

# The Origins and History of Earned Value Management <sup>1</sup>

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## Introduction

The concept of controlling the work of projects has a long history of continuous development and innovation. Surprisingly sophisticated project control systems existed long before the concept of modern project management emerged in the first half of the 20<sup>th</sup> century.

In the past, tools being used defined the practice and the profession of traditional, and then modern, project management as we currently understand it, and this trend is continuing. The major phases of development of project controls being:

1. From early times through to the 1950s
2. From 1950s through to the present
3. Future interactive and intelligent systems.

Prior to the 1950s, the primary control tools showed static representations of deterministic data. The sophistication of both the management data, and its representation in reports improved over the centuries, but the controls processes focused on reactive management actions to correct observed deviations from the plan.

The current phase of development of project controls uses largely deterministic information to predict future outcomes. This phase of development started in the late 1950s with PERT and CPM schedules, and has progressed through to the point where there is general acceptance that Earned Value and Earned Schedule are among the best of the predictive control tools. Management is now expected to be proactive, working to minimize the negative effect of future problems identified using the predictive tools as well as dealing with current negative variances<sup>2</sup>. Earned Value Management (EVM), incorporating Earned Schedule (ES), is likely to be the pinnacle of development in this type of deterministic project control tool.



“Those who don’t study history are doomed to repeat it. Yet those who *do* study history are doomed to stand by helplessly while everyone else repeats it.”

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<sup>2</sup> For more on **the evolution of project management and project controls** see: <https://mosaicprojects.com.au/PMKI-ZSY-005.php#Overview>

The next generation of project controls are predicted to be integrated, adaptive, and intelligent<sup>3</sup>, with a focus on maximizing the efficient use of the project's resources. These tools will use machine learning, and be integrated into the systems used to design and develop the project's outputs<sup>4</sup> rather than operating as separate processes.

The purpose of this paper is to trace the history of the development of EVM and ES from the 1960s through to the present, in the hope that understanding the roots of the techniques will assist in transitioning EVM's core concepts across to the next generation of control tools, and encouraging their use in the current environment. The legal and management framework around modern project management is unlikely to change in next decade as fast as the technology, consequently organizations will benefit from the wide spread adoption of current best practices, which should include the use of EVM and ES.

## Defining Earned Value and Earned Schedule

For the purposes of this paper, I have adopted a fairly broad definition of Earned Value<sup>5</sup>:

- **Earned Value (EV)** – a performance measurement based on the value of work completed in a period, or cumulative to date, expressed in terms of the budget assigned to that work.
- **Earned Value Management (EVM)** – a management approach that integrates project<sup>6</sup> scope (technical performance), budget (cost performance), and schedule (time performance) for the assessment of a project's progress, and its predicted performance, by applying earned value techniques.
- **Earned Schedule (ES)** – an extension of earned value management which calculates schedule metrics and indicators on the time axis, rather than on the cost axis used by traditional earned value metrics.
- **Earned Value Management System (EVMS)** – The policies, processes, procedures, and tools (software) used by an organization to support its EVM practices.

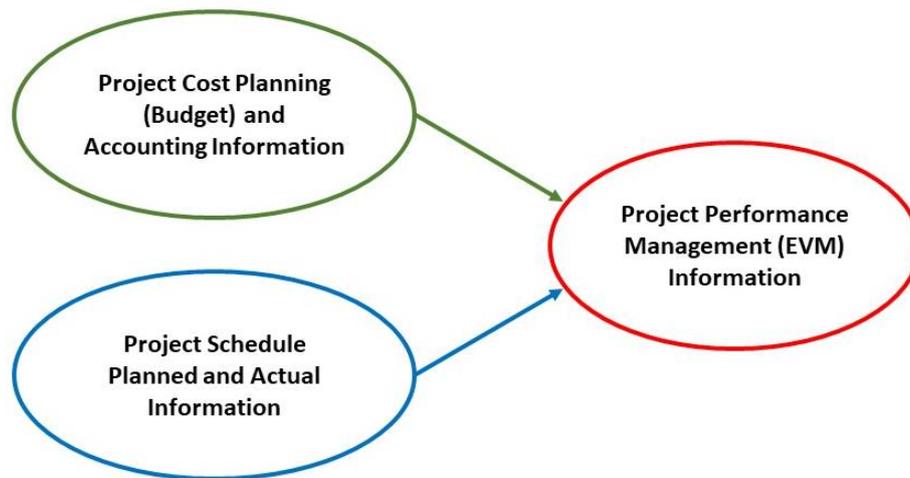
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<sup>3</sup> One example is the trends towards 5D BIM in the construction industries discussed in *Projects controls using integrated data – the opportunities and challenges!*  
[https://mosaicprojects.com.au/PDF\\_Papers/P200\\_Projects\\_controls\\_using\\_integrated\\_data.pdf](https://mosaicprojects.com.au/PDF_Papers/P200_Projects_controls_using_integrated_data.pdf)

<sup>4</sup> For more on *the future of project controls* see: <https://mosaicprojects.com.au/PMKI-SCH-005.php#Process2>

<sup>5</sup> For more on what EVM is, and is not, see *Earned Value Management Six things' people don't get!*:  
[https://mosaicprojects.com.au/Mag\\_Articles/AA011\\_EVM\\_Things\\_people\\_dont\\_get.pdf](https://mosaicprojects.com.au/Mag_Articles/AA011_EVM_Things_people_dont_get.pdf)

<sup>6</sup> For convenience, where the term 'project' is used in the remainder of this paper, it should be read as 'project or program'. EVM is equally applicable to both projects and programs.



The distinguishing feature of EVM and ES is the use of standard formulae to identify current variance in performance (both as a ratio and as a value), and based on this data predict future outcomes in a consistent manner<sup>7</sup>. The metric used in EVM calculations is usually money however, this is not a determinant of EVM or ES, any generally applicable metric from within the project's data set can be used to define the budget, the EV and the AC.

EVM is not a cost management or a cost accounting function. It is a performance management tool. Where money is used as the metric in an EVMS, the financial information comes from the project accounting system and is supported by information from the project's schedule management system.

Also, as with any other modelling system, the accuracy of future predictions depends on the quality of the data and other factors such a management action influenced by the information provided. There is solid evidence that predictions generated by EVM and ES are more accurate than most other approaches to determining future outcomes of a project, but this discussion is beyond the scope of this paper.

## The Evolution of EVM

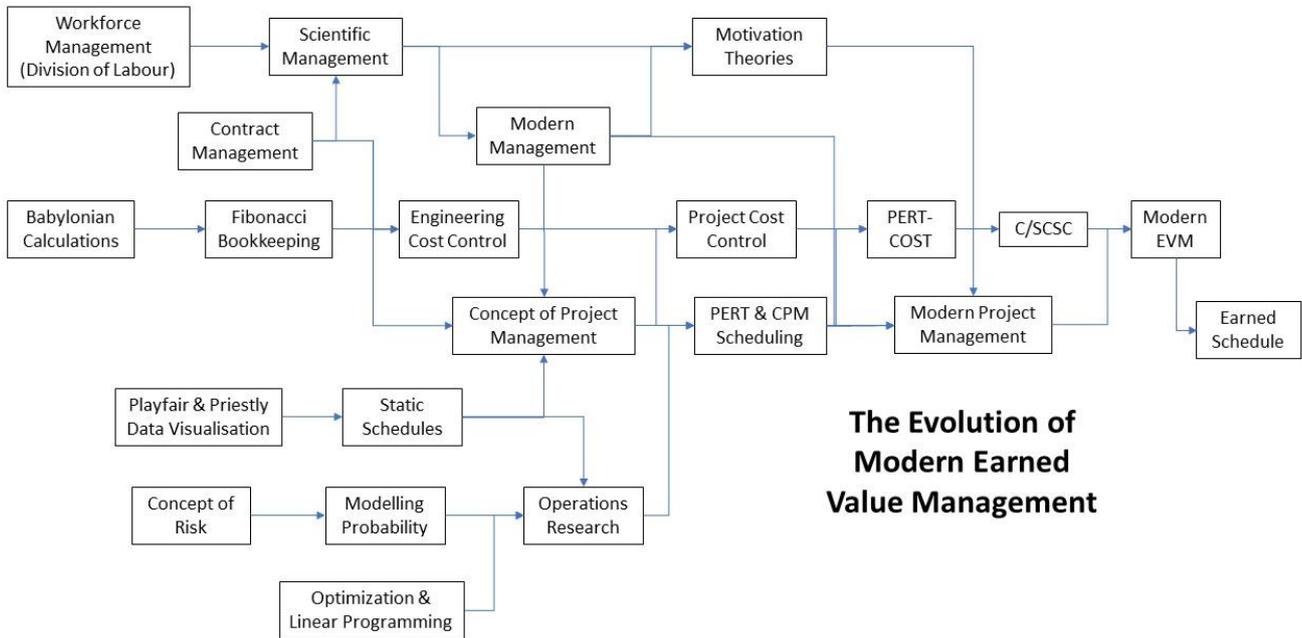
This paper focuses on the development of EVM from the early 1960s to the present time including

- a. PERT/Cost
- b. C/SPCS and C/SCSC
- c. Modern EVM and ES

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<sup>7</sup> The *formulae used in a standard EVMS* are described in:  
[https://mosaicprojects.com.au/Mag\\_Articles/N012\\_Earned\\_Value\\_Basics.pdf](https://mosaicprojects.com.au/Mag_Articles/N012_Earned_Value_Basics.pdf)  
This paper assumes a working knowledge of EVM.

However, the various concepts and techniques that were adapted for use in project controls, and evolved into modern EVM have very deep roots. The flow diagram below is a simplification, spanning some 5000 years – it is not intended to be definitive and is definitely not time-scaled<sup>8</sup>.



The four core components that modern EVM is built on are:

1. The concept of a **project** (or program) that defines the scope of work to be achieved and sets management parameters to be achieved. The concept of *modern project management* creates the environment within which EVM can be deployed<sup>9</sup>.
2. The **Work Breakdown Structure (WBS)** that is used to decompose the scope of work of the project into manageable elements. Where a WBS is used in EVM, the focus is on the Control Accounts and their underlying Work Packages.
3. The practice of **project or engineering cost control**.
4. The practice of **dynamic project scheduling**<sup>10</sup>.

Each of these are valuable management tools that can be used standalone, but need to be integrated to create an effective EVMS. The origins of each of these elements have been explored in the referenced papers, leading onto the development of EVM as it currently exists.

