introduction to Earned Value Management (EVM)

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FOREWORD

Jonathan D. Breul

Michael Lee

On behalf of the IBM Center for The Business of Government, we are pleased to present this report, "Project Management in Government: An Introduction to Earned Value Management (EVM)," by Young Hoon Kwak, The George Washington University, and Frank T. Anbari, Drexel University.

Management of government projects, programs, and portfolios—and the related expenditures of public funds—are major, visible areas of interest and concern. Emphasis on performance improvement in government continues to increase steadily, supported by mandates imposed by government laws and public pressure. Despite a growing understanding of the determinants of success, increasing maturity, and a stream of successful programs and projects, project failures continue at an alarming rate.

Earned Value Management (EVM) is a powerful methodology that gives the executive, program manager, project manager, and other stakeholders the ability to visualize a project's status at various points during the project life cycle and consequently manage projects, programs, and portfolios more effectively. EVM helps provide objective project assessments when applied appropriately, and clearly quantifies the opportunities to maintain control over cost, schedule, and specifications of various types of projects. EVM helps managers in making evidence-based decisions about project scope, resources, and risks; hence, it allows effective control and project oversight.

The National Aeronautics and Space Administration (NASA) has been one of the pioneers in the U.S. government in using project management principles, tools, and techniques, and consistently demonstrates the effective application of EVM to the oversight and management of its many projects and programs. This report describes how NASA applies EVM principles to accomplish agency objectives, strategies, and missions. By using EVM, NASA also complies with relevant federal government regulations that require continuous monitoring and control of projects and programs.

We trust that this report will be helpful to federal government agencies, other public organizations, government contractors, and private sector organizations in adapting EVM principles to enhance the management and success of their projects, programs, and portfolios.

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EXECUTIVE SUMMARY

The goal of this report is to investigate the practices and trends of the Earned Value Management (EVM) method, and seek opportunities and suggestions for wider implementation of EVM in government for objectively measuring project performance and progress. This report explores the full range of technical, financial, managerial, and organizational effects of applying EVM principles, thereby contributing to knowledge and practice in this area.

The report particularly focuses on identifying key success factors for implementing EVM in government programs and projects. The key success factors have been determined through examination of EVM adoption and implementation at the National Aeronautics and Space Administration (NASA), which has been using EVM extensively in the management of its projects and programs.

EVM is a management methodology for integrating the oversight of the scope, schedule, and cost of projects, and for objectively measuring project progress and performance. EVM is a powerful methodology that gives the manager the ability to visualize a project's status at various points during the project life cycle and consequently manage projects, programs, and portfolios more effectively. EVM helps provide objective project assessments when applied appropriately, and clearly quantifies the opportunities to maintain control over the cost and schedule aspects of various types of projects. EVM gives managers greater confidence in making evidence-based decisions about project scope, schedule, cost, resources, and risks; hence, it allows more effective control and project oversight.

NASA is one of the leading federal agencies in the U.S. government applying project management principles consistently by implementing the use of EVM. Its mandated use through detailed, specifically delineated organizational protocols; the commitment of resources to assist in the implementation of EVM use; the standardized data analysis capabilities; and formalized reporting requirements—as well as providing the training needed to ensure meaningful use of EVM across the agency—all clearly show how NASA is committed to incorporating EVM into its management processes. NASA adopts and applies sound project management processes in initiating, planning, executing, monitoring, controlling, and closing its programs and projects, within which the comprehensive incorporation and use of EVM techniques is one small, yet critical aspect.

This report provides an introduction to EVM and explores current EVM practices at NASA to identify emerging performance management techniques and suggest recommendations to improve current EVM practices for government programs and projects. Findings of this research are expected to contribute to the management for performance of future projects and to encourage the project management community to review, rethink, and advance the application of EVM.

The report demonstrates that EVM is a powerful, unique methodology for managing project performance and oversight. It shows that NASA is a project-driven organization that is applying project management to all its dynamic endeavors, and applying EVM effectively to enhance the success of its projects and programs. NASA complies with relevant federal government regulations that require the use of monitoring and control tools in projects and programs. The study demonstrates that NASA receives substantial value from its implementation of EVM, promotes consistent practices across the agency, and provides effective training for all staff members involved in project management processes. This agency-wide training curriculum includes courses on leadership, scheduling, EVM, and data analysis.

NASA developed an *EVM Implementation Handbook* that provides clear definitions of requirements, responsibilities, and detailed instructions for EVM implementation procedures and processes. It serves as a guideline for EVM implementation and addresses pre- and post-contract award procedures. The process by which NASA uses EVM includes an integrated baseline review, a schedule health assessment, an integrated information system, and an automated data analysis system. The directives that NASA uses are adopted with flexibility, depending on the size and complexity of specific projects. The expectation is that project managers will remain within the established NASA framework, but that determinations must be made to understand the context of the mission and how to best be successful within that context.

Introduction

Background and Purpose of the Report

The goal of this report is to investigate the practices and trends of the Earned Value Management (EVM) method, and seek opportunities and suggestions for wider implementation of EVM in government for objectively measuring project performance and progress. This report explores the full range of technical, financial, managerial, and organizational effects of applying EVM principles, contributing to knowledge and practice in this area. The research particularly focuses on identifying key success factors for implementing EVM in government programs and projects. This is addressed through extensive literature reviews, data analysis, detailed interviews, and discussions with EVM experts and practitioners at the National Aeronautics and Space Administration (NASA), which has used EVM successfully.

The emphasis on performance improvement in government continues to increase steadily, supported by mandates imposed by government laws and public pressure. Management of government projects, programs, and portfolios—and the related expenditures of public funds—are major, visible areas of concern (Lipke & Henderson, 2006). Despite a growing understanding of the determinants of success, increasing maturity, and a stream of successful programs and projects, project failures continue at an alarming rate (Anbari, 2003; Anbari & Kwak, 2004).

Key Legislation and Regulations Related to EVM

Title V of the Federal Acquisition Streamlining Act (FASA; U.S. Congress, 1994) requires that agency heads must define and approve the cost, performance, and schedule goals for major acquisitions and achieve, on average, 90 percent of the cost, performance, and schedule goals established.

The Clinger-Cohen Act (U.S. Congress, 1996) requires the Director of the Office of Management and Budget (OMB) to develop, as part of the budget process, a process—for analyzing, tracking, and evaluating the risks and results of all major capital investments for information systems—that encompasses the entire life of each system.

The OMB Circular A-11, Part 7 – Planning, Budgeting, Acquisition and Management of Capital Assets (OMB, 2008) and **the Capital Programming Guide** (OMB, 2006) were written to meet the requirements of FASA and the Clinger-Cohen Act. These documents set the policy, budget justifications, and reporting requirements that apply to all agencies of the executive branch of government that are subject to executive branch review. They addresses capital acquisition, require the use of EVM consistent with the American National Standards Institute ANSI/EIA 748 (ANSI, 2007) for both government and contractor work, and are the genesis for the EVM system (EVMS) requirements for the Federal Acquisition Regulation.

Why Is Project Management Needed in Government?

There are visible examples of failure in major public programs and projects. *Analytical Perspectives, Budget of the United States Government, Fiscal Year 2008* (OMB, 2008) points out that, of the 840 major information technology (IT) investments (about $65 billion) in the U.S. federal IT portfolio in fiscal year (FY) 2008, there were 346 major IT investments (about $27 billion) that were not well planned and managed, reflecting investments on the Management Watch List as well as those rated “Unacceptable.” It further states: "346 of 840 projects valued at $9.9 billion are on the 'Management Watch List.' These projects still need to address performance measures, implementation of Earned Value Management (EVM), security or other issues before obligating funding in FY 2008" (p. 153).

Unfortunately, these project failures are becoming generally expected and even accepted. Project and program failures deprive the sponsoring organization and the public from the anticipated benefits of the projects selected for deploying organizational strategy, and divert resources and funds from what might have been more promising endeavors. This ultimately weakens the society's competitive position, well-being, and security (Anbari, 2005).

EVM is a management methodology for integrating scope, schedule, and resources, and for objectively measuring project performance and progress (Anbari, 2003; Project Management Institute, 2008). Historically started as Cost/Schedule Control System Criteria (C/SCSC) by the U.S. Department of Defense in the 1960s, it is now mandated for many U.S. government programs and projects (Christensen, 1994; Abba, 1997, 2001; Kim et al., 2003).

The interest in and demand for applying and implementing EVM has increased in recent years in agencies where organizations and auditors are required to report on the adequacy of the organization's internal control over financial reporting (Fleming & Koppelman, 2003, 2004). EVM best practices being learned from the successful implementation of EVM in organizations such as NASA, as well as an increased understanding of the root causes of project oversight failure, have provided important insights into successfully managing for performance and results of government programs and projects.

The legislation, governing regulations, policies, standards, and guidance documents driving the use of project management and the implementation of EVMS in the U.S. government are presented in Appendix II.

Research Approach

This report explores current EVM practices at NASA in order to identify emerging performance measurement trends, seek improvements, and suggest recommendations for applying EVM practice to other government programs and projects (Henderson, 2003, 2004, 2005). The report includes a general description of EVM, explores current EVM practices at NASA, and summarizes results from interviews of leading EVM researchers and practitioners to examine the challenges and opportunities of implementing EVM. Findings of this research will contribute to the management for performance of future projects and encourage the project management community to review, rethink, and advance the application of EVM.

This report focuses on identifying key success factors in the performance measurement of government programs and projects. This is addressed through detailed interviews and discussions with leaders and experts in government programs and projects, and through a review of appropriate data provided by NASA. The research addresses the application of these success factors in current and future government programs and projects.

The research team conducted extensive literature reviews to collect, categorize, and compare EVM research to date, and had access to NASA's EVM practices, project performance data, and personnel. The study team conducted interviews with EVM researchers and practitioners to discuss and identify the challenges and opportunities of EVM implementation in the government sector.

