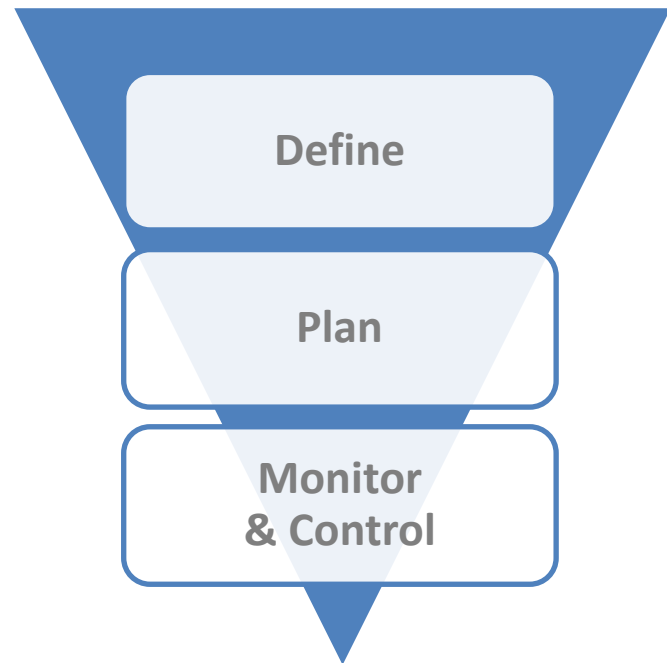
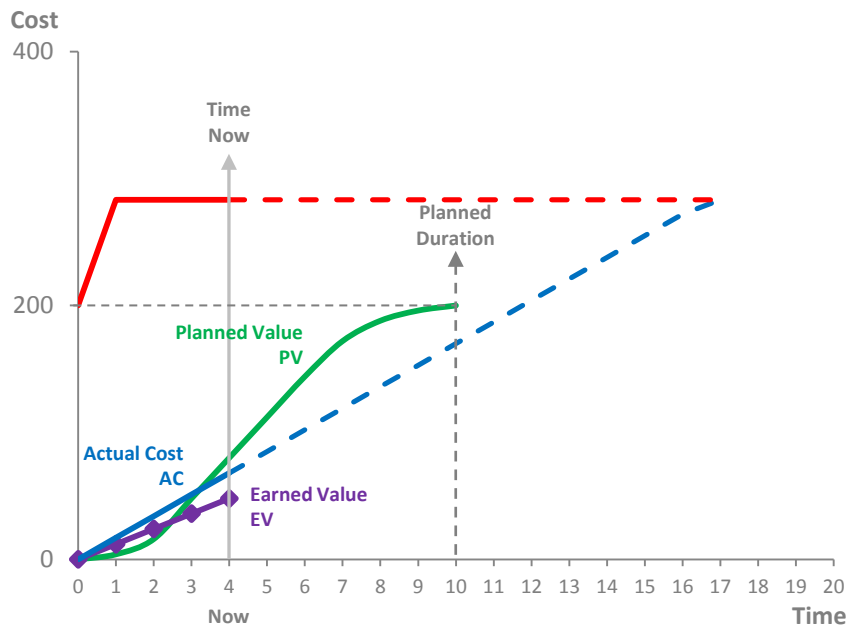


Earned Value Management



What is Earned Value Management?

Earned Value Management (EVM) originated at the US DoD in 1967 with their 'instruction 7000.2', mandating an early form of EVM for larger contracts. This was to prevent projects going so far before serious problems were apparent that too much had already been spent to contemplate cancelation.

“EVM is a project control process based on a structured approach to planning, cost collection and performance measurement. EVM facilitates the integration of project scope, time and cost objectives and the establishment of a baseline plan for performance measurement.” APM Competence Framework

EVM uses the Planned Value, the Actual Cost and the Earned Value to track performance
– and show what has been achieved for the money spent to date



Why Use EVM?

- Improves the predictability of projects
- An early indicator of problems
- A structured approach to planning and the data to enable performance management
- Objectively ties delivered value to spend, comparing that with what was planned
- Forecasts the impact of corrective actions



Earned Value Management Best Practice



US Standard

ANSI EIA 748-C [07-2013] Earned Value Management Systems [↗](#)



Australian Standard

AS 4817 [2006] Project Performance Using Earned Value [↗](#)



Association for Project Management

Earned Value Management Handbook [03-2013] [↗](#)

Earned Value Management APM Guidelines, 2nd edition [2008] [↗](#)



Interfacing Risk and Earned Value Management [2008] [↗](#)

The Earned Value Management Compass [2010] [↗](#)



Project Management Institute

Practice Standard for Earned Value Management [2011] [↗](#)



UK Government

Ministry of Defence Acquisition System Guidance: Earned Value Management [v3.2.16]



US Government

Department of Defence: Earned Value Management Implementation Guide [2006] [↗](#)



NASA

EVM Implementation Handbook [02-2013] [↗](#) and EVM Reference Card [↗](#)

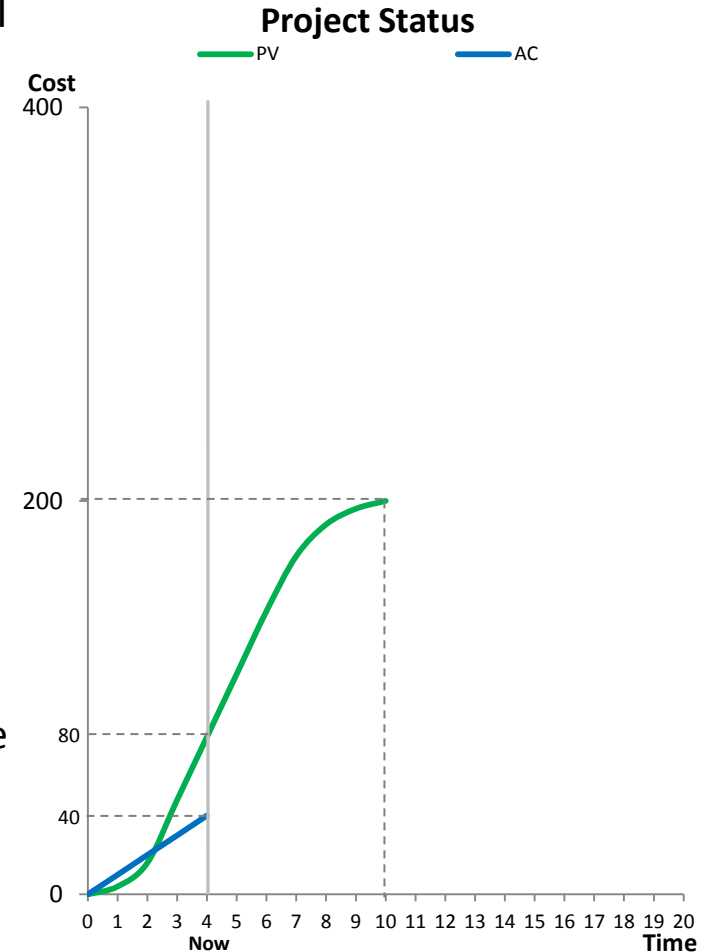


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Project Tracking using only Actual Cost

