



PRACTICAL APPLICATION OF EARNED VALUE PERFORMANCE MEASUREMENT

Practical Application of Earned Value Performance Measurement presented by Paul E Harris of Eastwood Harris Pty Ltd



Copyright

©Copyright 2010 by Eastwood Harris Pty Ltd.
No part of this publication may be reproduced or used in any form or by any method without the written permission of the author(s).

For further information please contact:

Paul E Harris
Director
Eastwood Harris Pty Ltd
P.O. Box 4032
Doncaster Heights 3109
Victoria
Australia
Phone: [61] 03-9846-7700
Mobile: [61] 04-1118-7701
Fax: [61] 03-9846-7900
Email: harrispe@eh.com.au
Web: www.eh.com.au



Administration

- Emergency Evacuation
- Timetable
- Catering
- Mobile Phones
- Emails
- Conduct of course.

Page 4



Introductions

- Your name,
- Current position,
- Projects you are currently working on,
- Experience in project planning, scheduling and control,
- What are your expectations from this course.

Page 5

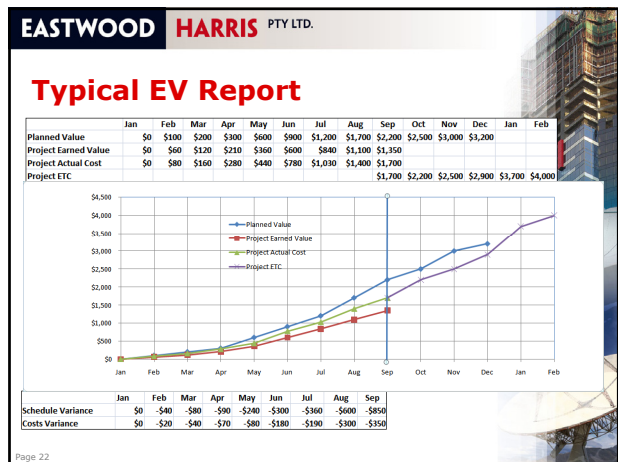
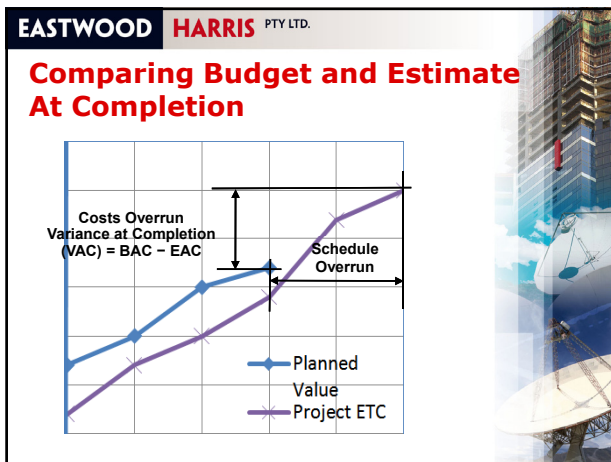
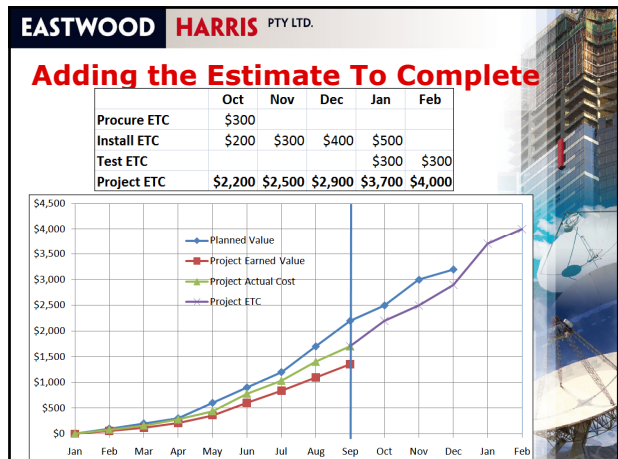
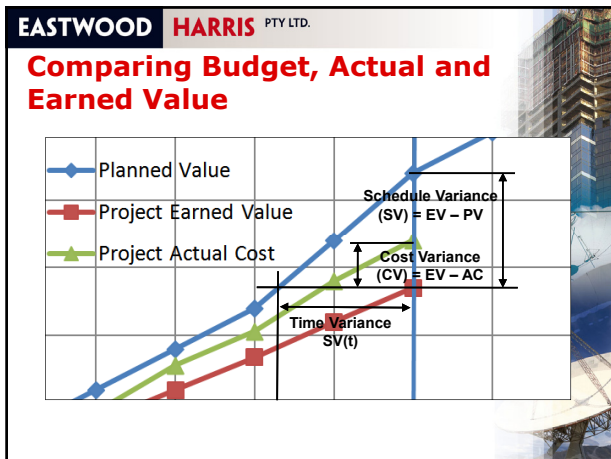


