MODULE 4

Process—
Primary Constraints

CHAPTER 4

Costs and Budget

Budget and Schedule Integration

Charter grants project manager degree of control over:

- Time (schedule).
- Money (budget).

Separate to plan but must integrate.

Inextricably intertwined: Schedule is primary determinant of project costs.

Budget balances project objectives, available resources, and standards.

Reducing a cost can increase other costs (no net savings).

- Example: Fewer design reviews, more rework.

Predictive: Project Cost Management

KNOWLEDGE AREAS	PROCESS GROUPS				
	Initiating	Planning	Executing	Monitoring and Controlling	Closing
Project Cost Management		• Plan Cost management • Estimate Costs • Determine Budget		• Control Costs	

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- Includes some of the same estimating tools as for Schedule Management but applied to estimating costs
- Produces key performance baseline
- Uses earned value analysis (EVA) as a control tool

Planning Costs on Agile/Hybrid Projects

Detailed cost calculations wasteful	• Likelihood of scope change • Primary cost: staff (easier to budget)
Lightweight estimations	• Fast, high-level forecasts
Short-term planning and just-in-time detailed estimates	• For iteration • For special need (e.g., new software)
Run rate: rate of project spending per iteration or week	• Stable team size = stable run rate • Limited team size = lower run rate
Plan to monitor and control: product owner	• Knows cost of adding another iteration • Approves spending in daily interactions • Specifies cost metrics to use

Predictive: Plan Cost Management

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- How costs will be estimated, budgeted, prioritized, tracked, and controlled
- How funding will be managed

Financial Measures

You probably won't see these on the exam, but to be safe you should be familiar with what they are.

Organizations have preferred measures and thresholds that guide project investment decisions.

- Effect of cost of money
  - Weighted average cost of capital (WACC)
- Internal hurdles
  - Payback period
  - Return on investment (ROI)
  - Internal rate of return (IRR)
- Impact of time on value
  - Discounted cash flow
  - Net present value (NPV)

Cost Management Plan

Units of measure

- Currency, exchange rates

Level of precision

- Rounding

Level of accuracy

- Acceptable estimate ranges, inclusion of contingency funds

Organizational procedure links

- Alignment with WBS control accounts

Control thresholds

- When alarms will go off

Measurement rules

- When and how to make what types of measurements

Record and report

- What to record, who gets a report, when and at what level

Possible additions

- Project-dependent information

Estimating Costs on Agile/Hybrid Projects

- Rolling wave planning:
  - Definitive estimate (–5% to +10%) for upcoming iteration.
  - Rough order of magnitude (ROM, –25% to +75%) for project.
- Iteration-based: Run rate known, scope completed varies.
- Flow-based: Scope for release known, estimate weeks x cost/week.
- First iteration will be estimate. (Velocity not known yet.)
  - Keep contracts flexible if possible.
  - Contract may require finishing first iteration at a fixed price or using contingency reserves.

Predictive: Estimate Costs

Inputs

Project management plan
- Cost management plan
- Quality management plan
- Scope baseline

Project documents
- Lessons learned register
- Project schedule
- Resources requirements
- Risk register

EEFs

OPAs

Tools and Techniques

Expert judgment

Analogous estimating

Parametric estimating

Bottom-up estimating

Multipoint estimating

Data analysis
- Alternatives analysis
- Reserve analysis
- Cost of quality

Project management information system

Decision making
- Voting

Outputs

Cost estimates

Basis of estimates

Project documents updates
- Assumptions log
- Lessons learned register
- Risk register

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Level of Precision

- What level of variance from estimates will trigger the need for further investigation and possible action?
- Organizations often assign several categories for various orders of magnitude (all skewed in direction of cost overages being more likely).