- Before EVM, projects were tracked by looking at actual spend and comparing with planned spend
- Compare Actual Cost (40) with Planned Cost (80) at time Now (4); what is the project status?
 - Is the project under-spent? Or over-spent?
 - Is the project on schedule? Or behind schedule?
- Status depends on how much of the planned work is complete
 - If all the work planned to time now is complete
Status: on schedule but 50% under-spent
 - If half the work planned to time now is complete
Status: on budget but 100% behind schedule
 - If a quarter of the work planned to time now is complete
Status: 200% over-spent and 400% behind schedule
 - If all the work planned is complete
Status: 80% under-spent and 60% ahead of schedule



Status cannot be known using Actual Cost alone



EVM Process

Define

What work needs to be done and who will do it, defined in the Statement of Work (SoW)

Product Breakdown Structure > Work Breakdown Structure > Work Packages > Tasks
or PBS > WBS > WP > Tasks

Use EVM at the WBS level, sometimes at the WP level, hardly ever at the task level
minimise the overhead whilst maximising the value of using EVM

Each WBS element, made up of a number of WPs, is a Control Account

Each Control Account has a Control Account Manager - on smaller projects the PM or a Team Leader

Plan

How and when the work will be done, at what cost

A PERT or Gantt chart with estimates for the cost per task as hours x hourly rate

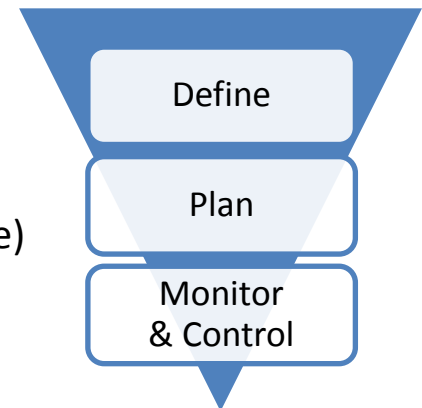
Resource level so the resources do not exceed those available at any given time

The sum cost of all the work will give us the Planned Value, or baseline for the project

Monitor & Control

Manage delivery performance during the project, against the baseline

At any point in time: how much have we delivered? (the Earned Value)
how much had we planned to deliver? (the Planned Value)
what are the variances?
are any corrective actions indicated?



Choose an Appropriate Measure of Progress

- **x/y: 0/100, 50/50, User Defined Percentage (10/90, 20/80...)**
The EV is x% at the start of the WP and a further y% at the end when the WP is complete.
If the work falls within a single reporting period, 0/100 may be appropriate.
If the work spans two reporting periods, 50/50 or a user defined percentage may be appropriate.
- **Milestones**
Setup milestones at the start of the project. Assign each milestone a proportion of the budget.
As milestones are completed, the EV is that part of the budget assigned to them.
If the work spans multiple reporting periods, this method may be appropriate.
- **Percent Complete**
EV depends on the percentage completion of the WP.
It can be difficult to agree an objective measure of percent complete...
- **Equivalent Units**
 $EV = WP \text{ budget} \times \frac{\text{the number of tasks completed}}{\text{by the number of tasks to be done}}$.
- **Level of Effort**
EV is set such that 1 hour effort = 1 hour EV.
Appropriate where there is no specific deliverable result, e.g. administration.
- **Apportioned Effort**
EV is equal to the EV on another directly related WP, e.g. if a Technical Authority works on two Control Accounts and one CA has 50% EV, the other CA is also considered to have 50% EV.
- **Individual Judgement**
Expert judgement may have to be used for complex work where no other method is applicable.



EVM Terms and Formulae

Basic Measures

- **Planned Value (PV)**, Planned Cost, Budget, Budgeted Cost of the Work Scheduled (BCWS)
The sum of all budgets for the planned work, to a point in time.
- **Budget At Completion (BAC)**
The total budget for completing the project. Note that contingency is usually excluded.
- **Planned Duration**
The planned duration of the project.
- **Actual Cost (AC)**, Actual Cost of the Work Performed (ACWP)
The sum of cost incurred in completing the work to a point in time.
- **Earned Value (EV)**, Budgeted Cost of the Work Performed (BCWP)
The sum of all budgets that were planned to complete the work that has actually been completed, at a point in time, or what the completed work should have cost.

Variances (good: positive values, possibly bad: negative values)

- **Schedule Variance (SV)** = $BCWP - BCWS$ or $EV - PV$
The difference between planned achievement and actual achievement, at a point in time.
Can be measured in both cost and time.
- **Cost Variance (CV)** = $BCWP - ACWP$ or $EV - AC$
The difference between planned achievement and actual spend to achieve this, at a point in time.



EVM Terms and Formulae II

Performance Indices ...or Variances as ratios (good: >1, possibly bad: <1, on plan: =1)

- **Schedule Performance Index (SPI)** = $\frac{BCWP}{BCWS} = \frac{EV}{PV}$

- **Cost Performance Index (CPI)** = $\frac{BCWP}{ACWP} = \frac{EV}{AC}$

- **To Complete Performance Index (TCPI)**

The anticipated performance to achieve the BAC = $TCPI_{BAC} = \frac{BAC - BCWP}{BAC - ACWP} = \frac{BAC - EV}{BAC - AC}$

or the EAC = $TCPI_{EAC} = \frac{BAC - BCWP}{EAC - ACWP} = \frac{BAC - EV}{EAC - AC}$

Calculated Estimates ...based on performance to date

- **Estimate At Completion (EAC)** = $\frac{BAC}{CPI}$

A forecast of the cost at completion.