Data Analysis

The analyses of literature provided theoretical, conceptual, and practical background of the EVM method, practices, and principles—and helped to identify future research needs. The analyses of EVM practices at NASA provided an overview of current EVM applications within NASA and in the U.S. government, in general.

The analyses of interviews with EVM experts identified trends, challenges, opportunities, and future directions of EVM and its impact on project performance management. The research team incorporated all of the reviews, interviews, surveys, and analyses to provide recommendations, highlight opportunities, and suggest strategies for advancing EVM use in government programs and projects.

Research Questions

This report explores the following questions related to EVM applications in government projects:

- What are EVM principles?
- How is EVM applied and implemented at NASA?
- What are the challenges and lessons learned from adopting and implementing EVM at NASA?
- What are the key success factors for successful EVM implementation?
- What improvements to current EVM standards might make them more applicable to government programs and projects?

What Is Earned Value Management?

Historical Background

Earned Value Management (EVM) is a critical project management methodology for measuring financial and project performance. A basic form of EVM can be traced back to industrial engineers on the factory floor in the late 1800s (Fleming & Koppelman, 2003, 2005; Kim et al., 2003). In 1967, EVM was introduced by the U.S. federal government as an integral part of the Cost/Schedule Control System Criteria (C/SCSC) to understand the financial aspects of programs and to be used in large acquisition programs in an attempt to establish a consistent methodology based on best practices. The method, variations, or parts of it have been used under several names such as Earned Value Project Management, Earned Value Method, Earned Value Analysis, and Cost/Schedule Summary Report.

To encourage wider use of EVM, the federal government decided to discard C/SCSC by the end of 1996 and turned toward a more flexible EVM System (EVMS). The American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA) published guidelines for EVMS initially in 1998. The Project Management Institute's (PMI®) *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* provided the basic terminology and formulas of EVM. The terminology was simplified and more details on EVM were provided starting in 2000 and in subsequent editions of the *PMBOK® Guide* (PMI, 2008) and in a separate Practice Standard (PMI, 2005b). Use of EVM in private industry, publications focused on EVM, and support by popular project management software packages have increased interest in EVM in recent years (Humphreys, 2002; Anbari, 2003; Fleming & Koppelman, 2005; PMI, 2005b; Antvik & Philipson, 2009).

EVMS guidance developed by ANSI/EIA identifies 32 criteria that reliable EVM systems should have. These criteria are organized into the following five categories:

- **Organization:** Activities that define the scope of the effort and assign responsibilities for the work
- **Planning and Budgeting:** Activities for planning, scheduling, budgeting, and authorizing the work
- **Accounting:** Activities to accumulate the costs of work and material needed to complete the work
- **Analysis:** Activities to compare budgeted, performed, and actual costs; analyze variances; and develop estimates of final costs
- **Revisions and Data Maintenance:** Activities to incorporate internal and external changes to the scheduled, budgeted, and authorized work

These five categories address specific areas in which to effectively manage large, complex projects with a commonsense approach. The criteria have been streamlined and simplified over the years so much that some leading practitioners suggest the use of "EVM Lite" (Fleming & Koppelman, 2007; Oracle Corporation, 2009; Pakiz, 2006).

An EVM progress timeline is shown in Appendix I.

EVM Definitions

The *PMBOK® Guide* defines EVM as "a management methodology for integrating scope, schedule, and resources, and for objectively measuring project performance and progress" (PMI, 2008).

The EVM method uses the following project parameters to evaluate project performance, as shown in Figure 1 (Anbari, 2003).

Planned Value (PV): This is the time-phased budget baseline. It is the approved budget for accomplishing the activity, work package, or project related to the schedule. It can be viewed as the value to be earned as a function of accomplishments up to a given point in time. A graph of cumulative PV is often referred to as the S-curve (because, with a little imagination, it looks like an S). This was previously called the Budgeted Cost of Work Scheduled.

Budget at Completion (BAC): This is the total budget baseline for the activity, work package, or project. It is the highest value of PV, and the last point on the cumulative PV curve.

Actual Cost (AC): This is the actual cost spent to accomplish an activity, work package, or project and to earn the related value up to a given point in time. This was previously called the Actual Cost of Work Performed.

Earned Value (EV): This is the earned value for the work completed to a point in time. It represents the amount budgeted for performing the work which was accomplished by a given point in time. This was previously called the Budgeted Cost of Work Performed.

Performance Measures

Cost Variance (CV): This is the algebraic difference between the value of the work accomplished in terms of the baseline (EV) and the amount spent to accomplish the work (AC). Expressed by the formula: CV = EV – AC

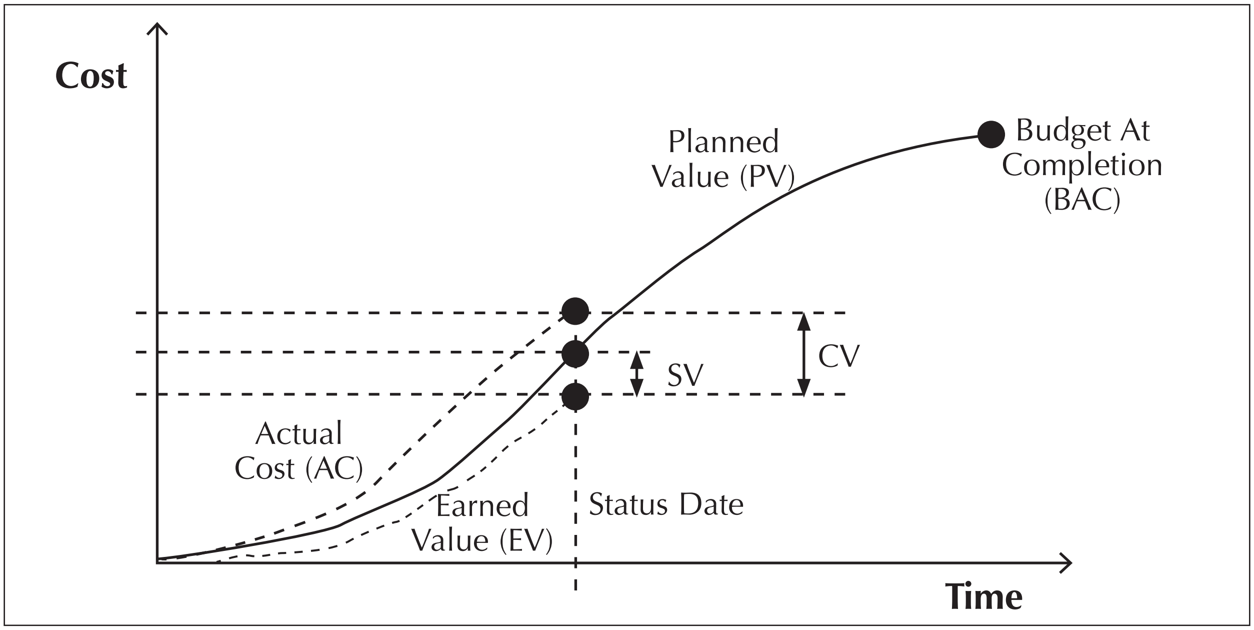
Schedule Variance (SV): This is the algebraic difference between the value of the work accomplished in terms of the baseline (EV) and the amount of work that was planned (PV). Expressed by the formula: SV = EV – PV

Cost Performance Index (CPI): This is the ratio of the value of the work accomplished in terms of the baseline (EV) and the amount spent to accomplish the work (AC). Expressed by the formula:
CPI = EV ÷ AC

Schedule Performance Index (SPI): This is the ratio of the value of the work accomplished in terms of the baseline (EV) and the amount of work that was planned (PV). Expressed by the formula:
SPI = EV ÷ PV

The performance measures shown above provide indicators as to the status of the project (e.g., behind schedule, below budget, etc.). A performance measure with a positive variance (>0) is deemed as

Figure 1: Components of Earned Value Management



Source: *Adapted from Anbari, 2003.*

favorable, while a performance measure with a negative variance (<0) is deemed as unfavorable. Similarly, a performance measure with a performance index greater than one (>1) indicates a favorable condition, while a performance measure with a performance index less than one (<1) indicates an unfavorable condition.

Cost Forecasting

Estimate to Complete (ETC): This is the expected cost needed to complete all the remaining work for an activity, work package, or project.

Estimate at Completion (EAC): This is the expected total cost of an activity, work package, or project when the defined scope is completed. EAC is equal to the actual cost (AC) plus the ETC for all remaining work. Expressed by the formula: EAC = AC + ETC. If we assume that the cost efficiency experienced to date will continue throughout the remainder of the activity, work package, or project, then EAC expressed by a formula is:
EAC = AC + (BAC – EV) ÷ CPI = BAC ÷ CPI

Variance at Completion (VAC): The VAC provides an indication of the estimated cost underrun or overrun at the completion of the project. Expressed by the formula: VAC = BAC – EAC. A positive variance (>0) is deemed as favorable, while a negative variance (<0) is deemed as unfavorable.