Course Aim

- To demonstrate:
 - The principals of Earned Value Performance Measurement,
 - How projects benefit from an EVPM system (EVPMS),
 - An overview of some current standards,
 - Practical advice in creating, running and reporting from an EVPM system.

Page 6





- EASTWOOD HARRIS PTY LTD.**
- ### Basic Definitions
- **Budget** is the total original approved value of the project,
 - **Budgeted at Completion (BAC)** is the Budget less Management Reserve and is used for Earned Value calculations ,
 - **Performance Measurement Baseline (PMB)** is a time phased BAC,
 - **Planned Value (PV)**, or Budgeted Cost of Work Scheduled (BCWS) is the value of planned work at a point in time derived from the PMB,
 - **Earned Value (EV)**, or Budgeted Cost of Work Performed (BCWP) is the value of work completed at a point in time,
 - **Actual Costs (AC)**, or Actual Cost of Work Performed (ACWP) is the expenditure at a point in time to complete the work,

- EASTWOOD HARRIS PTY LTD.**
- ### Basic Definitions continued
- **Estimate to Complete (ETC)**, a revised estimate of the remaining work,
 - **Estimate at Completion (EAC)** = AC + ETC,
 - **Variance at Completion (VAC)** = BAC - EAC
 - **Schedule Variance (SV)** = EV - PV, or BCWP - BCWS, + ahead of plan & - behind plan,
 - **Cost Variance (CV)** = EV - AC, or BCWP - ACWP, + below costs & - above cost,
 - **Cost Performance Index (CPI)** EV /AC. 1 indicates on plan, over 1 is overspending and under 1 indicates is spending,
 - **The Schedule Performance Index (SPI)** EV/PV. 1 indicates to plan, <1 indicates behind plan and >1 ahead of plan,
 - **NOTE:** CPI & SPI allows projects of different values to be compared.

EASTWOOD HARRIS PTY LTD.

Elements of a CCMS that may be used for EVPM

- Both the Budget and Schedule from a CCMS may be used when they are aligned under a common WBS,
- An accurate and disciplined accrual system must be in place if it is to be used for calculating the Actual Costs,
- The ETC may be calculated for the addition of:
 - Incomplete portion of POs and Contracts plus
 - The value of unawarded work from the estimate.

Page 37

EASTWOOD HARRIS PTY LTD.

Additional data required to establish an EVPM system

- The following additional items are required to run an EVPM system:
 - The education in and acceptance of EVPM by all managers and users of the system,
 - An Organisational Breakdown Structure which has a responsibility assigned to each node of the WBS,
 - Structured WBS common to both the Schedule and Budget,
 - A method of measuring progress against all elements that are to be controlled by EVPM; this includes additional reporting requirements for contracts and purchase orders,
 - All assignment of work which includes contracts and purchase orders must be structured such that control of costs and progress may be aligned to the WBS.

Page 38

EASTWOOD HARRIS PTY LTD.

Workshop 2 – Create the Actual Curve

Using the data provided add to your existing graphs:

- Draw the Actual Cost curve
- Draw the Forecast To Complete curve
- Calculate the Cost Variance per period
- Calculate the Cost Performance Index per period
- What conclusions can you draw from the results?