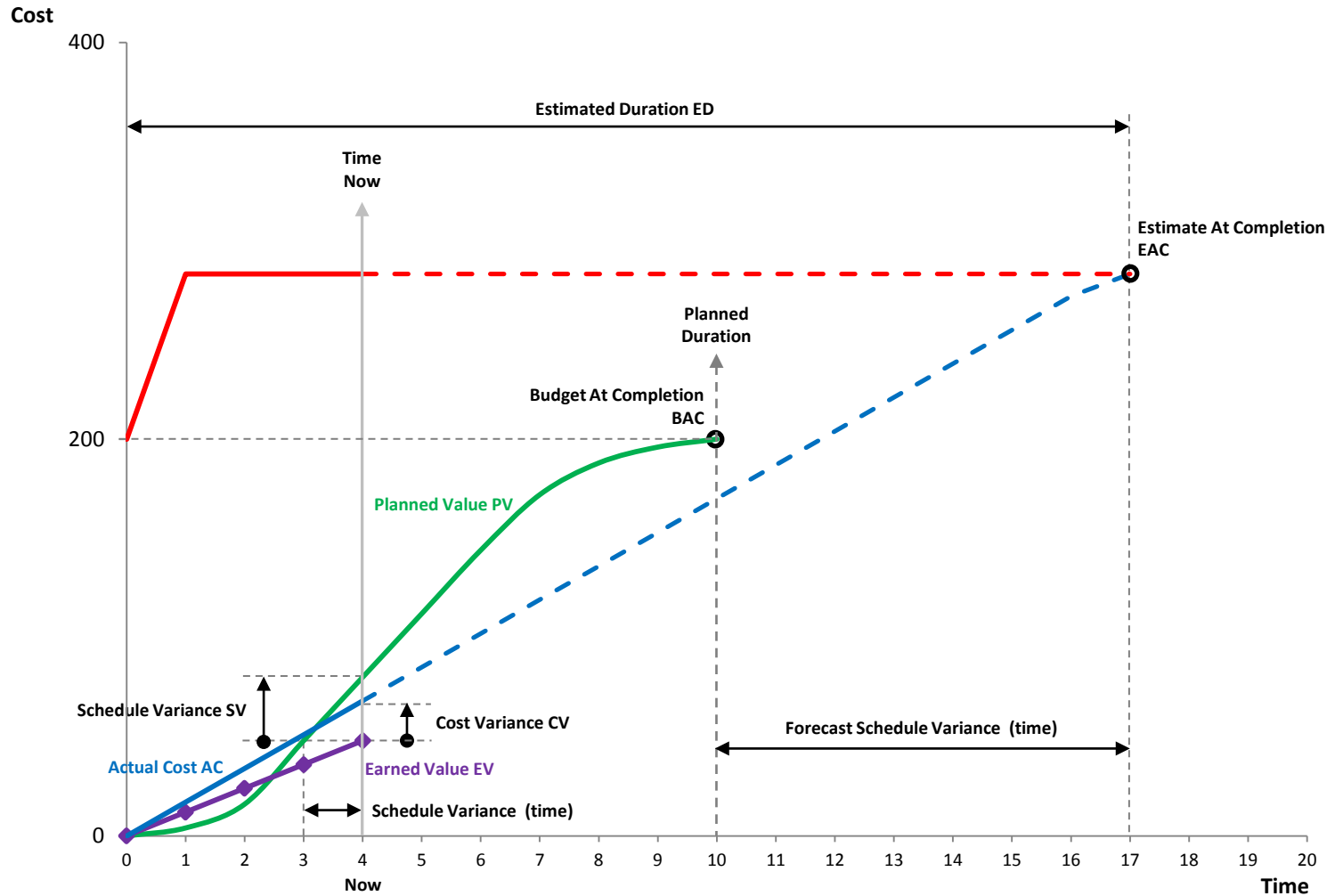
- **Estimate To Completion (ETC)** = EAC - ACWP or EAC - AC
A forecast of the costs remaining to get to completion.

- **Estimated Duration** = $\frac{\text{Planned Duration}}{SPI}$

A forecast of the total duration of the project.



EVM Chart



EVM Example

Status at Time Now (4)

Basic Measures

BAC = 200, Planned Duration = 10

PV = 80, AC = 80, EV = 80

Variiances

SV = 0, CV = 0

Performance Indices

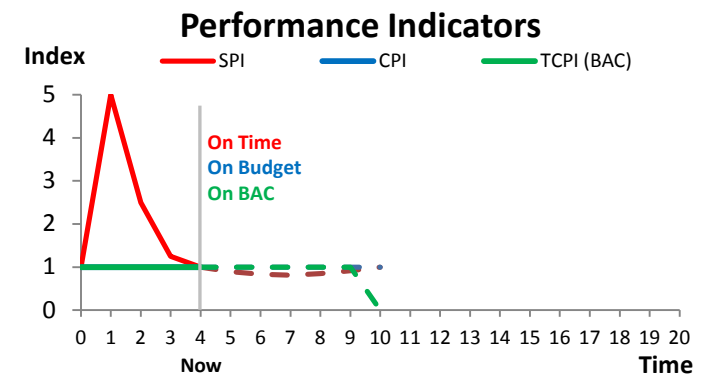
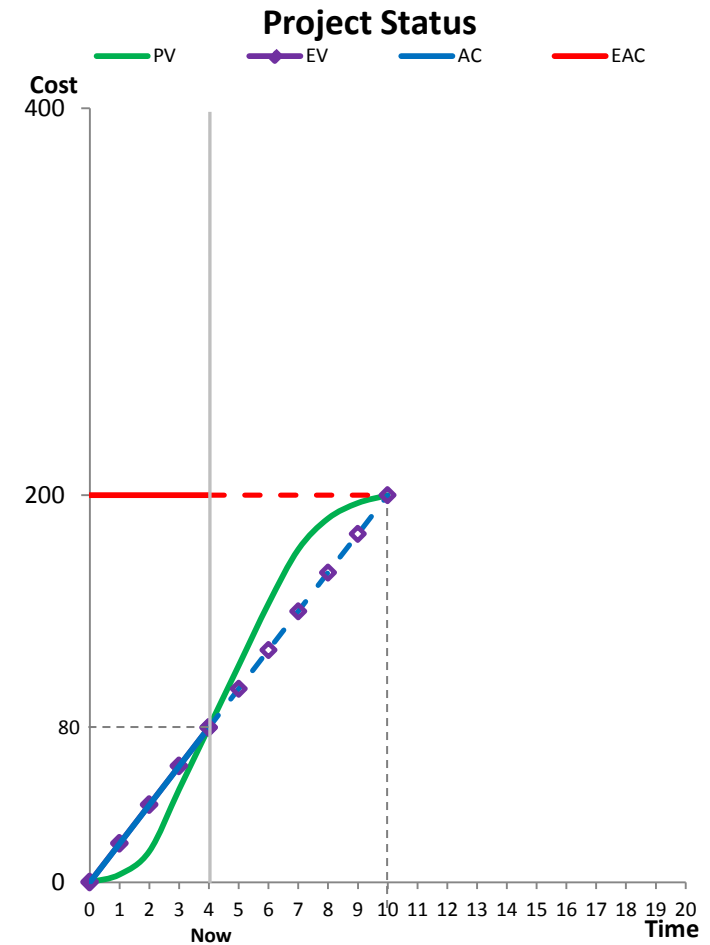
SPI = 1.0, CPI = 1.0, $TCPI_{(BAC)} = 1.0$