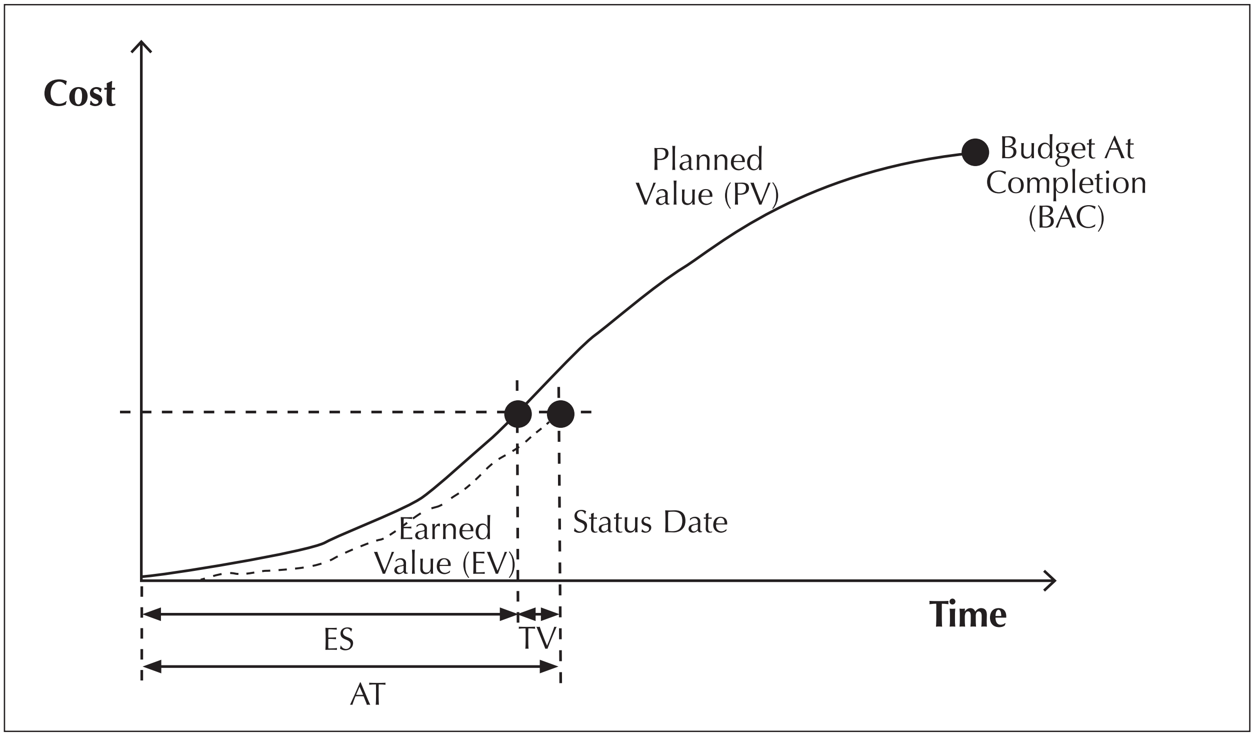
Extension of EVM to the Earned Schedule Concept

In its original form, EVM was not used to estimate the time needed to complete an activity, work package, or project, or to forecast their completion dates. However, extensions to EVM have been developed to use EVM data for that purpose (Anbari, 2003; Lipke et al., 2009; Lipke, 2009). The main components of the Earned Schedule are shown in Figure 2 and described below.

Earned Schedule (ES): The duration from the beginning of the project to the date on which the PV should have been equal to the current value of EV. In Figure 2, it is the date at which the horizontal line through the current value of EV intersects the PV curve.

Actual Time (AT): The duration from the beginning of the project to the status date. AT has also been called the Actual Duration.

Figure 2: Components of the Earned Schedule



Source: *Adapted from Anbari, 2003; Lipke et al., 2009; Lipke, 2009; Turner et al., 2010.*

Time Variance (TV): A measure of schedule performance measured in terms of time. Expressed by the formula: TV = ES – AT

TV can be approximated by dividing SV by the PV rate. The result is the approximate TV in time units.

If TV is positive, then the activity, work package, or project is ahead of schedule. If TV is negative, then the activity, work package, or project is behind schedule. TV has also been called the Schedule Variance (time), or $SV_{(t)}$. A comprehensive examples is shown on page 16.

The above components have been used to calculate a time performance index and to estimate the time at completion (Anbari, 2003; Lipke et al., 2009; Lipke, 2009).

Summary

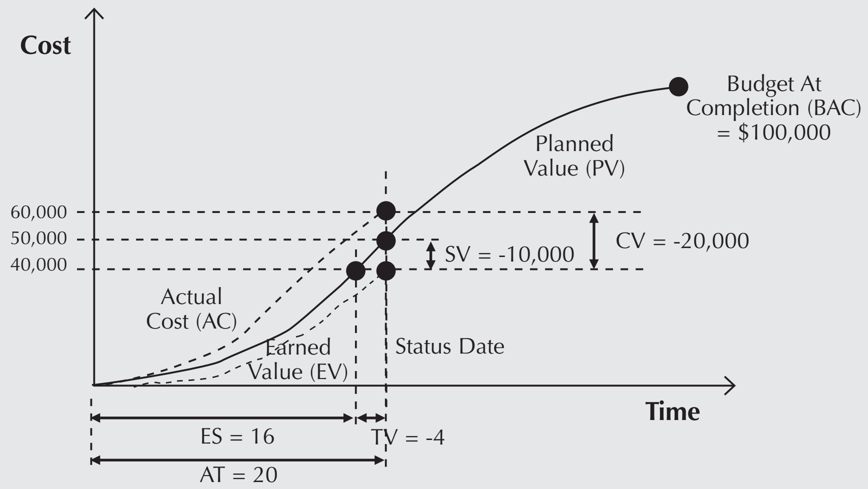
EVM is a powerful methodology that gives the executive, program manager, project manager, and other stakeholders the ability to visualize a project's status at various points during the project life cycle and consequently manage projects, programs, and portfolios more effectively.

A Comprehensive Example

(Adapted from Anbari, 2003)

Consider a project that has a baseline BAC of $100,000 and a baseline schedule of 40 weeks. The baseline indicates that, by the end of week 20, the project is planned to be 50 percent complete. At the end of week 20, it is reported that 40 percent of the project work has been completed at a cost of $60,000. The main components of this example are shown in the figure below.

From the example, we can conclude that this project is in serious trouble in terms of both cost and schedule performance. Corrective actions should have already been taken. It is critical to conduct an immediate review of this project, evaluate the underlying causes of the problems facing it, and make appropriate decisions promptly.



Using the EVM method:

BAC = $100,000
AT = 20 weeks
AC = $60,000

PV = 50% x $100,000 = $50,000
EV = 40% x $100,000 = $40,000

Therefore:

% Complete = EV ÷ BAC = $40,000 ÷ $100,000 = 40%
% Spent = AC ÷ BAC = $60,000 ÷ $100,000 = 60%

Cost and Schedule Variances:

CV = EV – AC = $40,000 – $60,000 = -$20,000
SV = EV – PV = $40,000 – $50,000 = -$10,000

Time Variance:

PV Rate = $100,000 ÷ 40 weeks = $2,500 per week
TV = SV ÷ PV Rate = -$10,000 ÷ $2,500 per week = -4 weeks

Performance Indices:

CPI = EV ÷ AC = $40,000 ÷ $60,000 = 0.67
SPI = EV ÷ PV = $40,000 ÷ $50,000 = 0.80

Estimate at Completion and Variance at Completion:

EAC = BAC ÷ CPI = $100,000 ÷ 0.67 = $150,000
VAC = BAC – EAC = $100,000 – $150,000 = -$50,000

Source: *Adapted from Anbari, 2003.*

Implementation of EVM at NASA

Historically, space programs are financed by government funds. However, that is changing somewhat with the inception of more commercial space projects. NASA's annual budget is over $18 billion for fiscal year 2010. For the cases examined regarding NASA's use of EVM, these government programs spend taxpayer dollars. It is for this reason that such programs use EVM to more effectively track project expenditures and schedule performance.

In February 1997, the agency issued NASA Policy Directive (NPD) 9501.3—Earned Value Performance Measurement to establish the basis for applying EVM to NASA contracts (NASA, 2002). Before issuance of the directive, NASA centers used their individual policies on performance measurement systems. The 1997 directive required NASA project managers to ensure implementation of EVM in contracts. Regularly, NASA's Office of the Inspector General and the Government Accountability Office conduct audits of current projects and provide recommendations for EVM-related integration and improvements. Some of these reports illustrate the benefits and shortcomings of projects in which EVM has been applied at NASA.

To better understand NASA's project management practices, it is worthwhile to have an overview of NASA's projects and organizational structure, as discussed in Appendix III.

Program Management at NASA

In 2008, NASA issued NPD 7120.7—NASA Information Technology and Institutional Infrastructure Program and Project Requirements (NASA, 2008b), which provided for the actual definition of a project and the responsibilities of the project manager, and further delineated the following four common requirements for the management of projects:

- **Project Formulation:** The assessment of feasibility; technology and concepts; risk assessment; team-building; development of operations concepts; alternatives evaluation and trade studies; acquisition strategies; establishment of high-level requirements and success criteria; the preparation of plans, budgets, and schedules essential to the success of a program or project; and the identification of how the program or project supports the agency's strategic needs, goals, objectives, and/or NASA education outcomes.
- **Approval:** The acknowledgement by the responsible official (the "decision authority") that the program/project has met expectations and formulation requirements and is ready to proceed to implementation.
- **Implementation:** The execution of approved plans for the development, construction, testing, and operation of products and services, and the use of control systems to ensure performance to approved plans and alignment with the NASA Strategic Plan.
- **Evaluation:** The continual, independent (i.e., outside the advocacy chain of the program or project) evaluation of the performance of a program or project and incorporation of the evaluation findings to ensure adequacy of planning and execution according to approved plans (NASA, 2008b).

The up-front work (project formulation) required before project approval at NASA is extensive. Project plans are required to include objectives, mission description, customer and stakeholder definition/advocacy, project authority, management, governance structure, project requirements, technical summary, implementation approach including the work breakdown structure (WBS), program/project dependencies, and logistics. Furthermore, the project baseline must include master schedules, resources (including funding, institutional, and facility requirements), acquisition management, and performance measurement indicators.

Project managers who are identified in a Program Plan must meet all requirements outlined irrespective of the size of the project and the program of which it is an element (NASA, 2008b). NASA interviewees reiterated the expectation that project managers remain within this framework, but that mission-specific determinations must be made based on their understanding of the context of the project. Project managers ultimately need to understand how to be successful within the context of the mission. NASA leadership also stated that project information technology (IT) investments are evaluated in terms of their return on investment (ROI) and are planned, budgeted, and managed outside the scope of the immediate project.