Page 39

EASTWOOD HARRIS PTY LTD.

Workshop 2 - Answers

Schedule Variance	\$0	-\$25	-\$50	-\$75	-\$105	-\$130	-\$155	-\$180
Costs Variance	\$0	-\$15	-\$30	-\$35	-\$45	-\$70	-\$75	-\$80
SPI - EV/PV		0.69	0.72	0.79	0.84	0.87	0.89	0.91
CPI - EV/AC		0.79	0.81	0.89	0.92	0.93	0.94	0.96

Page 40

EASTWOOD HARRIS PTY LTD.

TOPIC 3 – STANDARDS AND OTHER SUPPORTING LITERATURE

- Some current EVPM Standards:
 - AS 4817 Project performance using Earned Value 2006,
 - Defence Material Supplement to AS 4187,
 - ANSI/EIA-748-A-1998 Earned Value Management Systems,
 - PMI Practice Standard for Earned Value Management,
- Other material:
 - Earned Value Management: APM Guidelines,
 - Earned Value Project Management – Quentin W. Fleming and Joel M. Koppelman,
 - Many books and articles on the internet.

Page 41

EASTWOOD HARRIS PTY LTD.

AS4817 Project performance using Earned Value 2006

- AS4817 is a standard that establishes requirements and gives guidance for the measurement and reporting of cost and schedule performance of projects and programmes using the EVPM method,
- This standard is a practical guide explaining:
 - The basic processes of an Earned Value Performance Measurement including the calculations,
 - The steps required to run an EVPM system and includes requirements, guidance, examples, graphs and tables,
 - Analysis and reporting techniques. It includes a number of reports and their interpretation.

Page 42

EASTWOOD HARRIS PTY LTD.

Work Breakdown Structures

- DISCUSSION:** What environment would dictate the use of each of the hierarchical structures for three buildings?

Page 55

EASTWOOD HARRIS PTY LTD.

2. Assign responsibility

- An Organisational Breakdown Structure (OBS) should be created for the project with clearly defined roles and responsibilities.
- This is achieved by assigning responsibility for the work on each element on the WBS to a single person.
- NOTE:** A Responsibility Assignment Matrix (RAM) is created by mapping WBS Nodes to OBS Nodes and the intersection points are called Cost Accounts (CA) and these are managed by a Cost Account Manager.

Page 56

EASTWOOD HARRIS PTY LTD.

Responsibility Assignment Matrix (RAM)

Page 57

EASTWOOD HARRIS PTY LTD.

3. Schedule the work

- A schedule is created for the work under the WBS,
- Thus a minimum of one activity for each WBS element will be required,
- Milestones should be used to identify significant events and decision points,
- Interfaces to elements outside the PM's responsibility should be identified as Milestones with Constraints,
- All activities should be connected to create a closed Network,
- Activities which are not the responsibility of the project but affect the timing of the project such as approvals must be included in the schedule.

Page 58

EASTWOOD HARRIS PTY LTD.

4. Develop the time-phase budget

- Assign Budget Values to all the activities,
- The Budget may be represented in dollars, hours, or any other meaningful unit of measure,
- The time-phased budget is called the "Performance Measurement Baseline" (PMB),
- The Budget should be distributed in the same way that the costs will be recorded, thus if the project were to be executed exactly according to time then the Actual Cost Curve would overlay the Planned Curve,
- The Project Budget is the addition of the PMB + the Management Reserve (MR)+ Undistributed Budget (UB - the unplanned work).

Page 59

EASTWOOD HARRIS PTY LTD.

The Hierarchy of Contractor Budgets

Contract Price		
Contract Budget Baseline		Margin
Performance Measurement Baseline		Management Reserve
Distributed Budget	Undistributed Budget	
Control Account Budgets		
Work Packages	Planning Packages	

Page 60

EASTWOOD HARRIS PTY LTD.