Calculated Estimates

EAC = 200, ETC = 120, Estimated Duration = 10

Summary

On schedule, on budget



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EVM Example II

Status at Time Now (4)

Basic Measures

BAC = 200, Planned Duration = 10

PV = 80, AC = 40, EV = 40

Variiances

SV = -40, CV = 0

Performance Indices

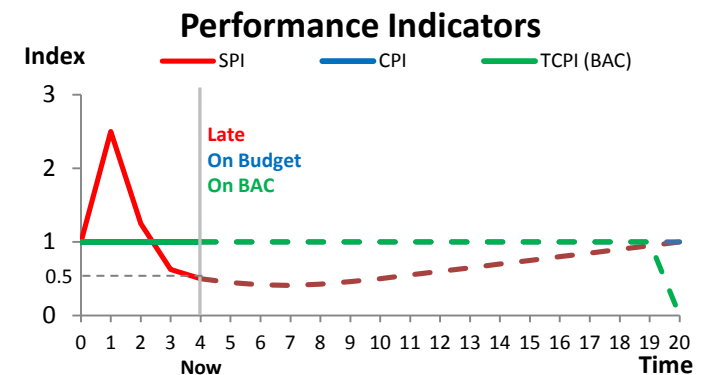
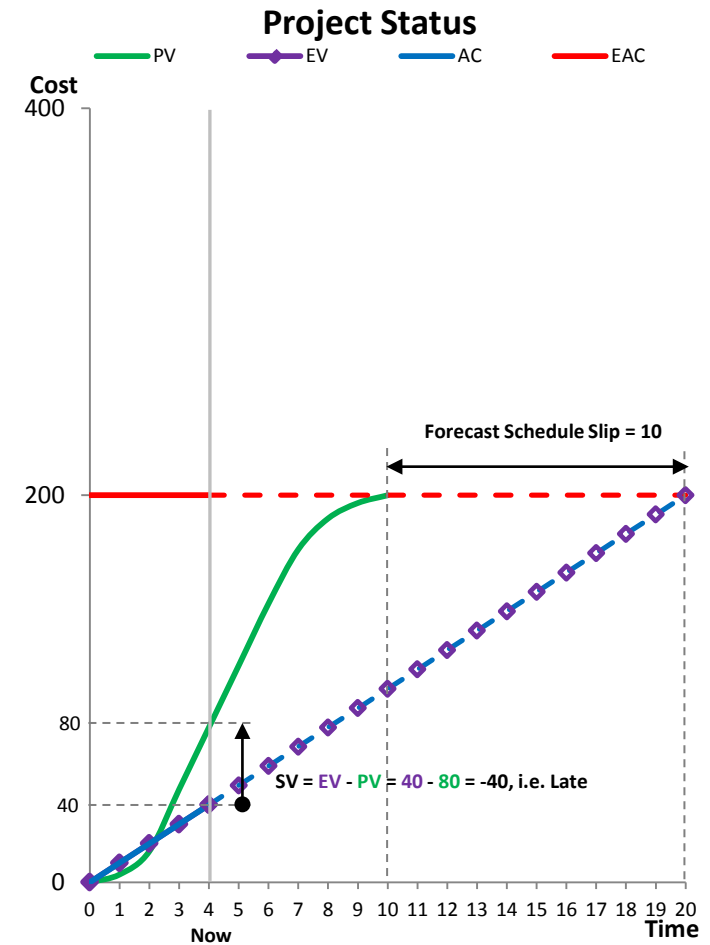
SPI = 0.5, CPI = 1.0, $TCPI_{(BAC)} = 1.0$

Calculated Estimates

EAC = 200, ETC = 160, Estimated Duration = 20

Summary

Behind schedule, on budget



EVM Example III

Status at Time Now (4)