Program management and project management are inextricably linked at NASA, and the relationship between the two levels of management is critical to achieving mission success. Project management is different, however, from program management when it comes to timing and composition. The project manager works in concert with the program manager, but focuses on the day-to-day execution of the project by industry contractors, universities, NASA personnel, and other agencies, both foreign and domestic. There is also considerable breadth needed to address the safety, cost, schedule, technical performance, team building, human resources, and institutional issues associated with managing a project. The project manager should be knowledgeable in all of these areas and utilize experts from line or functional organizations to assist in project formulation and implementation (NASA, 2008b).

NASA officials agreed that the level of technical knowledge should be correlated with the management level of the project manager. They elaborated that managers close to the project should have great technical knowledge, but that this capability alone could not ensure project success, which has more to do with the leadership ability of the managers and executives further away from the nuts and bolts of the project.

When Does NASA Apply EVM?

NASA currently has a significant infrastructure of processes and requirements in place that enables robust program and project management. As noted earlier, NPD 7120.5—NASA Space Flight Program and Project Management Requirements (NASA, 2008c) and NPD 7120.7—NASA Information Technology and Institutional Infrastructure Program and Project Requirements (NASA, 2008b) dictate the use of EVMS on NASA projects:

- For contracts and subcontracts valued from $20M to $50M, the contractor will have an EVMS compliant with the ANSI/EIA-748 Standard.
- For contracts or subcontracts above $50M, the contractor will have an EVMS formally validated and accepted by the federal government.
- EVMS is applied at the discretion of the project manager for nondevelopmental programs, steady state operations, support services, janitorial/ground maintenance services, as well as for basic and applied research projects.
- The Defense Contract Management Agency (DCMA) office shall be used by contractors to determine the adequacy of their EVMS plans (DCMA, 2009).

Solicitation provisions and contract clauses within the NASA Federal Acquisition Regulation (FAR) Supplement must be used to provide on contracts as well the government notice of intent to implement EVM. It is interesting to note that a project manager must apply to the NASA Chief Engineer for a waiver to be granted permission to *not* use EVMS on a NASA project (NASA, 2009/2010).

Training in EVM at NASA

NASA provides for all of its staff members an effective training curriculum that supports project management processes and promotes consistent practices across the agency. This includes an agency-wide training curriculum, providing courses and schedules for training, and project management courses on leadership, scheduling, EVM, and data analysis.

NASA developed an *EVM Implementation Handbook* (2009/2010) that provides implementation procedures, processes, and detailed instructions for applying EVM to NASA programs and projects. It includes clear definitions of requirements and responsibilities for the implementation process. It serves as a guideline for EVM implementation and addresses pre- and post-contract award procedures.

Steps in EVM Implementation at NASA

NASA uses a five-step approach to implement EVM, as outlined below.

Step 1. NASA's Integrated Baseline Review

This aspect specifies standardized guidance for the NASA Integrated Baseline Review (IBR) process by providing project managers, project staff, and EVM experts with a standard guide for conducting the IBR as a technical review, ensuring that the project manager has ownership of the process, and defines IBR responsibilities (Kerby & Counts, 2008). Requirements for the IBR can be found at http://evm.nasa.gov/.

Step 2. Schedule Health Assessment

This process allows the project manager to conduct a project schedule review, internally referred to as a schedule health assessment, that evaluates the soundness and validity of project schedules. The schedule health assessment is a quantitative, evaluative methodology that helps determine the credibility and practicality of the schedule for project management purposes. It improves the EVM process by evaluating life cycle plans and estimates that lay out the schedule baseline, provides a methodology that supports schedule health assessments for IBRs, and monitors project health during the execution of the project (Kerby & Counts, 2008).

Step 3. Integrated Information System

This information system is used to apply project review concepts through the use of an in-house EVMS. By utilizing an enhanced EVM server and database configuration, NASA provides its project managers with a practical in-house EVMS that enhances the planning, execution, and performance management of NASA programs and projects. The system also provides smaller in-house projects with basic performance management tools, a user-friendly interface, scheduling capability and interface, analysis and reporting functionalities, and standardized software integration (Kerby & Counts, 2008). The NASA Data Requirements Document incorporates the use of the Cost Performance Report and formalizes the reporting structure. A NASA EVM focal point is assigned where surveillance is delegated (NASA, 2009/2010).

Step 4. Automated Data Analysis

This capability allows for continuous review of data through the use of an automated data analysis system. Through the automated analytical capability that performs EVM calculations by utilizing the above-mentioned integrated information system, timely and routine analyses of EVM data are facilitated that enable real-time project-related decision making. Thus, the automated data analysis capability allows for the quick identification of cost and schedule drivers, provides independent estimates at completion, generates data for the centralized database that supports and facilitates agency-wide implementation of proprietary software and other initiatives, and provides a capability for standardized report generation (Kerby & Counts, 2008).

The *NASA EVM Handbook* also mentions that project managers can delegate EVM monitoring to the DCMA, but must provide resources and assistance in the joint monitoring agreement. It is further stipulated that continuous EVM monitoring is maintained closely at all times. The integration and correlation of EVM data with the project's risk management plan is emphasized as well in order to facilitate the tracking and management of the risk mitigation process. EVM data is to be included in all management and Project Management Council reviews (NASA, 2009/2010).

Step 5. Organizational Investiture

Overall, the directives that NASA uses are adopted with flexibility depending on the size and complexity of specific projects. The degree of alignment to NASA project management practices is generally left up to the project manager. The expectation is that project managers will remain within the established NASA framework, but that determinations must be made in order to understand the context of the mission and how to best be successful within that context (Hoffman, 2008). But in terms of results or the approach of the organization, it is vital to NASA that viable results are achieved within budgetary constraints and that public perceptions are maintained, showing that NASA's overall approach to managing projects falls within the confines of the law and demonstrative successes are achieved, ready to display to the public. An entire department has been created for the use of EVM at NASA, which clearly delineates the level of investiture in this best practice.

Definition of Success at NASA

NASA highlights the uniqueness of its programs and projects, and that it typically conducts high-risk missions using new technologies or systems in one-of-a-kind or first-of-a-kind applications. NASA defines its major development projects as those with a life cycle cost exceeding $250 million. NASA defines success as follows:

- NASA will maintain a cost performance level for its portfolio of major development projects that is within 110 percent of the budget-weighted aggregate cost baseline.
- NASA will meet the baseline schedule goals for its portfolio of major development projects, with aggregate schedule slippage falling within 110 percent of baseline.
- NASA will sustain mission success by staying on course to meet Level 1 requirements for 90 percent of its portfolio of major development projects (NASA, 2008a).

Summary

NASA consistently demonstrates the effective application of EVM to its comprehensive program and project portfolio. Its mandated use through detailed, specifically delineated organizational protocols; the commitment of resources to assist in the implementation and use of EVM; the standardized data analysis capabilities; and formalized reporting approaches—as well as providing the training needed to ensure meaningful use of EVM across the agency—all clearly show how NASA is committed to incorporating EVM in its management processes. NASA continues to improve the usage of EVM in project management planning, execution, control, and closeout processes.

Case Studies on EVM Implementation at NASA

Three NASA projects in which EVM was implemented successfully in planning, management, and control were identified. They are the Habitat Holding Rack (HHR), the Jet Propulsion Laboratory (JPL), and the Constellation program. These projects are discussed below.

Habitat Holding Rack Project of the International Space Station

One example of successful EVM implementation at NASA is its application to the biological studies involving various habitat construction efforts of the HHR project of the International Space Station (ISS). A subteam of the ISS project (biological studies) undertook the construction of the HHR in 2004. During the "mini-IBR" to establish the performance measurement baseline, it was determined that the contractors, while having identified critical paths for specific aspects of the project, did not have a high-level schedule to tie all aspects of the HHR deliverables together. As a result, the high-level schedule was developed, the true project critical path was identified, and needed changes were made to provide a realistic end date forecast for the project.

The value of EVM was realized when integrating the existing schedules was done. Although contractor personnel had established critical paths for every piece of the project schedule, an overall, high-level schedule did not exist to integrate them. Creating a single, uniform project schedule and linking all the major pieces of the project together empowered the staff with the ability to predict a date for completion of the work, as well as to develop a true critical path for the project. Integration of the schedule also allowed for schedule changes and updates to be made.

These changes helped to identify clear critical paths for the project, and also helped the team to pinpoint an end date which was tied to the impact of those changes (Kerby, 2009). Even when NASA contractors use EVM, they often apply it inconsistently and even interpret or deliver the status incorrectly. With good EVM tools, solid up-front planning, and effective implementation of these tools, project managers can be better informed to make effective management decisions during the entire life of the project (Kerby, 2009).

Through the use of EVM, contractors and NASA were able to ascertain how the project had progressed to that point, the direction it was taking, and what the true cost and schedule drivers were to get the project to where it needed to be. It was through this application of EVM that the HHR project was brought back in line.

In summary, four steps were implemented to introduce EVM to HHR (Kerby & Counts, 2008):

- Step 1. Determining the status of the project
- Step 2: Working with the schedule
- Step 3. Applying the review concepts
- Step 4. Continuous review of data

EVM at the Jet Propulsion Laboratory

JPL is a not-for-profit, federally funded research and development center located at the California Institute of Technology in Pasadena, California. JPL is the NASA center for the unmanned exploration of the universe and conducts work for NASA; the Departments of Defense (DOD), Transportation, Energy (DOE); and other federal agencies. JPL has adopted the Cost Management/Earned Value Management (CM/EVM) system to use EVM not only to keep track of financial reporting requirements, but also to use it as a management methodology that helps to integrate project management principles. Specifically, project teams develop, manage, and analyze budgets, costs, and variances, as well as forecast and measure performance and facilitate project reporting by using CM/EVM.

Numerous factors have affected the environment in which the CM/EVM system was conceived, developed, and deployed (Jansma et al., 2000). They are:

- JPL's shift to process-based management,
- Major reengineering activities at JPL in 1995 and ISO 9000 certification in 1999,
- Requirements to implement NASA program and project management process published in 1998,
- NASA's prime contract for JPL in FY 1999, and
- A previous failed attempt to implement EVM systems at JPL.