<sup>8</sup> For more on the *Origins of Modern Management* see:  
[https://mosaicprojects.com.au/PDF\\_Papers/P050\\_Origins\\_of\\_Modern\\_Management.pdf](https://mosaicprojects.com.au/PDF_Papers/P050_Origins_of_Modern_Management.pdf)

<sup>9</sup> For more on the *Origins of Modern Project Management* see:  
[https://mosaicprojects.com.au/PDF\\_Papers/P050\\_Origins\\_of\\_Modern\\_PM.pdf](https://mosaicprojects.com.au/PDF_Papers/P050_Origins_of_Modern_PM.pdf)

<sup>10</sup> The development of dynamic schedules (CPM and PERT) is described in *A Brief History of Scheduling* see:  
[https://mosaicprojects.com.au/PDF\\_Papers/P042\\_History\\_of\\_Scheduling.pdf](https://mosaicprojects.com.au/PDF_Papers/P042_History_of_Scheduling.pdf)

## In the beginning

This paper looks at the development of EVM starting with the introduction of PERT/Cost in the early 1960s. Prior to this time, most of the foundations needed for EVM had been established.

- Construction and engineering cost controls had been developed by the 1920s<sup>11</sup>
- Critical path scheduling (CPM) by 1957<sup>12</sup>
- PERT schedules also by 1957<sup>13</sup>
- Work Breakdown Structures (WBS)<sup>14</sup> as part of the PERT developments, and
- Organizational Breakdown Structures (OBS) by 1854<sup>15</sup>.

The challenge facing the United States Department of Defense (DoD) in the early 60s, which led them to pioneer many of today's project management techniques, was the requirement for rapid responses to the changing threats of the 'cold war'. Meeting these challenges often required the DoD contractors and program managers to develop totally new technology. But, when attempting to do something that has never been done before in a hurry, the development program is inevitably high risk! Which in turn makes it difficult, if not impossible, to establish a sensible firm price for the work.

With its priority being the speed of delivery so as to maintain a technological edge over the Russians, the DoD had to accept a large proportion of the cost risk inherent in its programs through the use of various forms of flexibly priced, or cost-plus, contract. The resulting large (often \$Billion+), high-risk contracts not only pushed the technical state of the art, they also challenge accepted management techniques<sup>16</sup>.

The DoD is, and was, a public agency subject to constant scrutiny by various government entities, the public, the Congress, and the Senate. As a result of these pressures, in the early part of the 1960s, the DoD recognized that the cost management control systems currently in use on large Defense programs needed to be improved to compensate for the increased uncertainty, and accepted risks, inherent in the rapid development of new high-tech weapon systems. The traditional approach to cost control developed in the 1920s for construction and engineering projects was not working.

Under the traditional *spend-plan* system, contractors were required to report actual expenditures against planned expenditure. But, in a program where the technology was

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<sup>11</sup> See the *Origins and History of Cost Engineering*:

[https://mosaicprojects.com.au/PDF\\_Papers/P207\\_Cost\\_History.pdf](https://mosaicprojects.com.au/PDF_Papers/P207_Cost_History.pdf)

<sup>12</sup> See the *Origins of CPM* at: <https://mosaicprojects.com.au/PMKI-ZSY-030.php#Overview>

<sup>13</sup> See the *Origins and limitations of PERT* at: <https://mosaicprojects.com.au/PMKI-ZSY-030.php#Process2>

<sup>14</sup> See *The Origin of Work Breakdown Structures (WBS)* at: <https://mosaicprojects.com.au/PMKI-ZSY-020.php#WBS>

<sup>15</sup> See *Organization Charts* at: <https://mosaicprojects.com.au/PMKI-ZSY-020.php#OrgChart>

<sup>16</sup> Wayne F. Abba. *Earned Value Management — Reconciling Government and Commercial Practices*. PM: Special Issue January - February 1997. [https://mosaicprojects.com.au/PDF-Gen/Aba\\_on\\_EVM\\_1997.pdf](https://mosaicprojects.com.au/PDF-Gen/Aba_on_EVM_1997.pdf).

continually being developed and evolving, the money spent often had no objective relationship to the work accomplished in the reporting period.

New schedule management tools had been developed by the Navy starting in the late 1950s, initially PERT by the Polaris Program office in 1957<sup>17</sup>, and then in 1961, the PDM variant of CPM by the Navy Bureau of Yards and Docks<sup>18</sup>. As these tools were developed, other areas of the DoD, particularly the air force became early adopters of the techniques, and then innovators. By the early 1960s, the DoD was looking to produce similar levels of visibility and control over the cost aspects of its major programs.

The development of PERT/Cost (discussed below) was part of a comprehensive policy change within the DoD, primarily derived from the thinking of Charles Hitch, and implemented by Robert McNamara following his appointment as Defense Secretary in 1961<sup>19</sup>.

Before the McNamara reforms, the DoD developed its force structure based on the allocated budget; it had no pragmatic way of relating costs to weapon systems, tasks, and missions. Over time, the reforms changed this approach; with cost estimating and requirements analysis slowly becoming key inputs to both policy development and decision making. Within this framework, the need to effectively manage the cost and performance aspects of programs also became an imperative.

## EVM developments since the 1960s

This paper traces the development of EVM and ES from the creation of PERT/Cost the early 1960s through to the present. By 1960, the DoD and NASA had introduced and to an extent mandated the use of PERT for schedule control on their programs, and in the commercial sphere PERT and CPM were starting to competing for dominance. These systems gave the impression of effective control over the management and scheduling of work, and the DoD was looking to achieve a similar level of control over project costs.

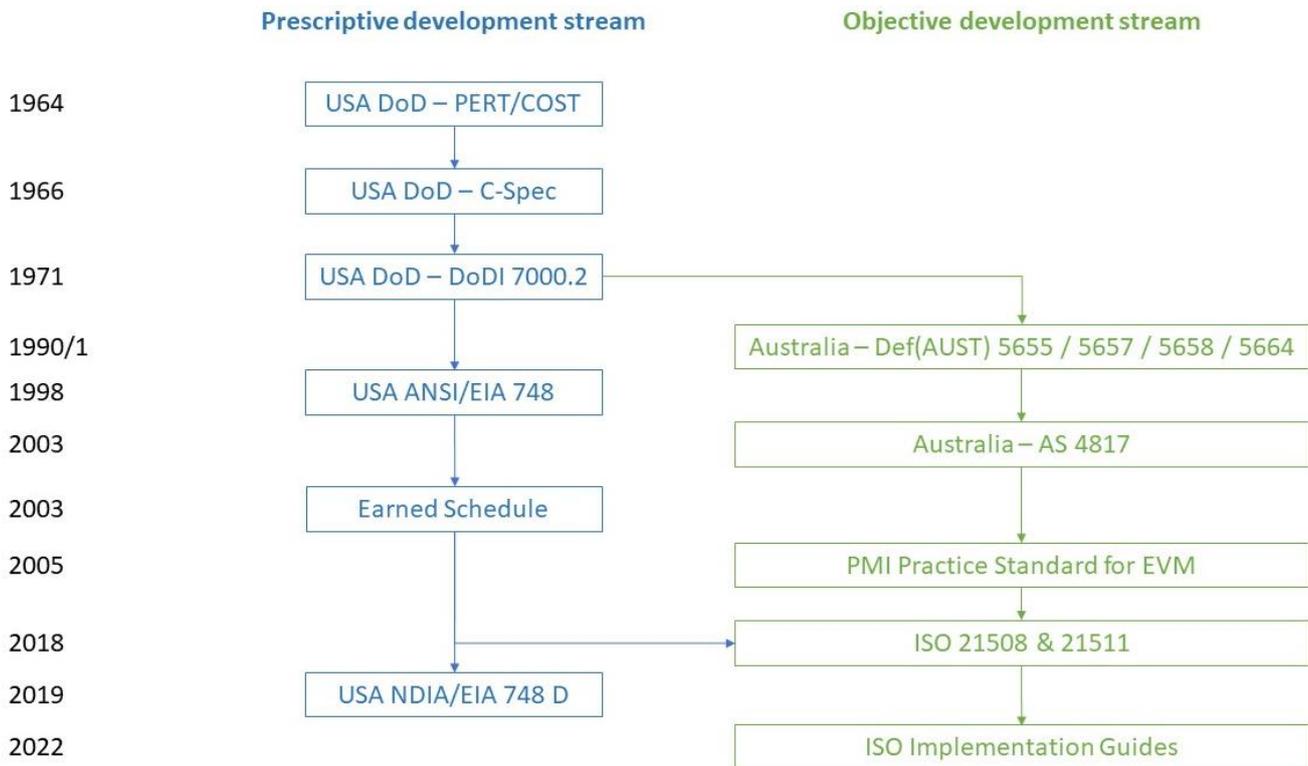
The diagram below shows the general flow of the developments considered in this paper.

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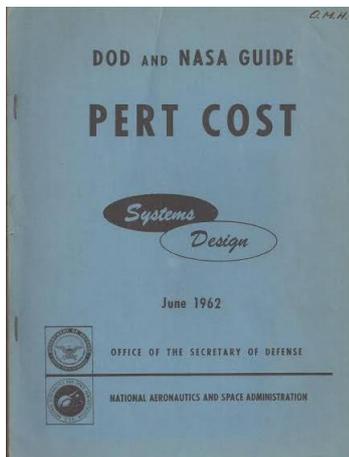
<sup>17</sup> The development of the Polaris missile system was the first generation of the USA Fleet Ballistic Missile program. Starting in 1955, the program included new launch, guidance and control systems for the missile, and a new generation of submarines large enough to carry the missiles.

<sup>18</sup> For more on the *Origins of PDM (Precedence Diagramming Method)* version of CPM see:  
<https://mosaicprojects.com.au/PMKI-ZSY-030.php#Process1>

<sup>19</sup> The development of the DoD policy framework from the 1960s to 1980 is described in  
*COST DATA BASE DEVELOPMENT - A TWELVE-YEAR PERSPECTIVE*, 1981:  
[https://mosaicprojects.com.au/PDF-Gen/Cost\\_Data\\_Development\\_1981.pdf](https://mosaicprojects.com.au/PDF-Gen/Cost_Data_Development_1981.pdf)



## PERT/Cost



Between 1960 and 1962 a joint Stanford/Navy team embarked on a project to expand PERT to include resources. Their assumption was if you could accurately simulate the work of a project by creating a logic network, adding resources into the network will facilitate the management of both time and costs. This resource/cost-loaded network system was called PERT/Cost. The first implementations worked after a fashion and the system evolved over time into a more robust model, but the concepts were often misunderstood by other programs that attempted to apply it.