When are Costs Mandatory in a EVPMS

- If a multi phase and multi discipline project is to be managed using EV then all measures must be converted to a cost, as this is the only common parameter allowing all elements to be combined,
- This is usually a currency, but points may be used to hide the total cost of a project by a contractor from a customer,
- Points are a calculated value assigned to activities and the total value of a project adds up to a round figure of say 10,000.
- Using commodities or labour hours are good measurement parameters when EV is to be performed on a part of a project in isolation, such as the design phases or installation.

Page 73

EASTWOOD HARRIS PTY LTD.

Points

- A project estimate may be divided by a factor so the estimate added up to 10,000 for example and the EV value calculated in points.
- This is useful when a contractor has to show progress of a project in detail but does not want to give the client a breakdown of the project costs,
- A customer may easily take this value and calculate their own EV from the points.

Page 74

EASTWOOD HARRIS PTY LTD.

System Integration Problems

- There are many systems that may be used for estimating and collecting costs,
- System Integration Problems occur when:
 - Estimates are completed without the understanding that EVPM is to be used to manage costs,
 - The estimate can not be reformatted easily for EVPM due to the lack of a Project WBS, or a WBS not being used in the estimate,
 - Accounting systems that do not record costs by Activity or WBS. These usually record costs by a standard costs account and not a WBS and may not be easily used for EVPM,
 - Contracts Contract management systems set up without regard to the needs of EVPM Systems,
- A person delegated with the task of setting up an EVPM system must take ownership of these systems early in a project.

Page 75

EASTWOOD HARRIS PTY LTD.

Other Cost Recording Problems

- The rate used in the Plan should be on the same basis as the one used to calculate the Actuals,
- E.g. the estimate and cost recording must be on the same basis and at the same level,
- There are other issues to address:
 - Are GST and other taxes included or excluded in the costs?
 - How is retention handled?
 - How is charge back handled?
 - How are Overheads spread?

Page 76

EASTWOOD HARRIS PTY LTD.

Labour hour issues

- Are the paid or worked hours recorded?
- Is work recorded in days or hours?
- When costs are calculated from recorded hours:
 - With or without labour burdens etc?
 - Is there different labour doing the work to the estimated labour?
 - How is paid leave handled, is it charged to the job?
 - Is the contract rate different from the estimated rate?

Page 77

EASTWOOD HARRIS PTY LTD.

Mobile equipment issues

- Mobile Equipment costs are made up of a number of variables:
 - Mobilisation and demobilisation costs
 - Ownership costs
 - Maintenance costs
 - Operating cost
 - Standby costs
- How is the actual costs calculated and is this the same as the estimated:
 - Timesheets
 - Daily rate
- How are non worked/idle equipment hours costed?

Page 78

EASTWOOD HARRIS PTY LTD.

Late Levelled Curves

- The Late Levelled Curve is the Latest that activities may take place without delaying the end date of a project when acknowledging schedule relationships and resource availability,
- Activities are moved to an earlier date when resources are not available.

Page 91

EASTWOOD HARRIS PTY LTD.

Where to set the baseline

- Lets discuss the envelope, or "Banana", and where you would set baseline,
- The disadvantage of most commercial software is that it does not allow the setting of the Performance Measurement Baseline (PMB) in the middle of the Early Levelled and Late Levelled, the "Banana".

Page 92

EASTWOOD HARRIS PTY LTD.

Baseline Setting Guidelines

- Standards do not provide any guidance as to how the Performance Measurement Baseline should be set in relation to Early and Late Dates,
- If the Early Dates are used then the project will normally always be behind,
- Some options are:
 - Display the "Banana" as the Performance Measurement Baseline,
 - Set a line half way between the Early Levelled and Late Levelled line.
- The issue here is that most commercial scheduling software does not have the ability to display other options other than Early and Late Unlevelled and Levelled.

Page 93

EASTWOOD HARRIS PTY LTD.

Critical Chain Scheduling

- Critical Chain scheduling is based on a book published 1997, by Dr. Eliyahu Goldratt,
- It introduced a new approach to project management with the publication of his business novel, Critical Chain,
- In summary all work is scheduled As Late As Possible with a "Buffer" task at the end of each chain to allow for delays,
- This process creates another opportunity for the establishment of a more realistic Performance Measurement Baseline.