In the early 1990s, JPL failed to implement a full criterion-based EVMS. The primary reasons were that the organizational culture at JPL was not ready to adopt and implement project management principles, and that there was a lack of technical capability and compatibility to integrate with the existing system. Interestingly, mini-implementations of EVM were done independently with JPL flight projects, which led to success. However, there was a series of shortcomings, including:

- A lack of full EVM system implementation,
- A lack of integration with the JPL's institutional business system, and
- A mediocre tool set that was not capable of supporting complex funding and cost accounting models (Jansma et al., 2000).

In short, there was no well-defined project management process in place to adopt and implement such principles, tools, and practices at JPL.

In the late 1990s, JPL developed a three-phase strategy for achieving the goal to implement an EVMS (Jansma et al., 2000). The first phase was to build a system that integrated EVM methods with the existing business system. The second phase was to involve users and receive feedback by using a prototyping development approach to ensure acceptance among team members. The final phase was to adopt a project resource management process before system implementation, test different scenarios, and provide relevant training. The three-phase approach helped JPL to have a smooth transition to the new process and tools, and to implement EVM successfully.

The Constellation Program

One of the Constellation program's goals is to integrate, view, and analyze project data to keep track of the project's whereabouts. Implementing EVM was necessary to manage and monitor various Constellation projects successfully.

The following steps were used to effectively apply and implement EVM principles:

- Conduct solid communication with all stakeholders,
- Develop process documentation and maintain an implementation schedule,
- Define requirements and expectations for projects using existing tools and guidelines,
- Understand the organizational culture and remain flexible when implementing the EVM system,
- Demonstrate the benefits to key stakeholders, and
- Keep strict deadlines to deliver the product, service, and data.

Challenges still remain in a few areas, such as the seamless integration between financial systems and EVM techniques, because the data are not fully compatible. Also, education and training in basic EVM principles for the project management team and other stakeholders are necessary to gain organizational support. The goal is to build a process that will help project managers and team members have access to the best EVM data possible to analyze project performance, manage risks, and make appropriate decisions.

Summary

Three cases of implementation of EVM principles and tools at NASA have been discussed, and some of the major steps and challenges have been highlighted.

It is critical that EVM be introduced at the beginning of the project to get the most benefit out of it. Using EVM provides enough groundwork and discipline to maintain schedule and cost baselines—and allows project managers to take the appropriate actions when project performance starts to slip, because EVM helps keep track of the trends of scope, cost, and schedule. EVM gives project managers the tools and techniques to manage risks proactively and to make better management decisions.

Assessing the EVM Experience at NASA

Findings Related to the Value of Project Management and EVM at NASA

Major findings related to the value of project management and EVM at NASA are presented below.

Finding One: With a project success rate of 97 percent (NASA, 1997), NASA personnel we interviewed indicated that no justification is needed for doing project management, but justification is needed if it is NOT done.

NASA's leadership indicated that, in fact, NASA is often criticized for not taking enough risks and, as a result, missing possible opportunities. The role of project management within NASA is clearly defined as the means by which missions are initiated, planned, executed, monitored, controlled, and closed.

Finding Two: It can be inferred that the assessment of the level of stakeholder satisfaction with project management at NASA is directly related to the tone of media coverage and public perception of NASA missions.

These missions are highly publicized due to the size of taxpayer contributions to the budget, and the success or failure of a mission is reported to the public as part of the 24/7 news cycle. This enables instantaneous analyses of NASA missions, however complex, and assessments, however accurate or inaccurate, that are globally publicized and have the ability to sway public opinion.

As an example of this type of media impact, one of NASA's leaders mentioned that one of the most challenging aspects of managing the Phoenix project was insulating the team from the criticisms leveled at the project, driven by its high visibility. Even though the relative size of the Phoenix budget ($400 million over 5 years) was small when compared to the overall NASA budget, the amount of attention the mission received was enormous. This high visibility and media coverage actually drove perceptions about the level of satisfaction with project management execution, and managing these perceptions internally took significant effort.

Finding Three: NASA's leadership stressed that the degree of alignment with NASA project management practices is generally left up to the project manager.

The expectation is that project managers will remain within this framework, but that the project manager needs to understand the context of the mission and determine how to be successful within that context.

Finding Four: When discussing the ability of a project management group to be successful, one of NASA's leaders suggested that some senior government executives tend to speak about project management in terms of overall mission and obligations, and do not discuss project management on a program or portfolio level.

This can be perceived as potential for improvement, because the involvement of senior executives is a crucial success factor in the management of projects that has been demonstrated repeatedly in various studies of successful and failed projects (Anbari & Kwak, 2004).

Finding Five: Project results are well documented at NASA (Gould, 2006).

Among a myriad of accomplishments, NASA has sent 14 people to the moon, landing 12, and safely returning all of them to earth; launched and subsequently repaired the Hubble Space telescope; continues to fly the space shuttle regularly and will do that until 2010; is in the process of building the ISS; has successfully landed an operational rover on Mars; and is currently developing the technology needed to return to the moon. All of these missions can attribute a large part of their success to the use of project management techniques, including EVM. The scientific innovations and breakthroughs that are part of space as an unknown frontier can, if not managed correctly, be the source of barriers to success that even the best project management techniques cannot overcome.

Finding Six: NASA demonstrated that it had satisfactorily addressed issues related to its leadership commitment; the quality of its corrective action plan; and its capacity to implement the plan, including program/project office involvement, validation of its accomplishments, and demonstrated progress in the timely accomplishment of its milestones (NASA, 2007/2008).

After the Columbia shuttle disaster, NASA conducted comprehensive studies of its managerial and technical procedures and implemented improvements throughout its processes to get its fleet flying again.

Finding Seven: NASA has an extensive, thorough "lessons learned" process.

Each NASA center has its own database where it stores information regarding successes and failures of its missions. This database is used for training and development for better risk management and decision making. In addition, NASA values human interfaces and shares reflective knowledge and information by holding various conferences and forums at which practitioners can communicate and learn from one another.

Finding Eight: Project management principles at NASA are defined as working as a team, measuring performance through the use of quantitative data, collaborating extensively with global stakeholders and contractors, implementing efficient change management practices, and allocating priorities to programs and projects using portfolio management concepts.

It is important to note that NASA considers its concept of accountability very seriously, while at the same time maintaining enough flexibility to adapt project management requirements to specific, unique situations.

Critical Success Factors in the Implementation of EVM at NASA

The following highlights areas of strength in the implementation of EVM at NASA—as a public organization that has been utilizing EVM effectively to monitor and control its projects:

- NASA invested in the use of EVM, as demonstrated by its comprehensive policies and procedures.
- The NASA EVM website (http://evm.nasa.gov) provides a detailed clearinghouse for training, policies, and procedures.
- A dedicated team to monitor EVM deployment and use is funded.
- A single IT system for tracking and reporting exists, synchronizing cost and schedule data into a consolidated repository.
- Trend analysis is performed from day one and throughout the life cycle of the project.
- Consistent reporting structures are required, with linkages to requirements documentation as a standard operating procedure.
- EVM analysis is used to make organizational-level decisions, schedule modifications, and funding allocations, and to document lessons learned.

Recommendations for Improving EVM at NASA

The following recommendations highlight potential opportunities for improvement in the implementation of EVM at NASA.

Recommendation One: NASA should apply EVM use to projects of $20 million or less.

NASA stipulates the use of EVM for projects over $20M, and requires the approval of the Chief Engineer to deviate from this mandate. By developing methods to use EVM for smaller-cost projects that may not be considered as high-visibility projects, NASA would have standardized processes and procedures for all of its projects.

Recommendation Two: NASA should apply EVM to firm fixed price projects.
Applications of EVM are usually conducted within cost-plus or incentive-type contracts. Typically firm fixed price contracts are not managed using EVM because these types of contracts are seen as a risk transfer to the contractor and not to NASA.

In reality, NASA is still exposed to risk in terms of quality, schedule, and the ability to complete the project—which ultimately can impact the agency's objectives. Therefore, a modified EVM approach may have meaningful applications to protect NASA from this exposure.

Recommendation Three: NASA should develop a scope management indicator as part of EVM.
Currently, NASA EVM measures only cost and schedule constraints. It may be possible to incorporate a scope management indicator to capture information on the stability of this important constraint.

Recommendation Four: NASA EVM should include a variance in time.
Current EVM metrics are expressed in terms of dollar cost and not in terms of the actual time. While schedule variances need to be stated in terms of dollar cost, it may be useful to express these variances in terms of time, or represent them in terms of duration as well. The schedule variance in terms of dollars may not effectively highlight the true requirement to realign the schedule.

Applying EVM in Other Government Agencies

There are numerous excellent implementations of EVM in organizations throughout agencies in the federal government, private industry, and other countries. Examples in the U.S. government include the DCMA, the DOD, the DOE, the Federal Aviation Administration, the U.S. Coast Guard, and many others (Daly, et al.). Details of some of these implementations can be found at the respective agency's website, such as http://guidebook.dcma.mil/79/EVMIG.doc.

The concept of organizational project management is based on the idea that there is a correlation between an organization's capabilities in project management, program management, and portfolio management and its effectiveness in implementing its organizational strategy. The degree to which an organization practices project management is referred to as its Organizational Project Management Maturity (PMI, 2005a). The basic purpose for initiating a project is to accomplish a set of specific goals. The reason for organizing the effort as a project is to focus the responsibility and authority for the attainment of the goals on an individual or small group (Kerzner, 2009; Meredith & Mantel, 2009). It is these concepts that are fully functionalized at NASA.

One of NASA's leaders specified that, to assure mission success, people who are familiar with processes are needed to ensure adherence to disciplines and provide a decision-making point. As a result of good decisions, better customer relations can be attained (Davis, 1974) and there will probably be a better project ROI (Kwak & Ibbs, 2000). These are all aspects of providing value: Results can be measured, performance can be monitored and quantified, situations that need to be managed have a defined focal point, and overall direction and leadership are defined by the participant's role within the organizational structure. One of NASA's leaders specified that value is also achieved by creating the wealth of institutional knowledge and in enabling managers and directors to share stories of their successes and failures—for all to examine and from which the entire organization can learn.