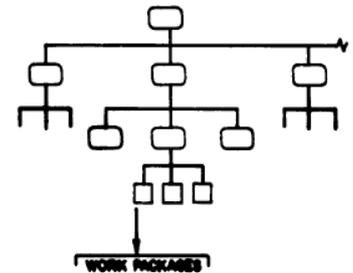
Despite the challenges, on June 1, 1962, PERT/Cost was adopted by Secretary of Defense Robert S. McNamara and Robert C. Seamans, Jr., Associate Director of National Aeronautics and Space Administration (NASA) as the standard supervisory format for major weapons and space programs.

To rationalize and coordinate developments, the DoD established the *OSD<sup>20</sup> PERT Coordinating Group*. However, by 1964, more than ten different PERT/Cost variations existed, each with a unique set of *how-to-manage* requirements imposed on the contractors by a DoD or NASA

<sup>20</sup> OSD = Office of the Secretary of Defense

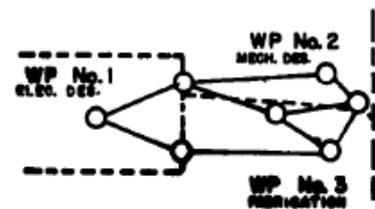
program. Industry viewed with alarm this proliferation of complex management systems, required by their various government customers. To standardize practice, the *OSD PERT Coordinating Group* published a set of requirements for the PERT/Cost system. The six basic concepts underlying the system<sup>21</sup> were:

1. **A work breakdown**<sup>22</sup>: The overall program is broken down by the government and the contractors into successively smaller pieces of hardware, services, equipment, or facilities until manageable units for planning and control are derived. A WBS code structure is used to permit cost summarization.

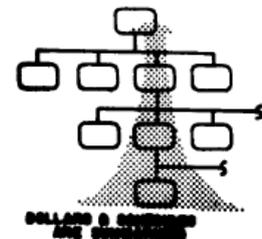


2. **Work Packages**: Work packages are established for each of the lowest level units on the work breakdown, and a charge number is assigned to each work package.

3. **Networks**: Networks are constructed which graphically interrelate activities and work packages. PERT/Time used an Activity-on-Arrow notation to construct the schedule, however, contractors were allowed to select their own scheduling approach for use in a PERT/Cost system.



4. **Time/Cost Interrelation**: Time and cost data can be directly correlated at the work package level and rolled up to the total program level. Summarization of work package costs enables the same comparison to be made for the total program and for each end item.



**Note:** As with modern EVM, the project accounting system and the project schedule are separate functions, integrated at the work package level and then rolled up to higher level summaries. This is a significant change from the first iteration of PERT/Cost developed by the Navy which included the resources in the PERT schedule.

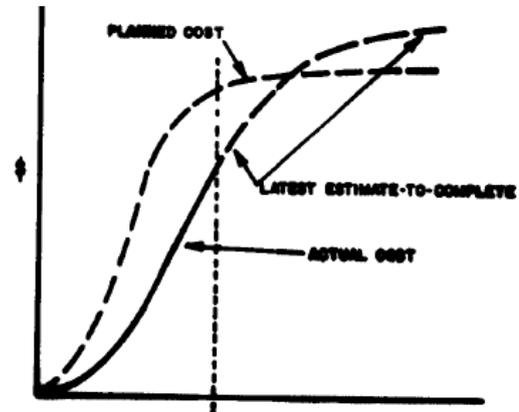
<sup>21</sup> Taken from the *USAF PERT COST System Description Manual*, download from: [https://mosaicprojects.com.au/PDF-Gen/USAF\\_PERT-COST\\_System\\_Description\\_Manual.pdf](https://mosaicprojects.com.au/PDF-Gen/USAF_PERT-COST_System_Description_Manual.pdf)

See also *USAF PERT COST System Description Manual*, download from: [https://mosaicprojects.com.au/PDF-Gen/PERT\\_Time\\_System\\_Manual\\_1963.pdf](https://mosaicprojects.com.au/PDF-Gen/PERT_Time_System_Manual_1963.pdf)

<sup>22</sup> **Note:** the concept of a WBS was integral to the original PERT/TIME concept (1957), PERT/COST formalized the WBS design and specifically included the concept of using the WBS to roll up costs, etc. For more on *The Origins of the WBS* see: [https://mosaicprojects.com.au/PDF\\_Papers/P207\\_WBS\\_History.pdf](https://mosaicprojects.com.au/PDF_Papers/P207_WBS_History.pdf)

5. **Cyclic Updating of the Estimates:** Periodically, an estimate-to-complete is made for each work package which is in progress or not yet performed. The addition of the actual costs incurred, plus the estimates to-complete produces the estimate at completion for the work package.

**Note:** Unlike PERT/Time, PERT/Cost only used a single cost estimate for the work package, derived from resource cost rates.



6. **Program Evaluation/Decision/Action:** Program evaluation is continuous throughout the life of the program. Management decisions are based on analyses and comparisons of actual to planned.

The PERT/Cost report formats were also defined by the *OSD PERT Coordinating Group*<sup>23</sup>. These report formats are the basis for most EVM reports in use today. For example, the Cost of Work report has most of the characteristics of the standard EVM 'S-Curve' chart:

<sup>23</sup> The PERT/Cost report formats are described in *DOD and NASA Guide, PERT COST Output Reports*, download from: [https://mosaicprojects.com.au/PDF-Gen/DOD\\_and\\_NASA\\_Guide\\_PERT\\_Cost\\_Output\\_Reports.pdf](https://mosaicprojects.com.au/PDF-Gen/DOD_and_NASA_Guide_PERT_Cost_Output_Reports.pdf)

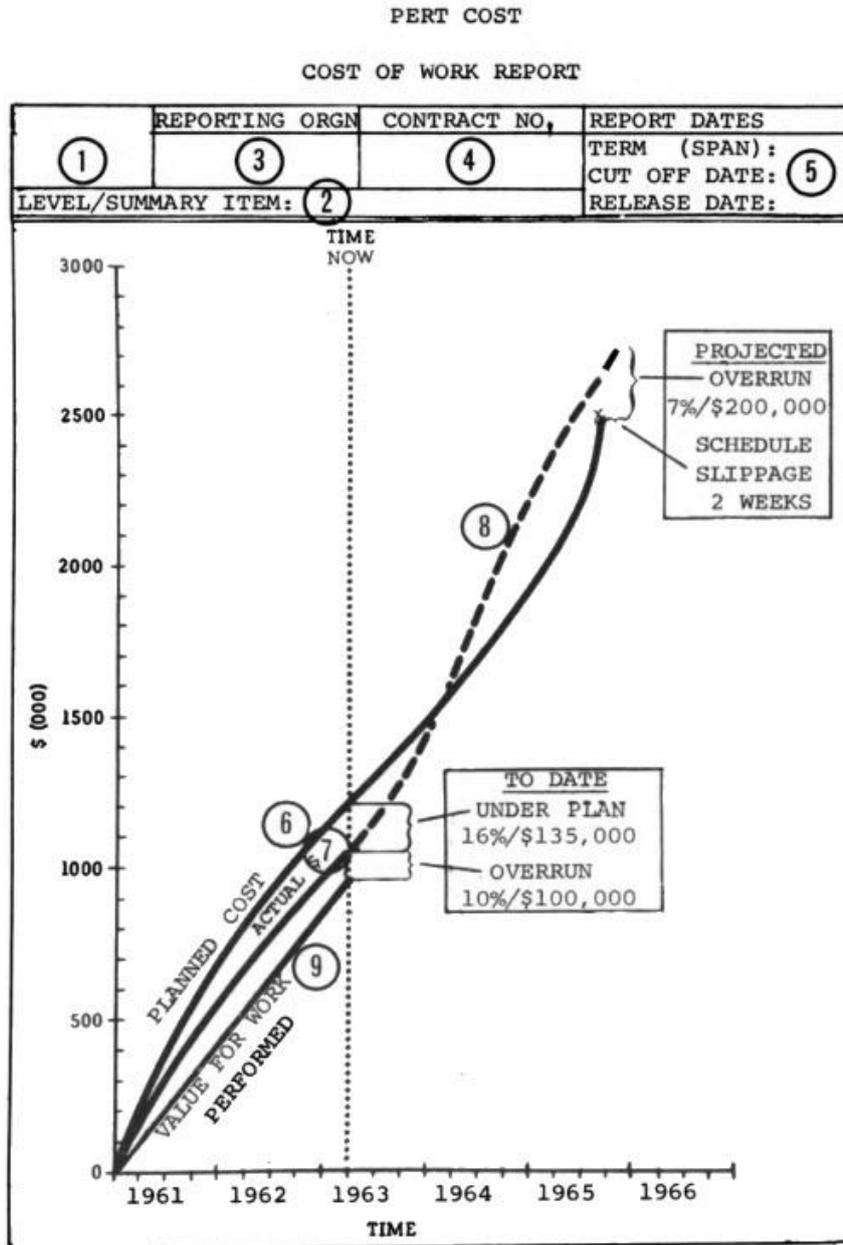


Figure 15  
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These curves were derived from more detailed reports based on the project WBS. The example below with instructions on competing the main part of the table are from *DOD and NASA Guide, PERT COST Output Reports*:



A review of the PERT/Cost system as evolved was commissioned in June 1964 from The Mitre Corporation under contract AF 19(628)-2390<sup>24</sup>. The findings from this review echo the problem of valuing EVM and similar project management tools and systems through to the present day:

#### **NO STRAIGHTFORWARD WAY TO EVALUATE PERT/COST**

**The major conclusion of this study is inescapable: there is no straightforward way to evaluate PERT/COST. The value of the system is intimately related to both the quality of its implementation and the capability and willingness of the appropriate managers to use it. The consequences of using the system can be ramified indefinitely. Military programs are not comparable, and standards do not exist. While value judgments about PERT and PERT/COST can be made meaningfully by those experienced in their use, there is no available methodology or established skill base capable of evaluating PERT/COST professionally on either an objective or a subjective basis.**

Despite the difficulty in evaluating PERT/Cost, the USA Dept. of Defense obviously saw value in these systems because development continued.

#### **Summary**

The major difference between PERT/Cost and EVM is in the way progress is measured and outcomes forecast for work packages in progress:

- PERT/Cost:
  - An Estimate to Complete for each work package is made by the supervisor
  - The Latest Revised Estimate (Total at Completion) is the Actual Cost, plus the Estimate to Complete.
  - The percent complete is (Actual Cost / Latest Revised Estimate) \*100
  - Planned Costs are recorded separately.
- EVM:
  - The value of work completed (EV) is determined by applying the objective measure of performance to the Planned Value (PV)
  - The Cost Performance Index is the EV/ Actual Costs
  - The Estimate at Completion (ie, Total at Completion) is calculated from the Total Planned Cost (BAC) / CPI<sup>25</sup>.