Page 94

EASTWOOD HARRIS PTY LTD.

Workshop 6 – Discussion

In your groups discuss your project:

- What are your options for setting the PMB?
- What is your preferred option?

Page 95

EASTWOOD HARRIS PTY LTD.

TOPIC 7 - MEASURING PROGRESS AND CALCULATING THE EARNED VALUE

- Standards allow a number of options for measuring progress, but provide little guidance,
- Sometimes it is very hard to find an objective measurement of progress, for example, lets discuss:
 - How do you measure the progress of software when it keeps failing user acceptance tests?
 - What is the best way of measuring the progress of the purchase of an overseas supplied large piece of machinery?
- At what level should progress be measured?
- The Baseline MUST be set using the parameters that are going to be used to measure progress.

Page 96

EASTWOOD HARRIS PTY LTD.

Workshop 9 – Discussion

In your groups discuss and present how you:

- Calculate the ETC for your project for four types of activity?
- How you would create the FCT curve?

Page 109

EASTWOOD HARRIS PTY LTD.

TOPIC 10 - REPORTING AND SOFTWARE TOOLS

This section will deal with:

- Types of EV Reports
- Current planning and scheduling software:
- Specialised EV software

Page 110

EASTWOOD HARRIS PTY LTD.

Types of Reports

- Typical reports include:
 - S-Curves with Planned, Earned, Actual and ETC
 - Tabular reports by period, including CV, SV, CPI and SPI.
 - Gantt Chart showing Baseline and the Current Schedule with this period Planned, Earned, Actual and ETC in columns,
 - Bulls Eye Chart showing CPI & SPI,
 - Variance Trend Graphs,
 - Traffic Light reports.

Page 111

EASTWOOD HARRIS PTY LTD.

Tabular Reports

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Planned Value	\$0	\$100	\$200	\$300	\$600	\$900	\$1,200	\$1,700	\$2,200
Project Earned Value	\$0	\$60	\$120	\$210	\$360	\$600	\$840	\$1,100	\$1,350
Project Actual Cost	\$0	\$80	\$160	\$280	\$440	\$780	\$1,030	\$1,400	\$1,700
Project ETC									\$1,700
Schedule Variance	\$0	-\$40	-\$80	-\$90	-\$240	-\$300	-\$360	-\$600	-\$850
Costs Variance	\$0	-\$20	-\$40	-\$70	-\$80	-\$180	-\$190	-\$300	-\$350
CPI - EV/AC		0.75	0.75	0.75	0.82	0.77	0.82	0.79	0.79
SPI - EV/PV		0.60	0.60	0.70	0.60	0.67	0.70	0.65	0.61

Activity Name	Orig Dur	Rem Dur	Start	Finish	Phys % Comp	BAC	PV	AC	EV	CP	SPI	ETC	EAC	VAC	SV
Dummy Earn	50	25	27-Apr-09 08:00	15-Jun-09 16:00		A1300	A1100	A850	A650	1.00	0.50	A4200	A1200	A3300	A6500
Design	15d	5d	27-Apr-09 08:00	15-May-09 16:00		A1100	A1100	A850	A650	1.00	0.50	A444	A254	A46	A4500
Procure	10d	10d	18-May-09 08:00	29-May-09 16:00	50%	A1100	A80	A80	A80	0.00	0.00	A888	A888	A812	A80
Install	25d	25d	11-May-09 08:00	15-Jun-09 16:00	0%	A1100	A80	A80	A80	0.00	0.00	A888	A888	A812	A80
Install	10d	10d	01-Jun-09 08:00	15-Jun-09 16:00	0%	A1100	A80	A80	A80	0.00	0.00	A888	A888	A812	A80

Page 112

EASTWOOD HARRIS PTY LTD.

S-Curves with Planned, Earned, Actual and ETC

Page 113

EASTWOOD HARRIS PTY LTD.

Variance Trend Graphs

Page 114