In terms of results and approach, it is evident that for NASA it is vital that viable results are achieved within tight budgetary constraints, and that public confidence—that NASA's approach to managing projects is successful and falls within the confines of the law—is maintained.

NASA's leadership emphasized that NASA should be in the leading role of developing new generations of project managers who possess the sense of leadership, sense of understanding of complex systems, and sense of people management and clear communication. In other words, NASA is looking for a person with "project sensibility."

This report raises some questions about the applicability of the processes defined by NASA to specific types of projects/missions. As one of NASA's leaders pointed out, science projects, technology projects, and human exploration projects all have varying degrees of budgetary, scheduling, and safety constraints, which in turn influence the level of complexity of the project. Getting the right people at the very beginning of the project, following and implementing project guidelines that are key to success (cost, time, and quality), being knowledgeable about the overall aspects of project performance and status, and being honest about progress reporting are the key values of project management at NASA and are the primary reasons why NASA has been so successful in applying and implementing project management since its formation. The approach that NASA uses to scale the extent of the policies and procedures used to create value through projects is fascinating.

This report demonstrates that NASA is a project-driven organization that is applying project management to all of its dynamic endeavors. NASA complies with relevant U.S. federal government regulations that require the use of monitoring and control tools in projects and programs. NASA is effectively applying its own policies and procedures related to project management to accomplish its objectives, strategies, and missions. The study demonstrates that NASA is receiving substantial value from its implementation of project management in terms of an extremely high project success rate and the achievement of organizational goals. Adapting NASA's approach to project management and its implementation of EVM should prove useful in other government agencies.

The value of project management to organizations has been established globally in extensive studies (Thomas & Mullaly, 2008). Understanding of project management and its applications in government continue to grow (PMI, 2006). Government agencies can successfully utilize proven principles of project management and tools of earned value management to achieve their goals and enhance the well-being of society.

Recommendation for Agencies

Recommendation: EVM should be widely adopted by agencies across government.
EVM is a powerful methodology that gives the manager the ability to visualize a project's status at various points during the project life cycle and consequently manage risks more effectively. EVM has given managers greater confidence in making evidence-based inferences about project resources and scope management; hence, it has allowed more project control and oversight. EVM also brings other innovations into projects. It calls for a project-oriented management structure, a learning culture in the organization, the recognition of specialized skills and expertise, and more interface and interdependence within reporting lines.

EVM has been instrumental in supporting stronger cash flow management capacity, improving transparency and governance, facilitating prevention or mitigation of conflicts, and above all helping bring several large-scope projects to completion on time and within budget. EVM is an effective management methodology that helps provide objective project assessments when applied appropriately, and clearly quantifies the opportunities to maintain control over cost and schedule aspects of various projects and programs.

EVM as a methodology has proven merits and continues to expand to several sectors. It advocates for more rigor in project planning and implementation, which are undeniably prerequisites for any successful project. The use of EVM, parts of it, or tailoring it to specific situations has allowed managers to enjoy its benefits, including better cash flow management, improved relationships with clients, and successful management of project constraints. Knowledge, skills, applications, and maturity in EVM continue to grow as this powerful method is being used more widely (Stratton, 2006; Solomon & Ralph, 2007). EVM will continue to grow as long as more of its weaknesses are known and turned into opportunities for improvement.

Appendix I: EVM Progress Timeline

EVM was introduced in 1967 by the U.S. federal government as an integral part of the Cost/Schedule Control System Criteria (C/SCSC) to understand the financial aspects of large acquisition programs. The method, variations, or parts of it have been used under several names. The federal government turned toward a more flexible EVM System (EVMS) in 1996. The American National Standards Institute (ANSI)/ Electronic Industries Alliance (EIA) published guidelines for EVMS in 1998. The Project Management Institute's (PMI®) *A Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*) provided the basic terminology and formulas of EVM in 1996.

PMI® published the simplified terminology and more details on EVM starting in 2000 and in subsequent editions of the *PMBOK® Guide* as well as in a separate *Practice Standard for Earned Value Management*. Table A.1 shows some of the important milestones in EVM implementation timeline.

Table A.1: EVM Progress Timeline

Year	Event
1967	Cost/Schedule Control System Criteria (C/SCSC) introduced by U.S. Department of Defense (DOD).
1972	First C/SCSC Joint Implementation Guide issued to ensure consistency among military departments.
1991	DOD Instruction 5000.2—Defense Acquisition Management Policies and Procedures issued reaffirming use of EVM.
1996	DODR 5000.2-R—Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information System Acquisition Programs issued. Draft industry guidelines accepted by Under Secretary of Defense and C/SCSC revised from 35 to 32 criteria
1998	American National Standards Institute / Electronic Industries Alliance published industry guidelines for EVM Systems (EVMS; ANSI/EIA-748-98).
1999	Under Secretary of Defense adopts ANSI/EIA-748-98 for DOD acquisition.
2000	Simplified EVM Terminology published by Project Management Institute.
2005	*Practice Standard for Earned Value Management* published by the Project Management Institute

Details of important milestones in the progress of EVM implementation can be found in several sources such as: http://www.acq.osd.mil/pm/historical/Timeline/EV%20Timeline.htm

Appendix II: Governing Regulations, Policies, and Standards for EVM

As organizations continue to bid for government projects and government agencies request funding for new project initiatives, they must become familiar with the regulations, policies, and guidelines for using EVM. The legislation, regulations, policies, and standards driving the implementation of EVMS are summarized in this appendix.

Legislation and Regulations

Legislation and regulations have driven the implementation of cost control techniques such as EVM within the government sector since the early 1990s. Legislation relating to controlling and measuring performance began as early as 1993 with the Government Performance and Results Act. Regulations, policies, and guidelines continue to be refined to describe how to implement EVMS on government projects based on industry standards.

Title V of the Federal Acquisition Streamlining Act (FASA; U.S. Congress, 1994) requires that agency heads must define and approve the cost, performance, and schedule goals for major acquisitions—and achieve, on average, 90 percent of the cost, performance, and schedule goals established. The Clinger-Cohen Act (U.S. Congress, 1996) requires the Director of the OMB to develop, as part of the budget process, a process—for analyzing, tracking, and evaluating the risks and results of all major capital investments for information systems—that encompasses the entire life of each system. Table A.2 summarizes the main U.S. government legislation and regulations as they relate to cost control techniques and EVMS.

Policies

In 2002, the OMB required the use of EVM for reporting performance for ongoing federal projects. The Planning, Budgeting, Acquisition, and Management of Capital Assets part of the circular states that, "*If any of the cost, schedule, or performance variances are a negative 10 percent or more you must provide a complete analysis of the reasons for the variances, the corrective actions that will be taken and the most likely estimate at completion (EAC). Use the EVMS system to identify the specific work packages where problems are occurring.*" To receive federal funding, projects are evaluated based on the business case submitted. The business case includes the use of a performance-based management system, specifically an EVMS. Projects are scored based on whether or not an ANSI/EIA-compliant EVMS system was in place for the project (OMB, 2008). Table A.3 shows some of the policies and orders from different U.S. government agencies.

Guidance Documents

Guidelines for using and establishing an EVMS were published to support the policies implemented for government agencies and industry standards. The OMB Circular A-11, Part 7 – Planning, Budgeting, Acquisition and Management of Capital Assets (OMB, 2008) and the Capital Programming Guide were written to meet the requirements of FASA and the Clinger-Cohen Act. These documents set the policy, budget justifications, and reporting requirements that apply to all agencies of the executive branch of government that are subject to executive branch review. They address capital acquisition, require the use of EVM consistent with the ANSI/EIA-748 (ANSI, 2007) for both government and contractor work, and are the genesis of the EVMS requirements for the FAR. Table A.4 summarizes current guidelines.

Table A.2: Legislation and Regulations Related to EVM

Date	Title	Information
1993	Government Performance and Results Act of 1993	"Requires organizational strategic planning and use of performance measurement for any program using U.S. federal dollars."
1994	Title V of the Federal Acquisition Streamlining Act of 1994	"Requires agency heads to achieve, on average, 90% of the cost and schedule goals established for major and non-major acquisition programs of the agency without reducing the performance or capabilities of the items being acquired."
July 2006	Federal Acquisition Regulation (FAR), Major Systems Acquisition, 48 CFR part 34, subpart 34.2, Earned Value Management System	This regulation applies to Department of Defense (DOD), General Services Administration, and National Aeronautics and Space Administration. The regulation was based on the OMB Circular A-11. The FAR states that "an Earned Value Management System (EVMS) is required for major acquisitions for development, in accordance with OMB Circular A-11. The government may also require an EVMS for other acquisitions, in accordance with agency procedures." The Civilian Agency Acquisition Council and the Defense Acquisition Regulations Council set forth the following rules (FAR, 2006, p. 38239). • "EVMS application should be based on the particular agency facts and circumstances rather than specifying a threshold in the FAR. • "It is not appropriate to exclude certain contract types from EVMS requirements in the FAR. • "Agencies have significant discretion in determining the size and complexity of projects that meet the criteria for a major acquisition set by the agency."
April 2008	Defense Federal Acquisition Regulation Supplement; Earned Value Management Systems (DFARS Case 2005-D006)	This rule is a supplement to the FAR and documents DOD-specific EVM requirements. The requirements for an EVMS include: • Cost or incentive contracts and subcontracts equal to or greater than $20 million are required to use an EVMS that complies with ANSI/EIA-748. • Cost or incentive contracts and subcontracts equal to or greater than $50 million are required to use an EVMS system that has been validated as being in compliance with ANSI/EIA-748. • Cost incentive contracts and subcontracts less than $20 million are not required to use an EVM. EVM is optional and should be assessed by determining project risk. • Firm fixed xprice contracts and subcontracts are not required to use EVM. The use of EVM on these types of contracts is discouraged.