Basic Measures

BAC = 200, Planned Duration = 10

PV = 80, AC = 114, EV = 114

Variiances

SV = 34, CV = 0

Performance Indices

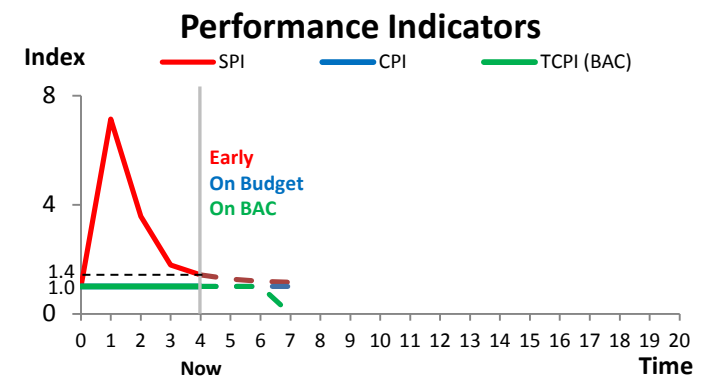
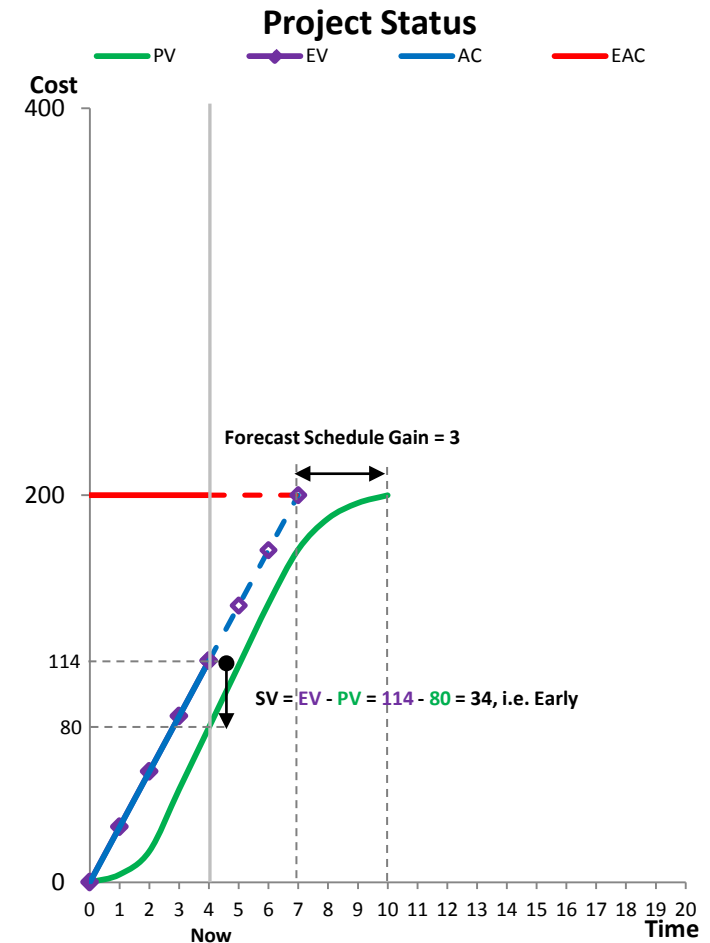
SPI = 1.4, CPI = 1.0, $TCPI_{(BAC)} = 1.0$

Calculated Estimates

EAC = 200, ETC = 86, Estimated Duration = 7

Summary

Ahead of schedule, on budget



EVM Example IV

Status at Time Now (4)

Basic Measures

BAC = 200, Planned Duration = 10

PV = 80, AC = 100, EV = 80

Variiances

SV = 0, CV = -20

Performance Indices

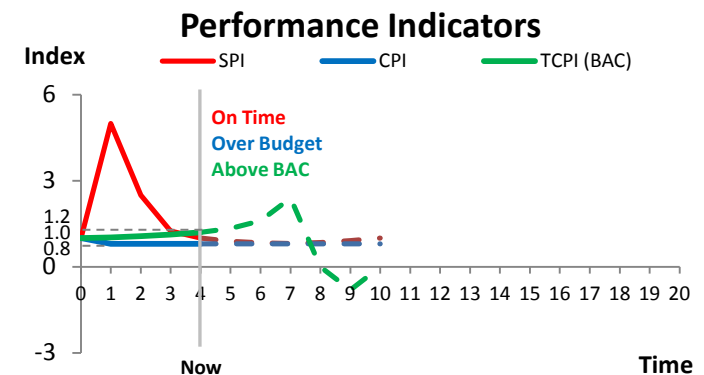
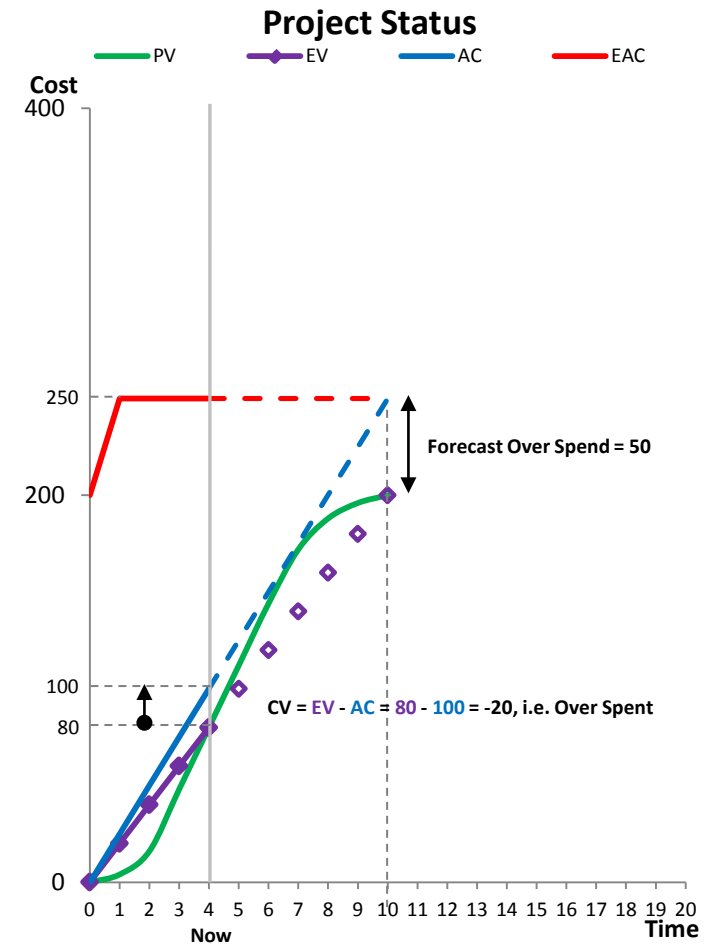
SPI = 1.0, CPI = 0.8, TCPI_(BAC) = 1.2

Calculated Estimates

EAC = 250, ETC = 150, Estimated Duration = 10

Summary

On schedule, over budget



EVM Example V

Status at Time Now (4)