The major innovation in PERT/Cost are:

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<sup>24</sup> Download the Mitre report 'Study of Methods for Evaluation of the PERT/Cost Management System' from: [https://mosaicprojects.com.au/PDF-Gen/PERT-Cost\\_Evaluation\\_1964.pdf](https://mosaicprojects.com.au/PDF-Gen/PERT-Cost_Evaluation_1964.pdf)

<sup>25</sup> **Note:** There are a number of ways to calculate the IEAC, this option is the simplest.

1. The introduction of a routine process for determining the expected final cost of the project based on assessments made at the work package level. The performance measurement baseline used for PERT/Cost was frequently updated estimates, this factor separates the development of EVM from traditional cost engineering.
2. The invention of work packages, and the integration of schedule information and cost information (planned and actual) at the work package level.

The major change between PERT/Cost and later version of EVM is the removal of a subjective estimate to complete from the calculations, this is replaced by the introduction of objective measures of performance to determine the Earned Value, and the use of pre-defined measures and calculations.

The biggest issues with the standardized PERT/Cost processes were in part:

- Associated with the bureaucracy that grew up around the implementation and assessment of the overall 'standard' system by the *OSD PERT Coordinating Group*,
- Caused by the proliferation of non-standard PERT/Cost systems,
- Caused by a fairly widespread misunderstanding that PERT/Cost involved costing a PERT schedule network at the activity level (which was not the intention)<sup>26</sup>, and
- The cost to industry caused by the imposition of a government-imposed management systems at contractor locations, which led to the development of parallel systems, one for internal management and other to meet government requirements.

These factors were canvassed at the AFSC Industry Conference held in Monterey, California, in May 1962, and were the trigger for C/SPCS.

## **C/SPCS (C-Spec)**

There were two main streams of development within the USAF that merged to become the US Air Force Cost/ Schedule Planning and Control Specification or C/SPEC. One lead by contractor, and later Air Force executive, A. Ernest 'Ernie' Fitzgerald and the other by Air Force officer Hans 'Whitey' Driessnack (who would retire as a lieutenant general). These two strands, and their merger to become C/SPEC are discussed below.

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<sup>26</sup> This misunderstanding carried forward for many years, for example from the late 1960s see, *PERT Time/Cost; An Aid to Agribusiness Management*. Ken D. Duft, Extension Marketing Economist, Washington State University: [https://mosaicprojects.com.au/PDF-Gen/PERT-Time+Cost\\_Manual.pdf](https://mosaicprojects.com.au/PDF-Gen/PERT-Time+Cost_Manual.pdf)

## A. Ernest 'Ernie' Fitzgerald

In 1963, building on the PERT/Cost efforts, Air Force implemented the first earned value management approach on the Minuteman Program. This development was based on creating a set of program management criteria<sup>27</sup> derived from best practices used by American industry.

In parallel with the Minuteman initiative, a similar concept was introduced for the management of the Titan III Space Booster, it is unclear how much information was passed between the two programs<sup>28</sup>.

As discussed above, the performance measurement baseline, and the estimate at completion, used in PERT/Cost was derived from frequently updated estimates. This use of estimates was both the strength of PERT/Time, and the weakness of PERT/Cost. There is a sharp distinction between the use of cost estimates, regardless of how detailed or often they are created, and the use of a standards-based measurement baseline – this is the critical difference between PERT/Cost and Earned Value.

Recognizing that program performance measurement, and more importantly, Estimates at Completion (EACs), were not going to improve with the tools then available, Ernie Fitzgerald formed a consulting firm, Performance Technology Corporation (PTC), to address these and other problems.

One of its first products was the seminal ***Earned Value Summary Guide***, submitted in partial fulfillment of a contract with the Ballistic Systems Division (BSD), Air Force Systems Command (AFSC); in draft on February 25<sup>th</sup> and in final on April 30<sup>th</sup> 1965. The draft and final version of the Guide contain a paragraph on page ix which states: *“Earned Value is a concept – the concept that an estimated value can be placed on all work to be performed, and once that work is accomplished that same estimated value can be considered to be “earned.” The utility of this concept as a management tool is that the summation of all earned values for work accomplished when compared to what was actually expended to perform the effort can provide management with a comprehensible, objective indicator of how the total effort or any identifiable segment is progressing.”*

Shortly thereafter (March 21<sup>st</sup>) the first 'criteria' were presented to Ballistics Systems Division (BSD)<sup>29</sup>. They consisted of 11 specifications/criteria and a checklist of 57 items to be used in determining whether the contractor's system was in compliance. These specifications were

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<sup>27</sup> **Criteria** = Brief statements of the attributes that a contractor's management system must meet. For example, any scheduling system could be used, provided that it described not only the sequence of the work, but also significant task interdependencies required to meet contract objectives.

<sup>28</sup> For an overview of the Titan III incentives and control systems see:  
[https://mosaicprojects.com.au/PDF-Gen/Chapman\\_Progress\\_Report\\_on\\_Martins\\_Titan\\_III\\_Incentives.pdf](https://mosaicprojects.com.au/PDF-Gen/Chapman_Progress_Report_on_Martins_Titan_III_Incentives.pdf)

<sup>29</sup> EARNED VALUE SUMMARY GUIDE, (draft copy) with transmittal letter signed by A. E. Fitzgerald, submitted Systems Division, Norton Air Force Base, San Bernardino, California, March 21, 1965, in accordance with CCN #1 to Contract AF 04-(694)- 682.

added to the contracts of the eight Minuteman Associate Contractors, beginning the implementation and validation of Earned Value<sup>30</sup>.

Concurrent with the introduction of Earned Value on the Minuteman Program, the Air Force began to consider the application of Earned Value to other major programs. Dr. Marks, Assistant Secretary of the Air Force, asked PTC to draft criteria based on the Minuteman Earned Value specs. In the Fall of 1965, Ernie supervised the drafting of what became the C/SPCS criteria. It was then forwarded for review and comment by a committee established to consider alternatives as well as to various Air Force Staff officers.

### **Hans H. 'Whitey' Driessnack**

Hans H. Driessnack (LT GEN at retirement), has recorded an oral history of his USAF career<sup>31</sup>. He served from 1951 to 1983 (including flying in Korean war). In 1963 he was assigned to the Air Force Systems Command (AFSC) as Comptroller in the Management Systems Development Division where he was involved in developing the USAF PERT documentation (Five manuals including volume III, PERT/Cost).

In 1964 Driessnack was transferred to the Office of the Assistant Secretary of the Air Force where he participated in a number of *OSD PERT Coordinating Group* meetings before instigating the decision to withdraw Air Force from the group. The *OSD PERT Coordinating Group* closed a short time later.

In reaction to the lack of flexibility shown by the *OSD PERT Coordinating Group* in implementing the PERT/Cost system (compliance with the manual was mandated), Driessnack drafted a set of ten criteria that in his view described the cost and schedule control systems that would be needed by an effective contractor to comply with the PERT-Cost requirements.

### **Creating C/SPEC**

The two lines of development merged when Ernie Fitzgerald was appointed Deputy Assistant Secretary for Management Systems in 1965.

Over a period of several months, the original criteria were refined and expanded into the ***Cost/Schedule Planning and Control Specification*** (C/SPCS - from where the term "C-Spec" originated.)

The specification approach, established clearly defined criteria that the contractor's systems were audited against. Give the marketing claims made by various contractors describing the excellence of their respective control systems, it was virtually impossible for industry to rebut

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<sup>30</sup> *How It All Began: The creation of earned value and the evolution of C/SPCS and C/SCSC*. James B. Morin. The Measurable News. 2016.01. Download from:  
[https://mosaicprojects.com.au/PDF-Gen/James\\_B.Morin-EVM\\_How\\_It\\_All\\_Began.pdf](https://mosaicprojects.com.au/PDF-Gen/James_B.Morin-EVM_How_It_All_Began.pdf)

<sup>31</sup> The full Hans H. Driessnack oral history can be downloaded from:  
[https://mosaicprojects.com.au/PDF-Gen/DRIESSNACK\\_HANS\\_H\\_Oral\\_History.pdf](https://mosaicprojects.com.au/PDF-Gen/DRIESSNACK_HANS_H_Oral_History.pdf)  
The sections referenced above start at page 105 of 525.

this approach. An approach that has continued for over fifty years, and has seen widespread use in other areas, including Material Management and Accounting Systems (MMAS) and Estimating Systems.

C/SPCS required the contractor to operate a single, formal, integrated controls system that served both the needs of the contractor and the needs of the government. There were 26 specifications that a contractor's system had to meet, including the requirement for a WBS, work packages, and integration with the schedule. New concepts included the introduction of Cost Accounts<sup>32</sup>, Level-of-Effort work packages, and management reserves (undistributed budget)<sup>33</sup>.

The Estimated Cost at Completion was now calculated:

$$\frac{\text{Actual Cost}}{\text{PVWA}} \times \text{Contract Target Cost} = \text{Estimated Cost at Completion}$$

C/SPCS was published as Annex 4 of Air Force Systems Command Manual (AFSCM) 70-5 in June 1966 and transmitted to AFSC Divisions and Centers by Herbert L. Repetti, Deputy Director of Procurement, on the 1<sup>st</sup> of August 1966. C/SPSC was revised in June 1967<sup>34</sup>. By this time the specification had been consolidated and restated into 35 criteria.

Some of the more interesting differences with the later C/SCSC are:

- a) Instead of BCWS and BCWP, the specification used PVWS (Planned Value of Work Scheduled) and PVWA (Planned Value of Work Accomplished)<sup>35</sup>,
- b) There was no requirement for a program organizational structure,
- c) There was no provision for unallocated budget, and
- d) ALL material PVWA was to be taken at point of usage.

The C/SPCS system was a USAF development that supported integrated reporting to all levels of management and government. This approach was then adopted by the DoD and evolved to become DoDI 7000.2.

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<sup>32</sup> Page 294, Driessnack oral history 1963: "so you had a functional matrixing with the work breakdown structure. ... Where those two intersected, we called that a cost account".