Table A.3: Policies and Orders Related to EVM

Date	Title	Information
June 2002	OMB Circular A-11, Preparation, Submission, and Execution of the Budget (Part 7, Planning Budgeting, Acquisition & Management of Capital Assets)	"EVMS is required for those parts of the investment where developmental effort is required. This includes prototypes and tests to select the most cost-effective alternative during the Planning Phase, the work during the Acquisition Phase, and any developmental, modification or upgrade work done during the Operational/Steady State Phase. EVMS is to be applied to both Government and contractor efforts and regardless of contract type" (OMB, 2008, p. 4).
March 2005	DOD, Revision to DOD Earned Value Management Policy	• This policy change was made to help improve and streamline consistency in the use of EVM in DOD. The policy led to the DFARS revisions in 2008. The changes to the DOD policy included ("DOD Revision," 2005, p. 1-2): • Cost or incentive contracts, subcontracts, work agreements: – Equal to or greater than $50 million shall have a validated EVMS based on ANSI/EIA-748. – Equal to or greater than $20 million are required to use an EVMS that complies with ANSI/EIA-748. – Less than $20 million are not required to use an EVM. It is optional, based on risk. • Firm fixed price contracts and subcontracts are not required to use EVM. The use of EVM on these types of contracts is discouraged. Note: This is in conflict with the OMB policy. DOD allows exemptions based on contract type. • Integrated baseline reviews are required when EVM is required.
July 2006	DOE O 413.3A	This Order sets the following thresholds and requirements for use of EVMS in the Department of Energy (DOE; U.S. Department of Energy, 2006, p. 13). • Projects with a total project cost greater than or equal to $20 million must have an ANSI/EIA-748-compliant EVMS (self-certified) by CD-2. • Projects with a total project cost equal to or greater than $50 million must have an ANSI/EIA-748-compliant EVMS certified by the Office of Engineering and Construction Management.

Table A.4: Guidance Documents Related to EVM

Date	Title	Information
December 2005	A Framework for Developing Earned Value Management Systems (EVMS) Policy for Information Technology Projects (IT) (Federal CIO Council, 2008)	This document was developed to provide "a model EVMS framework for the development of agency EVM policy," as required by OMB Memorandum M-05-23 (OMB, 2008).
June 2006	Capital Programming Guide Version 2.0: Supplement to Circular A-11, Part 7, Preparation, Submission, and Execution of the Budget	This guide was originally published in 1997 to assist federal departments, agencies, and administrations in establishing an effective capital programming process based on OMB Circular A-11 (Capital Programming Guide, 2006, p. 1).
November 2006	National Defense Industrial Association Program Management Systems Committee (PMSC) Earned Value Systems Intent Guide	The guide provides further clarification on the 32 criteria outlined in ANSI/EIA-748. The guide assists government agencies and industry in documenting compliance of their EVMSs with ANSI/EIA-748 (National Defense, 2006).

Appendix III: NASA's Organization and Projects

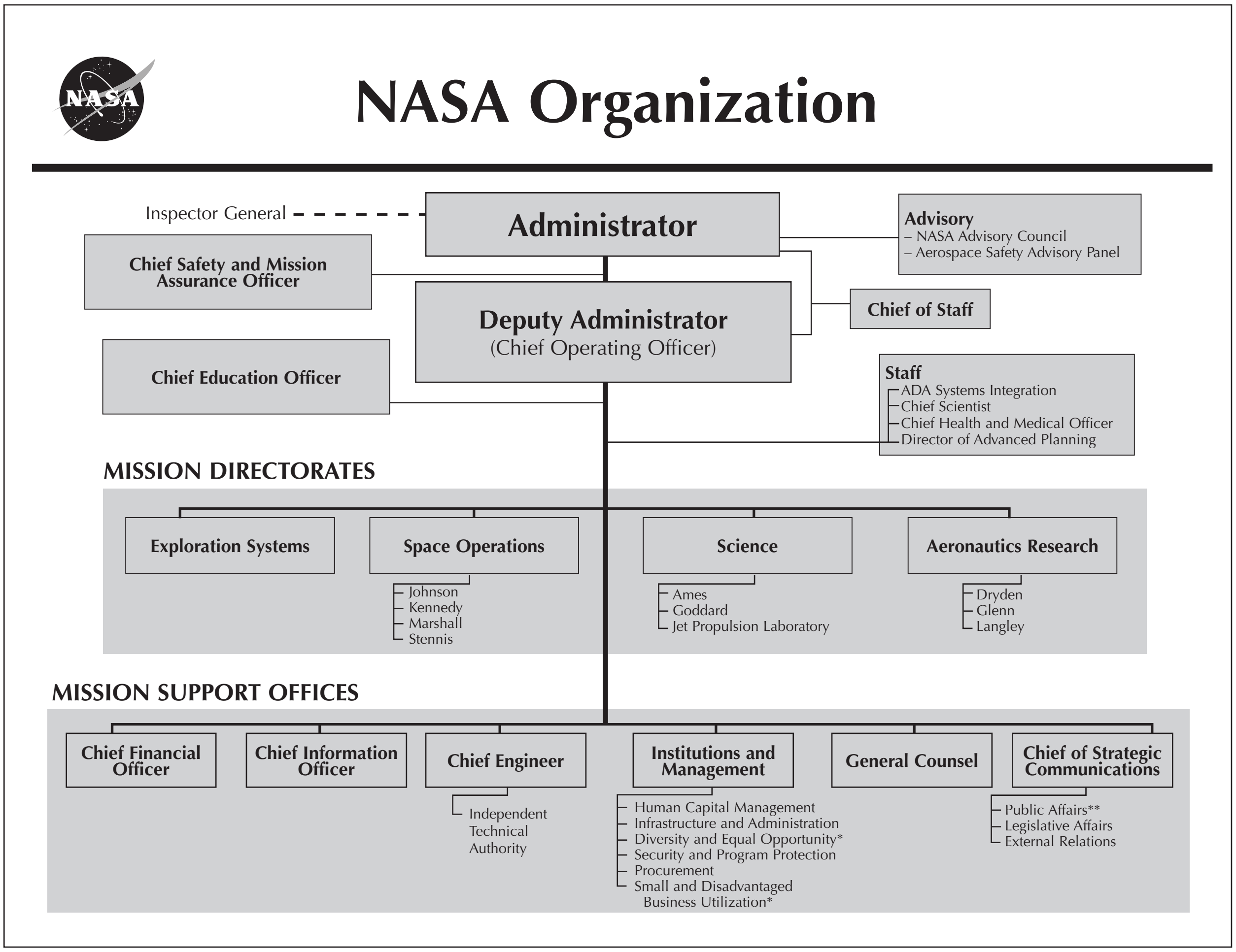
Everything the National Aeronautics and Space Administration (NASA) does is essentially related to managing programs and projects. NASA divides its missions into five categories: (1) Science, (2) Aeronautics and Space Research and Technology, (3) Exploration, (4) Space Operations, and (5) Education. Science missions and space operations are the two largest portions among the five categories and are generally led by scientists. All missions are defined within the context of project management at NASA, with a strong emphasis placed on developing professionals who can examine projects from a total system perspective to lead these projects. The Independent Program Assessment Office assesses newly proposed and ongoing programs and projects to provide objective advice to the mission directorates and agency program management committee. Science missions are generally 3–7 years long with budgets of $200 million to $1 billion, technology-based missions are 2–3 years long with budgets of $20 million to $200 million, and exploration missions are 5–7 years long with budgets of $500 million to $1 billion. Mission teams are typically comprised of industry experts (90 percent) and NASA personnel (10 percent).

To better understand NASA's project management practices, it is worthwhile to have an overview of NASA's organizational structure, as shown in Figure A1. At NASA, organizational structure is based on two primary levels of management responsibility: The first is agency management and the second is strategic enterprise management, which includes managing centers and programs. Internal integration is ensured through a number of management councils and boards that coordinate activities and planning among the individual enterprises and between the agency and enterprise management levels (NASA, 1996).

NASA's Office of the Chief Engineer provides policy direction, oversight, and assessment for NASA engineering and program management communities, and serves as the principal advisor to the NASA Administrator and other senior officials on matters pertaining to the technical readiness and execution of NASA programs and projects. Functions of the Office of the Chief Engineer are broken down into technology areas, among which are engineering excellence, systems engineering, training, lessons learned, earned value management (EVM), etc. (NASA, 2006). The Academy of Program/Project & Engineering Leadership (APPEL) operates under the Office of the Chief Engineer and provides leadership, advice, direction, and support for development and learning within NASA's program/project management and engineering community (Academy of Program/Project & Engineering Leadership, 2008). APPEL offers a training curriculum and promotes excellence in project management and engineering leadership development from knowledge-sharing initiatives. Its goal is to support engineers, practitioners, project teams, and program teams at every level of development.

NASA's organizational structure is shown in Figure A.1.

Figure A.1: NASA's Organizational Structure



Source: *Adapted from NASA, 1996, 2006*

References

Abba, W. (1997). Earned Value Management—Reconciling Government and Commercial Practices. *Program Manager,* 26 (January-February): 58-63.

Abba, W. (2001). How Earned Value Got to Prime Time: A Short Look Back and Glance Ahead. *The Measurable News.* Retrieved on June 1, 2010 from www.pmforum.org/editorials/2003/earnedvaluep-rimetime_abba.pdf.

Academy of Program/Project & Engineering Leadership (2008). Retrieved on June 1, 2010 from http://appel.nasa.gov/.

American National Standards Institute. (2007). *ANSI/EIA 748: Earned Value Management Systems.*

Anbari, F.T. (2003). Earned Value Project Management Method and Extensions. *Project Management Journal,* 34 (4): 12-23.

Anbari, F.T. (2005). Innovation, Project Management, and Six Sigma Method. *Current Topics in Management,* 10: 101-116, Transaction Publishers, New Brunswick, NJ.

Anbari, F.T., and Y.H. Kwak (2004). Success Factors in Managing Six Sigma Projects. *Proceedings of PMI Research Conference* [CD], London, UK, Project Management Institute, Newtown Square, PA.