Basic Measures

BAC = 200, Planned Duration = 10

PV = 80, AC = 40, EV = 80

Variiances

SV = 0, CV = 40

Performance Indices

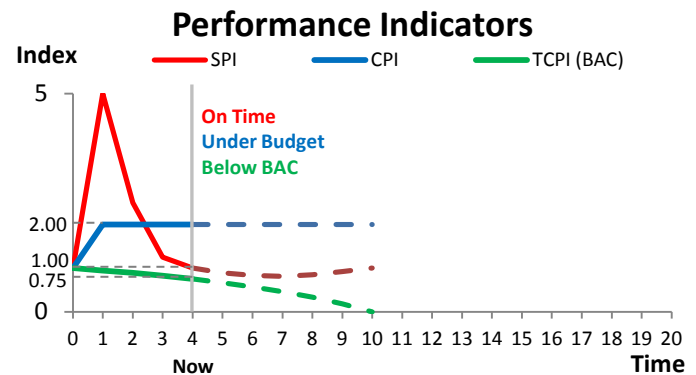
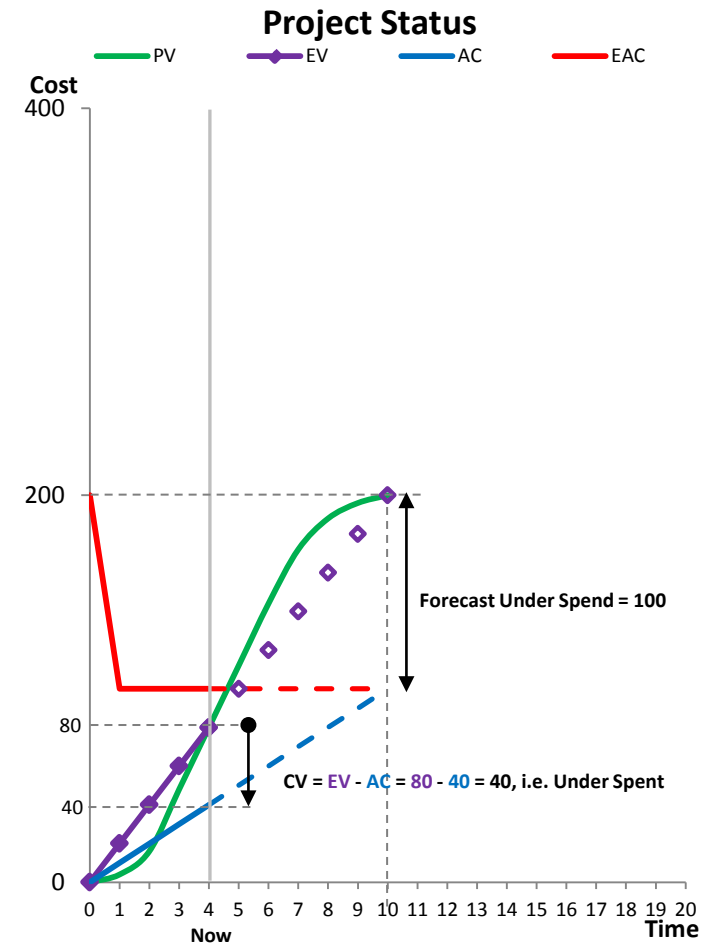
SPI = 1.0, CPI = 2.0, $TCPI_{(BAC)} = 0.75$

Calculated Estimates

EAC = 100, ETC = 60, Estimated Duration = 10

Summary

On schedule, under budget



EVM Example VI

Status at Time Now (4)

Basic Measures

BAC = 200, Planned Duration = 10

PV = 80, AC = 80, EV = 40

Variiances

SV = -40, CV = -40

Performance Indices

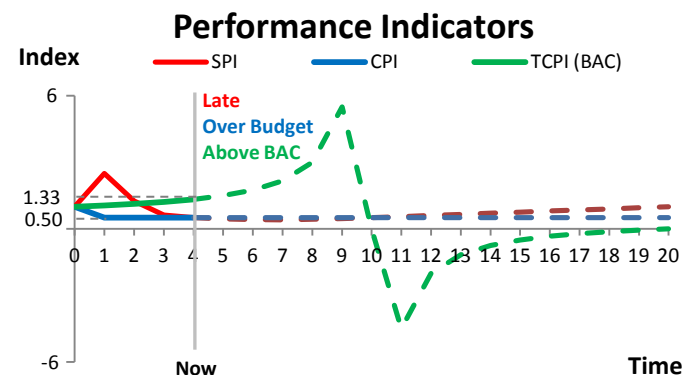
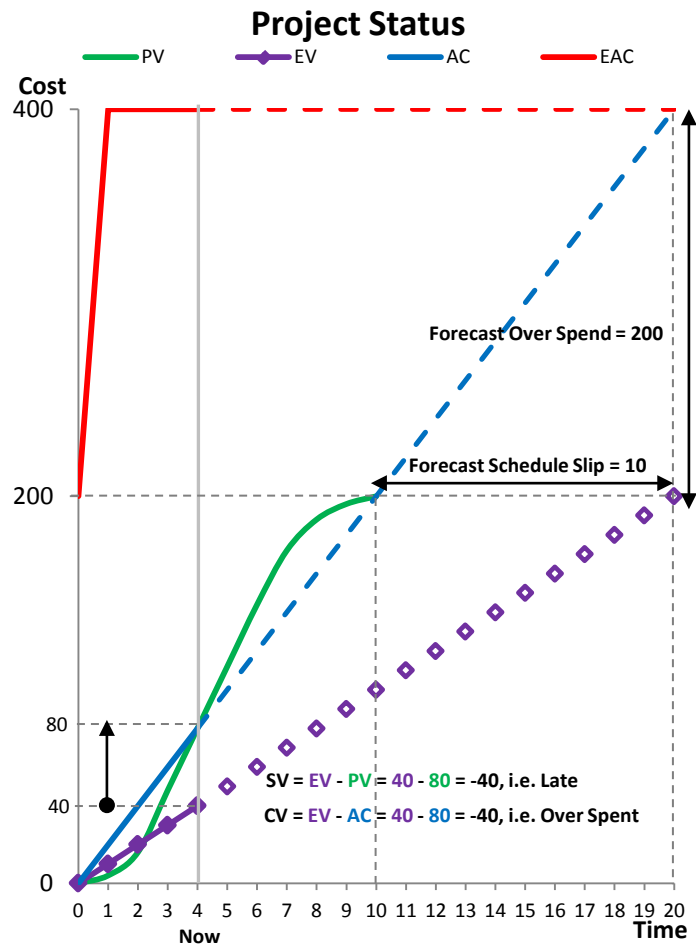
SPI = 0.5, CPI = 0.5, TCPI_(BAC) = 1.3