[https://mosaicprojects.com.au/PDF-Gen/DRIESSNACK\\_HANS\\_H\\_Oral\\_History.pdf](https://mosaicprojects.com.au/PDF-Gen/DRIESSNACK_HANS_H_Oral_History.pdf)

The concept of cost accounts appears to be derived from and similar to the use of cost accounts in the administration of public works. The *Manual of Financial and Accounting Procedures for Public Bodies* (1934), in Section IV describes the need for cost accounts (page 57) as '..... costs are usually assembled and distributed to different work features and work operations of the project through detailed cost accounts. These accounts and the information they provide are essential as a basis for intelligent administrative judgment as to the efficient application of the funds employed on the project. They are also valuable for furnishing comparable cost data where like projects are under construction or are to be undertaken'. Provision is also made for comparing cost accounts with estimates based on standard units for measuring each type of work. Download:

[https://mosaicprojects.com.au/PDF-Gen/Manual\\_of\\_Financial\\_and\\_Accounting\\_Processes\\_1934.pdf](https://mosaicprojects.com.au/PDF-Gen/Manual_of_Financial_and_Accounting_Processes_1934.pdf)

<sup>33</sup> Lorette R.J., Roth B.J. *Cost/Schedule Planning Control Specification*, The Air Force Comptroller Vol.4 No.1, Jan 1970: [https://mosaicprojects.com.au/PDF-Gen/The\\_Air\\_Force\\_Comptroller\\_Vol.4\\_No.1\\_Jan\\_70.pdf](https://mosaicprojects.com.au/PDF-Gen/The_Air_Force_Comptroller_Vol.4_No.1_Jan_70.pdf)

<sup>34</sup> Information provided by Tony Finefield, in an email published by Ray Stratton.

<sup>35</sup> **Comment:** how much easier would life have been if the DoD had stuck to those terms...

## C/SCSC

Dr. Robert N. Anthony, Assistant Secretary of Defense (Comptroller), recognized that the earned value approach had merit beyond the Air Force and decided that it would be worthwhile to expand the Air Force C/SPCS to a DoD-wide requirement. Accordingly, a joint-service team was appointed to determine how best to meet that objective. The result was the issue on December 22<sup>nd</sup>, 1967, of Department of Defense Instruction (DoDI) **7000.2, Performance Measurement for Selected Acquisitions**.

This initial version of DoDI 7000.2 stated that the use of Cost/Schedule Control Systems Criteria (C/SCSC) was required, but did not define, describe, or state the criteria; however, paragraph VI stated that a guide for performance measurement would be distributed separately from the Instruction. the Instruction's purpose was to set the policy for performance measurement throughout DoD.

A *Coordination Draft of the Guide for Performance Measurement* was published on June 28<sup>th</sup>, 1968, but it was neither user-friendly nor definitive. It, in turn, was followed by the *C/SCSC Joint Implementation Procedures*, transmitted on September 10<sup>th</sup>, 1970. Finally, a true *C/SCSC Joint Implementation Guide*, signed by each of the General officers of the appropriate commands, in the format most of us would recognize today, was published on January 27<sup>th</sup>, 1972<sup>36</sup>. This instruction introduced DoD-wide both the earned value concept and the criterion-based approach to management<sup>37</sup>. DODI 7000.2 was reissued in 1977<sup>38</sup>, containing the 35 criteria that remain essentially unchanged today.

This first C/SCSC guide issued in 1972 contained 76 pages, with 12 devoted to discussion explaining the intent of the criteria, the essence of the *Guide*. By 1987, the *Guide* had grown to 102 pages, with 20 pages (a two-thirds increase) in the criteria discussion chapter. This increase is significant because the 'discussions', were simply intended to clarify the criteria, instead they became de facto requirements. For example, despite the repeated cautions in the guide that detailed planning should relate to the nature of the work, arbitrary six-month 'rolling wave' planning horizons became a norm because:

- Contractors who used a six-month rolling wave planning horizon successfully passed the review process,
- Government review teams came to expect six-month planning, and

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<sup>36</sup> MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS, Performance Measurement for Selected Acquisitions, transmitted by Melvin Laird, Secretary of Defense, Jan 27 1972

<sup>37</sup> **Note:** The mandatory procedures for major defense acquisition programs (MDAPS and MAIS) defining the management authorities, requirements, and systems, required by the DoD are defined in DoD Directive 5000.1 and its accompanying DoD Instruction 5000.2, which were first issued in 1971. This procurement framework required the use of C/SCSC and then EVM for specified programs. For a discussion of the origins of the 5000 documents and an analysis of the nine versions issued between 1971 and 1993, download the paper by Joe Ferrara: [https://mosaicprojects.com.au/PDF-Gen/DoD\\_5000\\_documents.pdf](https://mosaicprojects.com.au/PDF-Gen/DoD_5000_documents.pdf)

<sup>38</sup> Download DODI 7000.2, 1977 from: [https://mosaicprojects.com.au/PDF-Gen/DoDI\\_7000.2-1977.pdf](https://mosaicprojects.com.au/PDF-Gen/DoDI_7000.2-1977.pdf)

- Consultants then recommended six month planning horizons to their contractor clients, who could then pass the review process.

In this circular fashion, the judgment inherent in the criterion-based approach often was replaced by rules, both written and unwritten creating a new bureaucratic system of compliance. To take Earned Value Management techniques beyond a government mandate, both private industry and the U.S. government strived to make it more user-friendly and more compatible with the needs of private industry.

In 1974, DODI 7000.10 established the Cost/Schedule Status Report (C/SSR) as a standard means of reporting summarized cost and schedule performance on contracts in conjunction with the Cost Performance Report (CPR), and the Contract Funds Status Report (CFSR)<sup>39</sup>. DODI 7000.10 was reissued in 1979<sup>40</sup>, and subsequently absorbed into the 5000 series of instructions. The basic format of these reports carry through from PERT/Cost to the present day<sup>41</sup>.

DoDI 7000.2 was replaced by DoDI 5000.2 in 1991, which was replaced by DODR 5000.2-R in 1996. 5000.2-R reduced the criteria from 35 to 32 in line with the ongoing work developing ANSI/EIA 748. DoDI 5000.02 remains the Dept. Defense authority for implementing EVM based on EIA 748<sup>42</sup>.

## ANSI/EIA 748

As part of a National Defense Industrial Association (NDIA) initiative, private industry took a proactive role in reengineering the original 35 C/SCSC criteria into the Earned Value Management System criteria, which consisted of 32 straightforward guidelines.

In 1996, these 32 criteria were accepted by the DoD and incorporated as part of DoD Instruction 5000.2-R. In the course of modifying the criteria, two significant shifts occurred:

1. EVM came to be identified more as a project management technique rather than a financial management one.
2. The ownership of earned value transferred from the DoD to private industry.

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<sup>39</sup> *Performance Measurement Systems, Recent Systems Development and Applications*. Rigney, R.A. 1979: [https://mosaicprojects.com.au/PDF-Gen/Performance\\_Measurement\\_Systems\\_Rigney\\_1979.pdf](https://mosaicprojects.com.au/PDF-Gen/Performance_Measurement_Systems_Rigney_1979.pdf)

<sup>40</sup> Download DODI 7000.10 (1979): [https://mosaicprojects.com.au/PDF-Gen/DODI\\_7000.10.pdf](https://mosaicprojects.com.au/PDF-Gen/DODI_7000.10.pdf)

<sup>41</sup> The 7000.10 report formats appear to draw on the standard form of reporting project cost information on US government projects documented in the first half of the 20<sup>th</sup> century. A number of examples can be downloaded from: <https://mosaicprojects.com.au/PMKI-ZSY-020.php#Process1>

<sup>42</sup> DoDI 5000.2 is implemented by the Office of Performance Assessments and Root Cause Analyses (PARCA), download a *2017 overview of the 'new' 5000.2 requirements*: <https://mosaicprojects.com.au/PDF-Gen/PARCA-EVM-POLICY-PS-FINAL.pdf>

See also the U.S. *DoD Earned Value Implementation Guide*: <https://mosaicprojects.com.au/PDF-Gen/DOD-EVMIG.pdf>

To solidify these changes, the Earned Value Management System was adopted as American National Standards Institute (ANSI/EIA) Standard 748 in July 1998<sup>43</sup>. This standard followed the same approach as DoDI 5000.2-R and was adopted by the USA Department of Defense in 1999.

Today EIA-748-D still contains thirty-two criteria as guidelines. A side-by-side review of the 32 Guidelines and the original corresponding criteria would show little change.

Key characteristics of this line of development include:

- The use of four-character acronyms for key variables:
  - BCWS = Budgeted Cost of Work Scheduled, previously PVWS (Planned Value of Work Scheduled) in C/SCSC
  - BCWP = Budgeted Cost of Work Performed, previously PVWA (Planned Value of Work Accomplished) in C/SCSC
  - ACWP = Actual Cost of Work Performed
- Forced compliance with the 32 Criteria and 182 Checklist items told contractors how to structure their businesses to achieve accreditation, but tended to create mountains of paper. It's easy for inspectors to *tick* compliance but is very bureaucratic.

The development of this standard followed the normal regular review and update process applied to all national and international standards:

- ANSI / EIA 748 Initial release approved May 1998 (Electronic Industries Alliance)
- ANSI / EIA 748-A Reaffirmed August 2002
- ANSI / EIA 748-B approved July 2007
- EIA 748-C approved March 2013 (TechAmerica)
- EIA 748-D approved 8 January 2019 (SAE International)

The National Defense Industrial Association (NDIA) is responsible for maintaining the EIA-748 Standard every five years with SAE International, the standards body that now sponsors the EIA 748. However, despite the changes in the responsible organizations, over the last 25 years, the 32 guidelines described in NDIA/EIA-748 have provided a consistent basis to assist the Government and the contractor in implementing and maintaining acceptable EVM systems. The American National Standards Institute (ANSI) is no longer sponsoring this standard.