Antvik, S. and Philipson, E. (2009). *Earned Value Management — An Introduction.* Philipson Biz, Stockholm, Sweden.

Christensen, D.S. (1994). A Review of C/SCSC Literature. *Project Management Journal,* 25(3): 32-39.

Daly, D., T. Grant, J. Kammel, and B. Maktabi. (2009). *Earned Value Methodology: A Project Management Best Practice Analysis,* research report prepared under the supervision of F.T. Anbari, The George Washington University, Washington, DC.

Defense Contract Management Agency. (2009). *DCMA Website Agency Data.* Retrieved on June 1, 2010 from http://www.dcma.mil/about.cfm.

Davis, E.W. (1974). CPM Use in Top 400 Construction Firms. *Journal of the Construction Division,* American Society of Civil Engineers.

Federal CIO Council. (2005). *A Framework for Developing Earned Value Management Systems (EVMS) Policy for Information Technology (IT) Projects.* Retrieved on June 1, 2010 from http://www.cio.gov/documents/Framework_for_Developing_EVMS_Policy_12-5-05.pdf

Fleming, Q.W., and J.M. Koppelman. (2003). What's Your Project's Real Price Tag? *Harvard Business Review,* September: 20-22.

Fleming, Q.W., and J.M. Koppelman. (2004). Sarbanes-Oxley: Does Compliance Require Earned Value Management on Projects? *Contract Management,* April: 26-28.

Fleming, Q.W. and Koppelman, J.M. (2005). *Earned Value Project Management,* 3rd edition. Project Management Institute, Newton Square, PA.

Fleming, Q.W. and Koppelman, J.M. (2007). *Earned Value Lite: Earned Value for the Masses.* Primavera, Bala Cynwyd, PA. Retrieved on June 1, 2010 from http://www.nu-solutions.com/downloads/earned_value_lite.pdf

Gould, A. (2006). *NASA Projects and Missions*. Retrieved on June 1, 2010 from http://www.lawrencehallofscience.org/sii/URLs/NASAprojects.html.

Henderson, K. (2003). Earned Schedule: A Breakthrough Extension to Earned Value Theory? A Retrospective Analysis of Real Project Data. *The Measurable News,* Summer: 13-23.

Henderson, K. (2004). Further Developments in Earned Schedule. *The Measurable News,* Spring: 15-22.

Henderson, K. (2005). Earned Schedule in Action. *The Measurable News,* Spring: 23-30.

Hoffman, E.J. (2008). Private communications.

Humphreys, G.C. (2002). *Project Management Using Earned Value*. Humphreys & Associates, Orange, CA.

Jansma, P.A., L.B. Gibby, C.R. Chambers, J.S. Joines, and R. Egger. (2000). When Serious Project Management is a Critical Business Requirement… *California Institute of Technology.* Retrieved on June 1, 2010 from http://www.projectp.com/demos/index.cgi?product=oaug.

Kerby, J.G., and S.M. Counts. (2008). *The Benefits of Earned Value Management from a Project Manager's Perspective* [white paper]. Retrieved on June 1, 2010 from http://www.nasa.gov/pdf/293270main_63777main_kerby_counts_forum9.pdf.

Kerby, J.G. (2009). Private communications. Jan. 17, 2009.

Kerzner, H. (2009). *Project Management: A Systems Approach to Planning, Scheduling, and Controlling,* Tenth Edition. Wiley, Hoboken, NJ.

Kim, E.H., W.G. Wells Jr., and M.R. Duffey. (2003). A Model for Effective Implementation of Earned Value Management Methodology. *International Journal of Project Management,* 21(5): 375-382.

Kwak, Y.H., and C.W. Ibbs. (2000). Calculating Project Management's Return on Investment. *Project Management Journal,* 31(2): 38-47.

Lipke, W.H. (2009). *Earned Schedule.* Lulu Publishing, Raleigh, NC.

Lipke, W.H., and Henderson, K. (2006, November). Earned Schedule: An Emerging Enhancement to Earned Value Management. *CrossTalk - The Journal of Defense Software Engineering,* 19: 26-30.

Lipke, W., O. Zwikael, K. Henderson, and F. Anbari. (2009). Prediction of Project Outcome: The Application of Statistical Methods to Earned Value Management and Earned Schedule Performance Indexes. *International Journal of Project Management,* 27(4): 400-407.

Meredith, J.R., and S.J. Mantel Jr. (2009). *Project Management: A Managerial Approach,* 7th edition, Wiley, Hoboken, NJ.

NASA (1996). *NASA Strategic Management Handbook*. Retrieved on June 1, 2010 from http://www.hq.nasa.gov/office/codez/strahand/roles.htm.

NASA (1997). *NASA Facts.* Retrieved on June 1, 2010 from http://www.nasa.gov/centers/goddard/pdf/106040main_coquidos.pdf

NASA (2002). *Earned Value Management* (NPD 9501.3A). Retrieved on June 1, 2010 from http://www.ksc.nasa.gov/procurement/kics/docs/npd95013a.pdf.

NASA (2006). *Functions of the Office of Chief Engineer.* Retrieved on June 1, 2010 from http://oce.nasa.gov/oce/functions/home/index.html.

NASA (2007/2008). *Plan for Improvement in the GAO High-Risk Area of Contract Management.* Retrieved on June 1, 2010 from http://www.nasa.gov/news/budget/index.html.

NASA (2008a). *NASA High Risk Corrective Action Plan Executive Summary and Definition of Success.* Retrieved on June 1, 2010 from http://www.nasa.gov/pdf/284074main_NASAHigh-Risk-CAPSum-09-08.pdf.

NASA (2008b). *NASA Information Technology and Institutional Infrastructure Program and Project Requirements.* Retrieved on June 1, 2010 from http://nodis.gsfc.nasa.gov/displayDir.cfm?Internal_ID=N_PR_7120_0007_&page_name=main.

NASA (2008c). *NASA Space Flight Program and Project Management Requirements*. Retrieved on June 1, 2010 from http://nodis3.gsfc.nasa.gov/npg_img/N_PR_7120_005D_/N_PR_7120_005D_.pdf.

NASA (2009/2010). *Earned Value Management (EVM): Implementation Handbooks*. Retrieved on June 1, 2010 from http://evm.nasa.gov/handbooks.html.

National Defense Industrial Association (NDIA) (2006). *Project Management Systems Committee (PMSC) Earned Value Management Systems Intent Guide*. Retrieved on June 1, 2010 from http://www.ndia.org/Divisions/ Divisions/Procurement/Documents/Content/ContentGroups/Divisions1/Procurement/EVMS_IntentGuide_Nov06.pdf.

Office of Management and Budget (2006). *Capital Programming Guide: Supplement to Office of Management and Budget Circular A-11, Part 7: Planning, Budgeting, and Acquisition of Capital Assets*. Retrieved on June 1, 2010 from http://www.whitehouse.gov/omb/assets/a11_current_year/part7.pdf.

Office of Management and Budget, Executive Office of the President. (2005). *M-05-23: Improving Information Technology (IT) Project Planning and Execution*. Retrieved on June 1, 2010 from www.whitehouse.gov/omb/memoranda/fy2005/m05-23.pdf.

Office of Management and Budget, Executive Office of the President. (2008). *Analytical Perspectives, Budget of the United States Government, Fiscal Year 2008*. Retrieved on June 1, 2010 from http://georgewbush-whitehouse.archives.gov/omb/budget/fy2008/pdf/spec.pdf.

Office of Management and Budget, Executive Office of the President (2008). *Circular A-11, Part 7, Planning, Budgeting, Acquisition and Management of Capital Assets*. Retrieved on June 1, 2010 from http://www.whitehouse.gov/omb/circulars/a11/current_year/s300.pdf.

Oracle Corporation (2009). *Earned Value Lite: Making Earned Value Management Work for Every Project*. Redwood Shores, CA. Retrieved on June 1, 2010 from http://www.oracle.com/applications/primavera/earned-value-lite-white-paper.pdf.

Pakiz, J.J. (2006). *The EVMS Light Book I*. Program Management Systems, Long Beach, CA.

Project Management Institute. (2005a). *Organizational Project Management Maturity Model (OPM3) Knowledge Foundation,* Project Management Institute, Newtown Square, PA.

Project Management Institute. (2005b). *Practice Standard for Earned Value Management*. Project Management Institute, Newtown Square, PA.

Project Management Institute. (2006). *Government Extension to the PMBOK® Guide Third Edition*. Project Management Institute, Newtown Square, PA.

Project Management Institute. (2008). *A Guide to the Project Management Body of Knowledge* (4th ed.). Project Management Institute, Newtown Square, PA.

Solomon, P.J. and R.Y. Ralph (2007). *Performance-Based Earned Value*. Wiley, Hoboken, NJ.

Stratton, R.W. (2006). *The Earned Value Management Maturity Model*. Management Concepts, Vienna, VA.

The Under Secretary of Defense, Acquisition, Technology and Logistics. (2005). *Revision to DoD Earned Value Management Policy*. Retrieved on June 1, 2010 from https://acc.dau.mil/GetAttachment.aspx?id=19553&pname=file&aid=1026&lang=en-US.

Thomas, J. and M. Mullaly. (2008). *Researching the Value of Project Management*. Project Management Institute, Newtown Square, PA.

Turner, J.R., M. Huemann, F.T. Anbari, and C.N. Bredillet (2010). *Perspectives on Projects*. Routledge, London and New York.

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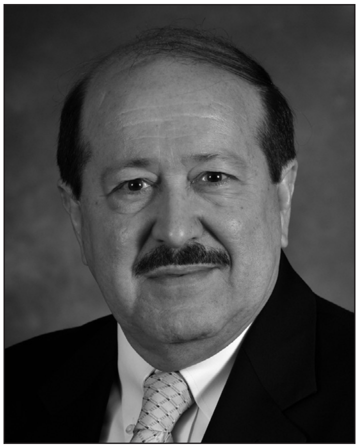

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