Calculated Estimates

EAC = 400, ETC = 320, Estimated Duration = 20

Summary

Behind schedule, over budget



EVM Example VII

Status at Time Now (4)

Basic Measures

BAC = 200, Planned Duration = 10

PV = 80, AC = 80, EV = 120

Variiances

SV = 40, CV = 40

Performance Indices

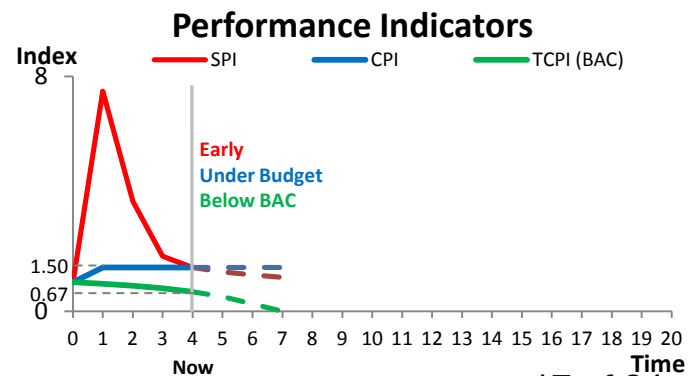
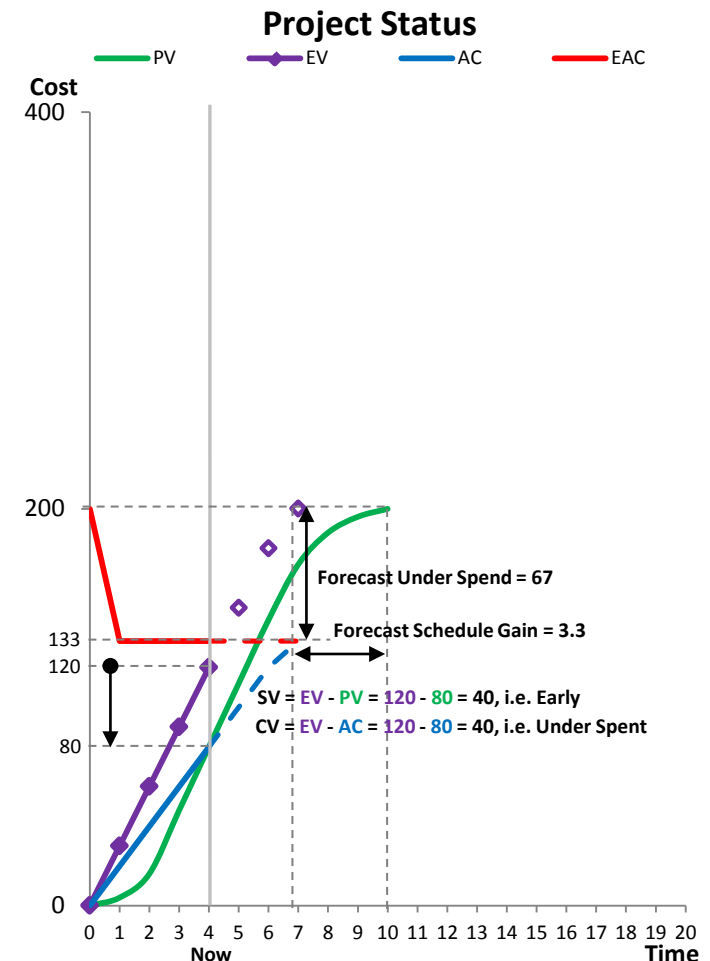
SPI = 1.5, CPI = 1.5, $TCPI_{(BAC)} = 0.67$

Calculated Estimates

EAC = 133, ETC = 53, Estimated Duration = 6.7

Summary

Ahead of schedule, under budget



Corrective Actions

Resource Problems

- Not enough resources?
- Wrong or insufficiently skilled resources? Training needed? Replacement needed?

Work Problems

- More difficult than anticipated?
- More rework than anticipated? Need technical help?

Assumption or Dependency Problems

- Incorrect assumption(s)?
- Missing in-feeds?

Data Problems

- Correct & consistent data? e.g. are Actuals for the same time as Planned
- Appropriate method of objectively assessing EV?