## Earned Schedule

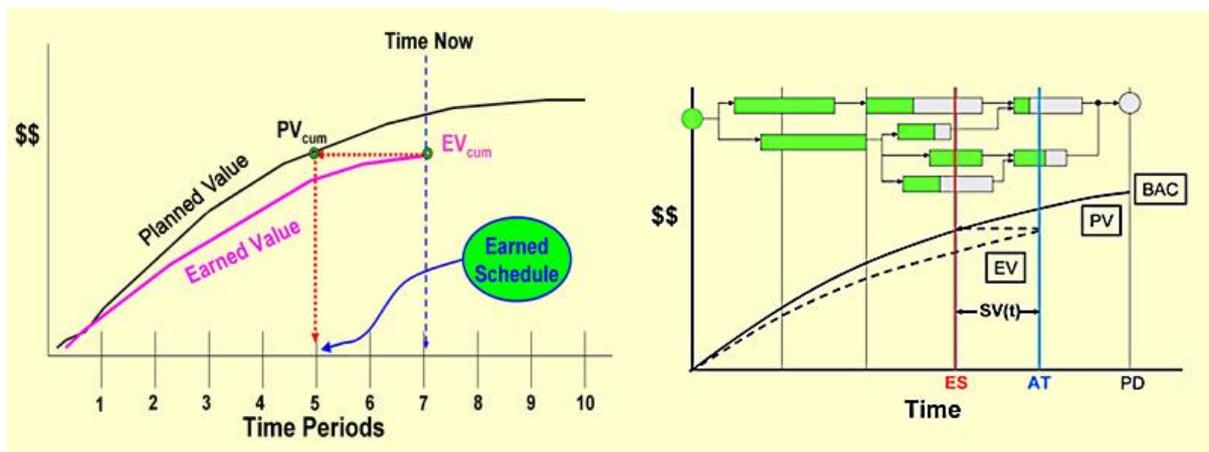
Earned Schedule is an extension to EVM that solves the problem of predicting a time outcome from EV data. Traditional EVM focuses on the cost dimension and using current performance data can provide an accurate prediction of the final project cost, the Independent Estimate At Completion (IEAC). The Cost Variance (CV) and Cost Performance Index (CPI) provide measures

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<sup>43</sup> Download a copy of ANSI/EIA 748:1998 from:  
[https://mosaicprojects.com.au/PDF-Gen/ANSI-EIA\\_748\\_May-1998.pdf](https://mosaicprojects.com.au/PDF-Gen/ANSI-EIA_748_May-1998.pdf)

of the cost efficiency of the project. Traditional Schedule Variance (SV) and Schedule Performance Index (SPI) use the same data and can define the value difference between the amount of work performed compared to the work planned, but this variance cannot be converted into a time prediction. Furthermore, at completion all of the work is accomplished, so the SPI will be 1.0, and the SV will be \$0 regardless of how late the work finished. The traditional answer to this shortcoming in EVM was to refer to the schedule.

This changed in 2003, with the publication by Walt Lipke of *Schedule is Different*<sup>44</sup>, this seminal paper introduced the concept of Earned Schedule (ES) to the EVM community.



Earned Schedule<sup>45</sup> resolved the long-standing dilemma of traditional EVM schedule indicators providing false information for late performing projects. ES has the ability to predict project completion dates, and is the bridge for performing meaningful schedule analysis from the EVM data. It uses the same data as traditional EVM, but shifts the calculations from the cost axis to the time axis.

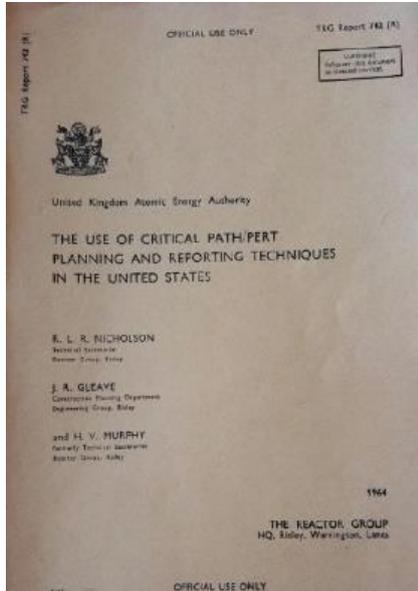
Despite early controversies over the approach, studies by a range of universities and other authorities have shown the project duration predictions calculated by ES are as accurate as the cost predictions generated by traditional EVM. Twenty years after its creation<sup>46</sup>, ES is now seen as a standard component of EVM and is included in most published Standards including ISO and ANSI/PMI.

<sup>44</sup> Lipke, Walt. *Schedule is Different*. The Measurable News, March & Summer 2003. Download from: [https://mosaicprojects.com.au/PDF-Gen/Schedule\\_is\\_different.pdf](https://mosaicprojects.com.au/PDF-Gen/Schedule_is_different.pdf)

<sup>45</sup> For more on Earned Schedule and access to the ES templates see: <https://www.earnedschedule.com/>

<sup>46</sup> For more on the development of Earned Schedule see *Earned Schedule - the First 20 Years*: [https://mosaicprojects.com.au/PDF\\_Papers/P207\\_Earned\\_Schedule\\_the\\_First\\_20\\_Years.pdf](https://mosaicprojects.com.au/PDF_Papers/P207_Earned_Schedule_the_First_20_Years.pdf)

## UK & Other National Standards



Interest in the use of PERT/Time and PERT/Cost spread relatively quickly to other areas of government and to industry both in the USA and overseas<sup>47</sup>. For example, the UK government sent a number of delegations to the USA, including one from the Atomic Energy Authority in 1964 to study PERT/Time.

For some reason, the spread of EVM was slower starting with Australia, UK, Sweden, and other countries only beginning their adoption of EVM in the 1980s. This spread was documented by Dr. Paul D. Giammalvo in a *PM World Today* article in April 2007. As at 2007, the countries that had formally adopted EVM as a government policy are shown in the diagram below using the blue callouts. Those countries that have expressed interest in EVM, not necessarily through government but through introduction by professional organizations such as AACE, IPMA, and/or PMI; or to comply with contractual requirements imposed by overseas buyers (often the Australian Dept. Defence) are shown with red callouts<sup>48</sup>.



<sup>47</sup> For example, *PERT Time/Cost; An Aid to Agribusiness Management*. Ken D. Duft, Extension Marketing Economist, Washington State University. (late 1960s): [https://mosaicprojects.com.au/PDF-Gen/PERT-Time+Cost\\_Manual.pdf](https://mosaicprojects.com.au/PDF-Gen/PERT-Time+Cost_Manual.pdf)

<sup>48</sup> Giammalvo, P.D. (2007). *Earned Value- A Leading Indicator of Clean Governance?* Originally published in *PM World Today*, April 2007. Republished as a Second Edition; *PM World Journal*, Vol. VIII, Issue I (January 2019).

Since 2007 EVM has continued to spread through the European Union but use is very intermittent, and the approach to implementing EVM varies from country to country:

- The default implementation is the USA DoD systems described above leading to NDIA/EIA 748 D. This process was and is driven by the need for organizations to work with the USA defence/industry conglomerate.
- After 2003, organizations contracting with the Australian Dept. Defence were progressively required to use the approach to EVM defined in AS 4817 (described below). The current version of AS 4817 is aligned with ISO 21508.
- Many commercial organizations used the standards and guidelines promulgated by various professional associations. These tended to focus on applying EVM calculations rather than organizational compliance with criteria.
- The relatively new ISO 21508:2018 *Earned value management in project and programme management* may start to become influential after the publication of the implementation guide in 2023 (ISO 21512).

The adoption of EVM in Sweden appears to be a government decision, to improve visibility and control of its defense projects. One of the early implementations being for the Gripen project, the design and development of a supersonic multi-role, single engine military aircraft. The contract between the Swedish aircraft industry and government was signed on June 30, 1982<sup>49</sup> included EVM.

The UK adoption of EVM was varied. The UK EVM implementation is closely coordinated with the USA, see APM/UK/IPMA below, and many contractors used EVM because of their involvement in the USA defense market, but government interest was slow. As late as 1998 the Ministry of Defence (MoD) as part of its Smart Procurement Initiative (SPI) only considered EVM as being consistent with the thrust of the SPI<sup>50</sup>. While the MoD recognized EVM provides an effective management discipline at the working level and a powerful means of communication throughout the project, it was not required. It was not until 1<sup>st</sup> January 2006 the use of EVM started to be mandated for a range of MoD projects.

## **Australian developments Def(AUST) and AS 4817**

The Australian Dept. of Defence was a relatively early adopter of EVM. By the early 1990s it was ready to start publishing its own EVM standards based on the USA DoDI 7000.2 family of documents. In the period 1992/1995 Department published:

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<sup>49</sup> See *Earned value management in Sweden--experiences and examples*:

<https://www.pmi.org/learning/library/evm-sweden-experiences-examples-133>

<sup>50</sup> Andrews, R. Nicholson, M. Blackmore, M. *Earned Value Management in the United Kingdom*. 10th Annual International Integrated Program Management Conference held October 18-22, 1998, Tysons Corner, VA.

- DEF(AUST) 5655, October 1992: Australian Cost/Schedule Control Systems Criteria<sup>51</sup>.
- DEF(AUST) 5657, March 1994: Australian Cost/Schedule Control Systems Criteria Implementation Guide<sup>52</sup>.
- DEF(AUST) 5658, February 1994: Cost/Schedule Status Reporting (CSSR) Specification and Implementation Guide<sup>53</sup>.
- DEF(AUST) 5664, August 1995: Work Breakdown Structures (WBS) for Defence Materiel projects<sup>54</sup>.

These standards started to distinguish between the needs of different size projects. The management system requirements for CSSR defined in DEF(AUST) 5658 were intended for use on lower risk projects and as a consequence were less stringent and permitted the contractor greater flexibility in the selection of its internal performance measurement techniques compared to achieving compliance with the 35 C/SCSC criteria defined in DEF(AUST) 5655.

A trilateral memorandum of understanding (MOU) was signed in 1995 by Australia, Canada, and the United States<sup>55</sup>. The MOU advocated using earned value as the integrating tool for the management of cost, schedule, and technical performance. It also pledged the participants to minimize differences between management practices used for government and commercial activities, including the mutual recognition of contractors accepted as compliant with each participant's requirements.

By the latter part of the 1990s, a view was emerging that the 35 criteria, extensive check lists and complex acronyms of traditional EVM were too complex and needed simplification. The USA response was ANSI / EIA 748 which reduced the criteria from 35 to 32 (not much else changed). Australia and PMI (discussed below) adopted a more radical approach. Both abandoned the concept of 'criteria' and check lists, and both changed the 'complicated' four-letter acronyms to 'simpler' two letter acronyms:

- BCWS became PV
- BCWP became EV
- ACWP became AC

This change seems to have been instigated by PMI in the 2000 edition of the *PMBOK® Guide*.