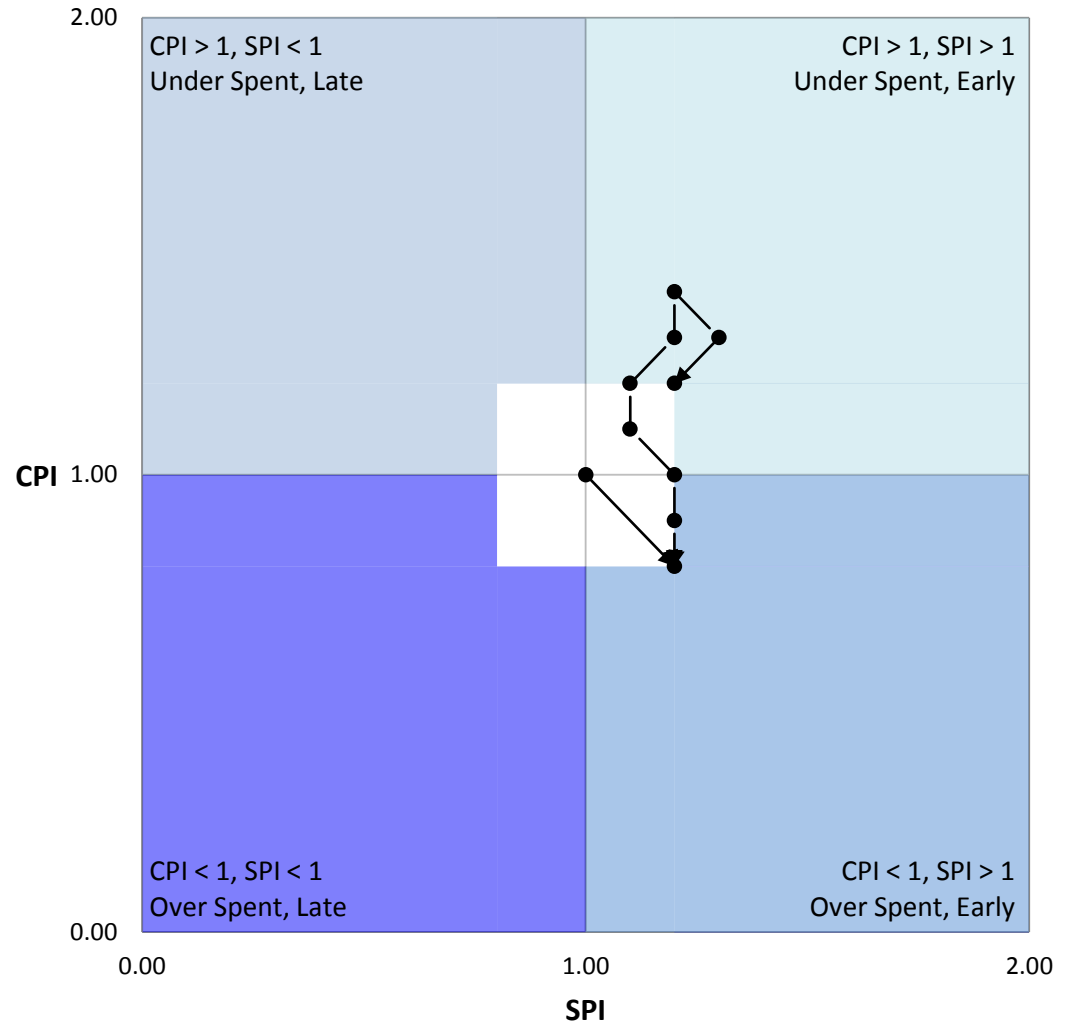


EVM Bulls Eye Chart

To make reporting easier, variance thresholds can be agreed at the start of a project. Variances within these thresholds can then be logged but with no explanation needed.

Variances might be presented using a Bulls Eye Chart.

CPI and SPI are plotted each reporting period (weekly, monthly or quarterly).



Risk Management & Change Control

- At the start of a project, the Planned Value does not include all the risk contingency as risk events are uncertain (i.e. have a probability less than 100%)
- Risk mitigation and enhancement tasks will be included in the PV
- As the project progresses it will likely be necessary to add or modify tasks – either adding further risk mitigations or enhancements, or because of scope change
 - These should update the baseline PV – in order to maintain the validity of the EVM data
 - This can be done within standard planning tools with care; or specialist tools are available



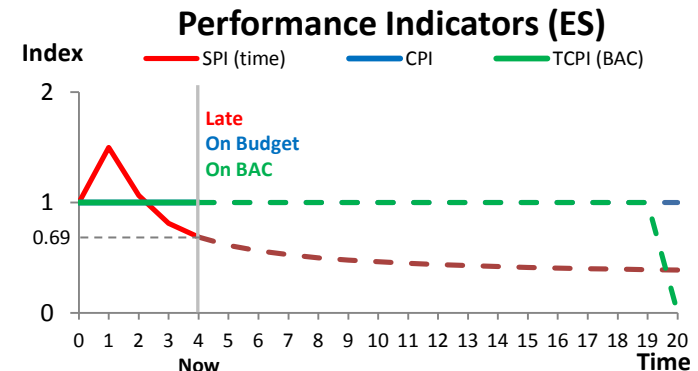
Earned Schedule



Schedule is Different

First proposed by Walt Lipke in 2003

- A schedule variance of 0 or SPI of 1 indicates that a project is exactly on schedule. However, when a project is complete, SV is always 0 and SPI is always 1, even if the project delivered late.
- Earned Schedule (ES) resolves the long-standing dilemma of the EVM schedule indicators providing false information for late performing projects.
- $ES = C + I$
 where $C = ES$ for completed PV time periods = $(EV \geq PV)_{\text{cumulative}}$
 and $I = ES$ for partially completed PV time periods = $(EV - PV_C) / (PV_{C+1} - PV_C)$
- $SV_{(\text{time})} = ES - \text{Actual Time}$
- $SPI_{(\text{time})} = \frac{ES}{\text{Actual Time}}$
- ES metrics are not a substitute for schedule analysis using the project plan.



EVM Example II (slide 12) using SPI (time) in place of SPI



Cautions & Tips

- SPI > 1 does not always mean the project is ahead of schedule. Schedule performance should be assessed looking at the project plan, in particular the critical path.
If more non-critical path work is done than planned at a given point, this could lead to SPI > 1, but this will not shorten the critical path!
- Take care that materials and expenses don't incorrectly skew EVM.
- Use EVM to trigger *appropriate* action.
Setting hares running on seeing CPI, SPI less than 1 may be neither necessary or helpful.
- EVM will not help a project with inadequate requirements, WBS or change control, i.e. EVM is not a substitute for general project management best practice.
- Remember that all measures of project progress are *estimates*.



Summary

Earned Value Management offers an objective way of visualising project performance, providing early indication of problems as well as a view on the impact of corrective actions. It is an indispensable project management tool for all but the smallest projects.

EVM is not complex to implement.

Like any tool, EVM is open to misuse in the wrong hands.

In competent hands EVM is the most efficient means of assessing project progress, providing a narrative for progress reporting and is highly recommended.



Author Profile



After 4 years as an electronics engineer for Siemens, achieving Chartered Engineer, I moved into project management for 14 years, at Siemens and Roke Manor Research. At Roke, my ability to successfully deliver the most challenging whole lifecycle product development projects on time and under budget led to a role as Projects Director and board member for 6 years. In 2013 I went back to hands-on project management, taking a Programme Director role at Cambridge Consultants, in the Cambridge Science Park.

In my board role I led a team of 22 professional Project Managers and 5 Quality Engineers, and ensured Roke's £79m project portfolio delivered better than budget profit. I ran a virtual PMO and created the Roke Engineering Process, REP, also managing the engineering tools to support it.

I created a project management competency framework, the PM Excellence Programme, which achieved [APM corporate accreditation](#), scoring 24 out of a possible 25 points in the APM assessment.

I chaired a quarterly PM forum which shared best practice and built a supportive PM community – seven of the project managers I coached achieved APM RPP, five gained PQ, and all passed APMP.

Together, these investments in PM professionalism led to a turn-around and annual improvement in project results across a typical portfolio of 400 projects a year and delivered an above budget performance in five consecutive years with profits totalling £7.9m above budget.

I am a passionate advocate of PM professionalism, a Fellow of the APM and the IET, and author of articles published in Project and PM Today.

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