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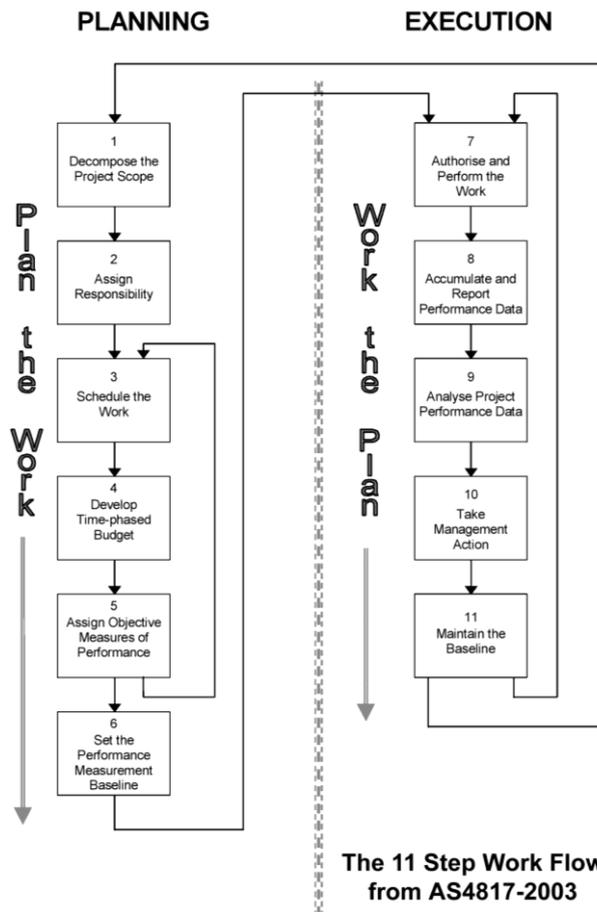
<sup>51</sup> Download DEF(AUST) 5655 (1992) from:  
[https://mosaicprojects.com.au/PDF-Gen/DEF\\_AUST\\_5655\\_CSCSC\\_Standard.pdf](https://mosaicprojects.com.au/PDF-Gen/DEF_AUST_5655_CSCSC_Standard.pdf)

<sup>52</sup> Download DEF(AUST) 5657 (1994) from:  
[https://mosaicprojects.com.au/PDF-Gen/DEF\\_AUST\\_5657\\_CSCSC\\_Implementation\\_Guide.pdf](https://mosaicprojects.com.au/PDF-Gen/DEF_AUST_5657_CSCSC_Implementation_Guide.pdf)

<sup>53</sup> Download DEF(AUST) 5658 (1994) from:  
[https://mosaicprojects.com.au/PDF-Gen/DEF\\_AUST\\_5658\\_CSSR\\_Standard.pdf](https://mosaicprojects.com.au/PDF-Gen/DEF_AUST_5658_CSSR_Standard.pdf)

<sup>54</sup> Download DEF(AUST) 5664 A (2004) from: [https://mosaicprojects.com.au/PDF-Gen/DEF\\_AUST\\_5664A\\_WBS.pdf](https://mosaicprojects.com.au/PDF-Gen/DEF_AUST_5664A_WBS.pdf)

<sup>55</sup> Wayne F. Abba. *Earned Value Management — Reconciling Government and Commercial Practices*. PM: Special Issue January - February 1997. [https://mosaicprojects.com.au/PDF-Gen/Aba\\_on\\_EVM\\_1997.pdf](https://mosaicprojects.com.au/PDF-Gen/Aba_on_EVM_1997.pdf).



NOTES:  
 1. Steps 3, 4 and 5 are performed iteratively.  
 2. Not all relationships are shown.

The Australian focus on simplifying C/SCSC was the publication of AS 4817:2003 *Project performance measurement using Earned Value* in 2003. This Australian Standard introduced an 11-step model focused on achieving business outcomes, supported by 54 requirements<sup>56</sup>. For example, a requirement that: *“Corrective action plans shall be developed and implemented...”* to overcome a negative variance<sup>57</sup>. Each business has the flexibility to decide how to manage its project to achieve the specified requirements, but could no longer hide behind superficial compliance with mandated criteria and check lists.

AS 4817 was updated in 2006 with relatively minor changes. This version then became a basis for the development of ISO 21508 (discussed below). Subsequent to the publication of ISO 21508, the ISO standard has been adopted with modifications as AS4817:2019. The modification was the incorporation of a normative annex (similar to AS 4817:2006 to allow the standard to be use in commercial contracts.

AS4817:2019 was adopted by the Australian Defence Dept. in 2020.

## Professional Association Standards for EVM

### PMI

The Project Management Institute<sup>58</sup> (PMI) based in Newtown Square, PA, USA, has been an advocate for the use of EVM as a project management tool for many years. It publishes two complementary publications the primary document is ‘*A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*’, supported by the *Practice Standard for Earned Value Management*, which in turn draws on the *PMI Practice Standard for Work Breakdown Structures*.

<sup>56</sup> Download AS 4817:2003 *Project performance measurement using Earned Value*:  
[https://mosaicprojects.com.au/PDF-Gen/AS4817-2003\\_Project\\_performance\\_measurement\\_using\\_Earned\\_Value.pdf](https://mosaicprojects.com.au/PDF-Gen/AS4817-2003_Project_performance_measurement_using_Earned_Value.pdf)

<sup>57</sup> For a full discussion on the eleven steps see:  
[https://mosaicprojects.com.au/Mag\\_Articles/N012\\_Earned\\_Value\\_Basics.pdf](https://mosaicprojects.com.au/Mag_Articles/N012_Earned_Value_Basics.pdf)

<sup>58</sup> Project Management Institute: <https://www.pmi.org/>

### **EVM in the PMBOK® Guide**

Prior to the 7<sup>th</sup> Edition published in 2021, the *PMBOK® Guide* focused its information in processes, where each process is divided into inputs, tools & techniques, and outputs. EVM is treated as a ‘tool & technique’, with a focus on the calculations rather than the context of EVM. Details of EVM<sup>59</sup> are included in:

- The 1996 edition in *Section 10.3. Performance Reporting* as ‘Earned value analysis’. Four-letter acronyms are used for BCWS, etc.
- The 2000 edition in *Section 10.3. Performance Reporting* continues the 1996 approach, but uses two-letter acronyms (PV, EV and AC) to replace the previous four-letter acronyms. This edition is an ANSI national standard.
- The Third edition (2004) describes the ‘Earned value technique (EVT)’ in *Section 7.3 Cost Control* under the subsection *Performance Measurement Analysis*. Two-letter acronyms are used exclusively.
- The Fourth edition (2008) describes ‘Earned Value Management (EVM)’ in *Section 7.3 Cost Control*. The To-Complete Performance Index (TCPI) is introduced.
- The Fifth edition (2013) describes ‘Earned Value Management (EVM)’ in *Section 7.4 Control Costs*. The section is enlarged, and most standard calculations are included.
- The Sixth edition (2017) describes ‘Earned Value Analysis (EVA)’ in *Section 7.4 Control Costs*. Earned Schedule (ES) is included as an emerging practice.
- The 7<sup>th</sup> Edition (2021) focuses on business outcomes rather than processes, it references aspects of EVM in combination with other measures of performance in *Section 2.7 Measurement Performance Domain*.

Some of the areas where the *PMBOK® Guide* differed from EIA 748 relate to the inclusion of Technical Performance Measures (TPM), quality, and risk, into the EVM measurement of performance (EV) these were/are optional in EIA 748<sup>60</sup>.

### **EVM in the PMI Practice Standards**

PMI practice standards are designed as supplements to the *PMBOK® Guide* focused on improving practice in specific areas of interest. From the perspective of EVM, the *Practice Standard for Work Breakdown Structures* has been consistent from its first edition published in 2001. The Second edition was published in 2006, and the current Third edition in 2019.

The *PMI Practice Standard for Earned Value Management*, was first published in 2005. The second edition in 2011 and was upgraded to *The Standard for Earned Value Management* (ANSI/PMI 19-006-2019) in 2019.

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<sup>59</sup> EVM is mention in the original 1987 version of the PMBOK, but only as a term in a glossary.

<sup>60</sup> Paul Solomon: <https://www.pb-ev.com/articles-and-tutorial.html>

- The 2005 Edition offered a basic guide to the processes of EVM. Consistent with the *PMBOK® Guide* two-letter acronyms are used. Earned Schedule is included as an emerging practice.
- The 2011 (Second) Edition was a major enhancement, expanding from the original 50 pages to 150 pages. Significant guidance is included on implementing an EVMS, and then analyzing and understanding the EVM outputs. Earned Schedule is included as a method for predicting the time needed for completion. Contrary to the CPI stability myth (discussed below), the forecast to complete is framed as ‘...if the performance of the project is not improved (ie, through management intervention) and continues like this, the final outcome is likely to be....’.
- The 2019 Standard, is based on the Second Edition. Consideration of the application of EVM to Agile projects is included, together with more focus on communication and stakeholder engagement. Earned Schedule has become a core component of an EVMS.

### **AACEi 82R-13**

The Association for the Advancement of Cost Engineering International (AACEi) publishes a wide range of guides<sup>61</sup>. Recommended practice *82R-13 Earned Value Management (EVM) Overview and Recommended Practices Consistent with EIA-748-C* is as the name suggests based on the requirements of NDIA/EIA 748-C. It provides an overview of the concept of earned value and its application in accordance with the EIA-748-C and a comparison with the AACEi Total Cost Management (TCM) Framework.

### **College of Performance Management (CPM)**

The College of Performance Management was formed in 1985 as the Performance Management Association (PMA)<sup>62</sup>. The CPM does not publish its own standards but is one of the key knowledge development entities associated with the NDIA/EIA holding two conferences per year in the USA.

### **APM / UK / IPMA**

British Standard BS 6079-1:2000 Project Management - Part 1: Guide to Project Management<sup>63</sup> included Section 4.6.6 *Earned value performance measurement*. This standard has been

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<sup>61</sup> For more on AACEi see: <https://web.aacei.org/>

<sup>62</sup> For more on the foundation of the PMA download *Performance Management Association - President's Report / History, 22 March 1987*: [https://mosaicprojects.com.au/PDF-Gen/CPM\\_Foundation-HISTORY.pdf](https://mosaicprojects.com.au/PDF-Gen/CPM_Foundation-HISTORY.pdf)

<sup>63</sup> It is unclear if the earlier BS 6079:1996 also included EVM. The latest version is BS 6079:2019.

routinely updated; the latest version is BS 6079:2019. Consistent with other UK standards, the EVM section is directly compatible with EIA 748.

The majority of the EVM guides produced in the UK have been by the Association for Project Management<sup>64</sup> (APM). The central document in the APM family is the *'Earned Value Management APM Guidelines'*. The first edition was published in 2002, with reviews and enhancements in 2007, and 2011. As with other UK documents, this guide is reciprocal with EIA 748. Other EVM related documents published by the APM<sup>65</sup> include the:

- *Earned Value Management Handbook,*
- *A Guide to Conducting Integrated Baseline Reviews,*
- *The Earned Value Management Compass,*
- *Interfacing Risk and Earned Value Management.*

APM meets regularly with the Integrated Program Management Division (IPMD) of the National Defense Industrial Association (NDIA) to discuss and reaffirm the bi-lateral Earned Value Equivalence Agreement. The UK/USA EVM equivalence agreement allows companies working on projects for both U.S. government agencies and for the UK Ministry of Defence, to have a single EVM process for their business.

## ISO 21508 and 21511

The development of the international standards ISO 21508 and ISO 21511 was global effort including input from, IPMA and PMI, and most countries implementing EVM. The development was based on information derived from the UK, Australian, and PMI standards, as well as a range of other sources. Developed in parallel, the two standards are:

- ISO 21508:2018 *Earned value management in project and programme management*
- ISO 21511:2018 *Work breakdown structures for project and programme management*

Following the publication of these standards, work commenced on ISO 21512:TBA *Earned Value Management (EVM) in Project and Programme Management — Implementation Guide*. Publication will most likely occur in 2023.

ISO 21508:2018 *Earned value management in project and programme management*, continues the use of the '11 steps' from AS 4817:2006 as well as adopting materials from the UK standards, and the two letter acronyms introduced by PMI and used in AS 4817. It is designed to be applicable to any type of organization and any type of project or program in terms of industry, complexity, size, or duration.

ISO 21508:2018 includes the following sections:

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<sup>64</sup> APM is the UK component of the International Project Management Association (IPMA).

<sup>65</sup> For more details of APM publications see: <https://www.apm.org.uk/book-shop/>

- a) Terms and definitions,
- b) Descriptions of the purpose and benefits of earned value management,
- c) The integration and relationship with project or program management,
- d) An overview of the processes and process descriptions,
- e) Basic requirements for an earned value management system, and
- f) Use of an earned value management system.

Consistent with other ISO standards, it does not provide guidance on the use of specific processes, methods or tools in the practice of earned value management. However, Annexes A, B, and C describe cost, schedule and performance analysis, commonly used formulae with associated interpretations, and the integration of earned value with other project or program management processes:

- Annex A: Cost and schedule performance measurement analysis using earned value management data (the standard formula).
- Annex B: Schedule analysis using earned value management data (earned schedule).
- Annex C: Integrating other project or programme management processes with earned value management.

## EVM Issues and challenges

### Software driving perceptions

The development and use of computer software to support scheduling and then EVM has been a core driver of the practices since the earliest days. PERT, and Pert/Cost were based on mainframe computer systems and software<sup>66</sup>. But, since the confusion around PERT/Cost in the early 1960s many people have continued to misunderstand the function of EVM, helped by misleading marketing aimed at selling computer software.

EVM is not financial management system and it is not a scheduling system<sup>67</sup>. EVM combines schedule and financial information in a structured WBS at the cost account level and then rolls the information up for higher level management reporting. Some EVM tools such as Deltek Cobra are built to run an EVM system<sup>68</sup>. While it is possible to perform EVM calculations in a scheduling tool, it is nearly impossible to accurately link actual costs, or accurately assess the

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<sup>66</sup> For more on *the role of early mainframe computer systems in EVM* see:

[https://mosaicprojects.com.au/PDF\\_Papers/P207\\_EVM\\_Early\\_Computers.pdf](https://mosaicprojects.com.au/PDF_Papers/P207_EVM_Early_Computers.pdf)

<sup>67</sup> For more on what EVM is, and is not see: *Earned Value Management - Six things' people don't get!*

[https://mosaicprojects.com.au/Mag\\_Articles/AA011\\_EVM\\_Things\\_people\\_dont\\_get.pdf](https://mosaicprojects.com.au/Mag_Articles/AA011_EVM_Things_people_dont_get.pdf)

<sup>68</sup> For a listing of *software tools* with various levels of EVM capability see:

<https://mosaicprojects.com.au/PMKI-SCH-030.php#Cost>

earned value achieved, against individual schedule activities – schedule progress is different to value earned.

### **CPI Stability Myth - 1993**

Many EVM books include support for the concept that the CPI of a project generally stabilizes at around the 20% completion stage, and is unlikely to significantly change thereafter<sup>69</sup>. Consequently, an accurately measured CPI early in a project can be used as an accurate estimate of the CPI at completion. This heuristic was based on the analysis of hundreds of defense acquisition contracts during the through the 1990s, by David S. Christensen and other researchers. The most widely known expression of the rule, states that *“There is a 95% probability that the cumulative cost performance index (CPI) will not change by more than 10% from its value at the 20% completion point, and in most cases, it only worsens”*.

Unfortunately, this heuristic is far less reliable than the stability myth implies. While EVM has repeatedly been shown to be one of the best tools for predicting project cost outcomes, the accuracy and stability of these predictions varies significantly.

### **EVM and Agile**

The adaptation of traditional EVM to projects being managed using Agile approaches is an ongoing area of development. The U.S. Government Accountability Office has published the *Agile Assessment Guide*<sup>70</sup>. *Chapter 7: Agile and Program Monitoring and Control* describes the use of EVM in the management of Agile project. It is anticipated this aspect of EVM will continue to evolve as experience is gained.

## **Conclusion**

### **Important EVM Milestones:**

The table below arranges some of the significant events in the evolution of EVM in date order:

1957 – PERT/Time and CPM developed

1960 – PERT/Cost development started

1963 – Earned Value Concept (MINUTEMAN)

1964 – Cost Accomplishment Concept (TITAN III)

1966 – USAF Cost/Schedule Planning and Control Specification (C/SPCS) issued

1967 – DODI 7000.2 – 35 Cost/Schedule Control Systems Criteria (C/SCSC) issued

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<sup>69</sup> For more on the *CPI Stability Myth* see:

[https://mosaicprojects.com.au/Mag\\_Articles/N002\\_CPI\\_Stability\\_Myth.pdf](https://mosaicprojects.com.au/Mag_Articles/N002_CPI_Stability_Myth.pdf)

<sup>70</sup> Download the *GAO Agile Assessment Guide*:

[https://mosaicprojects.com.au/PDF-Gen/GAO-Agile\\_Assessment\\_Guide.pdf](https://mosaicprojects.com.au/PDF-Gen/GAO-Agile_Assessment_Guide.pdf)

- 1972 – DOD – Revised DODI 7000.2 and Issued the Joint Implementation Guide (JIG)
- 1991 – DODI 5000.2 replaces DODI 7000.2
- 1992 – DEF(AUST) 5655: Australian Cost/Schedule Control Systems Criteria published
- 1994 – DEF(AUST) 5657: Australian Cost/Schedule Control Systems Criteria Implementation Guide
  - DEF(AUST) 5658: Cost/Schedule Status Reporting (CSSR) Specification and Implementation Guide
- 1995 – DEF(AUST) 5664: Work Breakdown Structures (WBS) for Defence Materiel projects published
- 1996 – DODR 5000.2-R replaces DODI 5000.2, C/SCSC revised from 35 to 32 criteria
  - Revised JIG—Renamed Earned Value Management Implementation Guide (EVMIG)
- 1998 – ANSI/EIA-748, “Earned Value Management Systems” (EVMS) adopted the 32 Criteria in DODI 5000.2
- 2003 – Earned Schedule defined
  - AS 4817 Project Performance Measurement using Earned Value published
- 2005 – PMI Practice Standard for Earned Value Management published
- 2013 – EIA-748-C EVMS Standard, replaces ANSI/EIA-748 with minor additions and corrections
- 2018 – ISO 21508:2018 Earned value management in project and programme management
  - ISO 21511:2018 Work breakdown structures for project and programme management
- 2019 – January, EIA-748-D published by Society of Automotive Engineers (SAE) / Electronics Industry Alliance (EIA), with minor additions and corrections but didn’t change the 32 criteria.
- 2019 – The Standard for Earned Value Management (ANSI/PMI 19-006-2019)
  - AS 4817:2019 Earned value management in project and programme management published

## **EVM Past, Present and Future**

Over the past 60 years of development outlined above, the practice of Earned Value Management has adapted and evolved to retain its position as the best tool for managing project and program delivery. It has three fundamental components:

1. All of the resources and work planned and used in the course of a project is reduced to a single metric (usually monetary value as at a baseline date), this includes labor, materials, suppliers, subcontractors and overheads.
2. The work is planned, and progress measured based on the metric to derive the planned and earned ‘values’, for the scope of work. Actual costs are accumulated on the same basis as the planned and earned values.
3. As work progresses, the current difference between planned and actual performance (as measured by the metric) is used to forecast future outcomes.

However, while all of the EVM formula and the majority of acronyms remain constant, there seems to be little interest in merging the two approached to EVM outlined above.

The future of EVM is likely to be significantly affected by changing technology and emerging management concepts such as Agile and Integrated Program Performance Management (IPPM). The next generation of project controls are predicted to be integrated, adaptive, and intelligent with a focus on maximizing the efficient use of the project's resources. These tools will use machine learning, and be integrated into the systems used to design and develop the project's outputs rather than operating as separate processes. If this occurs, the EVM concepts should form the basis for the new integrated control systems, but the role of EVM expert's will be very different to today.

## About the Author



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**Patrick Weaver**, PMP, PMI-SP, FAICD, FCIOB, is the Managing Director of Mosaic Project Services Pty Ltd, an Australian project management consultancy specializing in project control systems. He is a Fellow of the Chartered Institute of Building, Australasia (FCIOB) and a Fellow of the Australian Institute of Company Directors (FAICD). He is a member of the PMI Melbourne Chapter (Australia), as well a full member of AIPM, and the Project Management College of Scheduling (PMCOS).

Patrick has over 50 years' experience in Project Management. His career was initially focused on the planning and managing of construction, engineering and infrastructure projects in the UK and Australia. The last 35 years has seen his businesses and experience expand to include the successful delivery of project scheduling services and PMOs in a range of government, ICT and business environments; with a strong focus on project management training.

His consultancy work encompasses: developing and advising on project schedules, developing and presenting PM training courses, managing the development of internal project control systems for client organizations, and assisting with dispute resolution and claims management.

In the last few years, Patrick has sought to 'give back' to the industry he has participated in since leaving college through contributions to the development of the project management profession. In addition to his committee roles, he has presented papers at a wide range of project management conferences in the USA, Europe, Asia and Australia, has an on-going role with the PGCS conference in Australia and is part of the Australian delegation to ISO TC258.

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