Initiating	Early Planning	Final Planning and into Executing
Rough order of magnitude (ROM) –25% to +75%	**Conceptual –10% to +25%**	**Definitive –5% to +10%**

Discussion Question

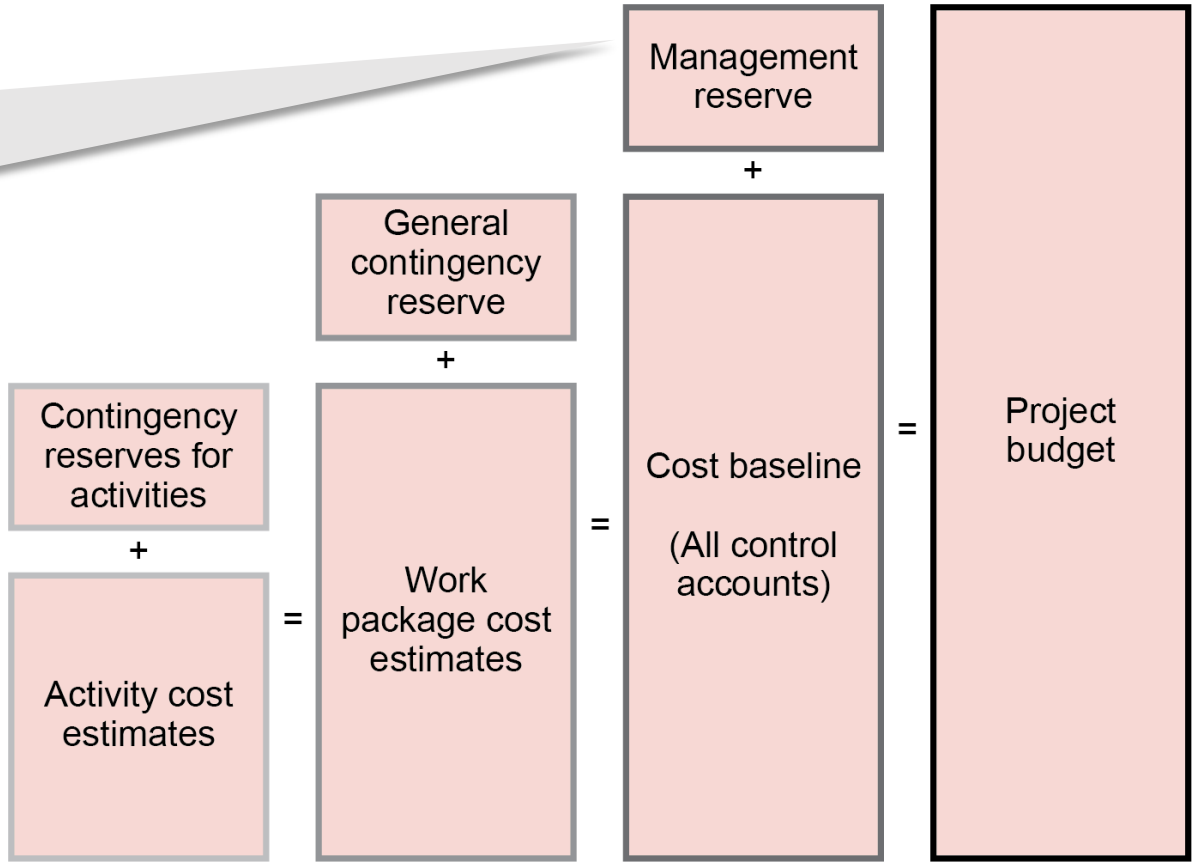
In the project charter, costs were estimated at US$2,000,000. What is the upper threshold to which costs might extend by the time the project work is being executed?

A. US$2,500,000
B. US$3,000,000
C. US$3,500,000
D. US$3,750,000

Management and Contingency Reserves

Management reserve
Amount of project budget withheld by management to respond to unforeseen needs

Contingency reserve
Budget within the cost baseline allocated for managing identified risks



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Discussion Question

During project execution, a contractor defaults. How will the resulting increases in costs be funded?

A. Contingency reserves
B. Management reserves
C. Change request to increase cost baseline

Cost Estimates

- Estimate costs by activity.
- Consider all costs:

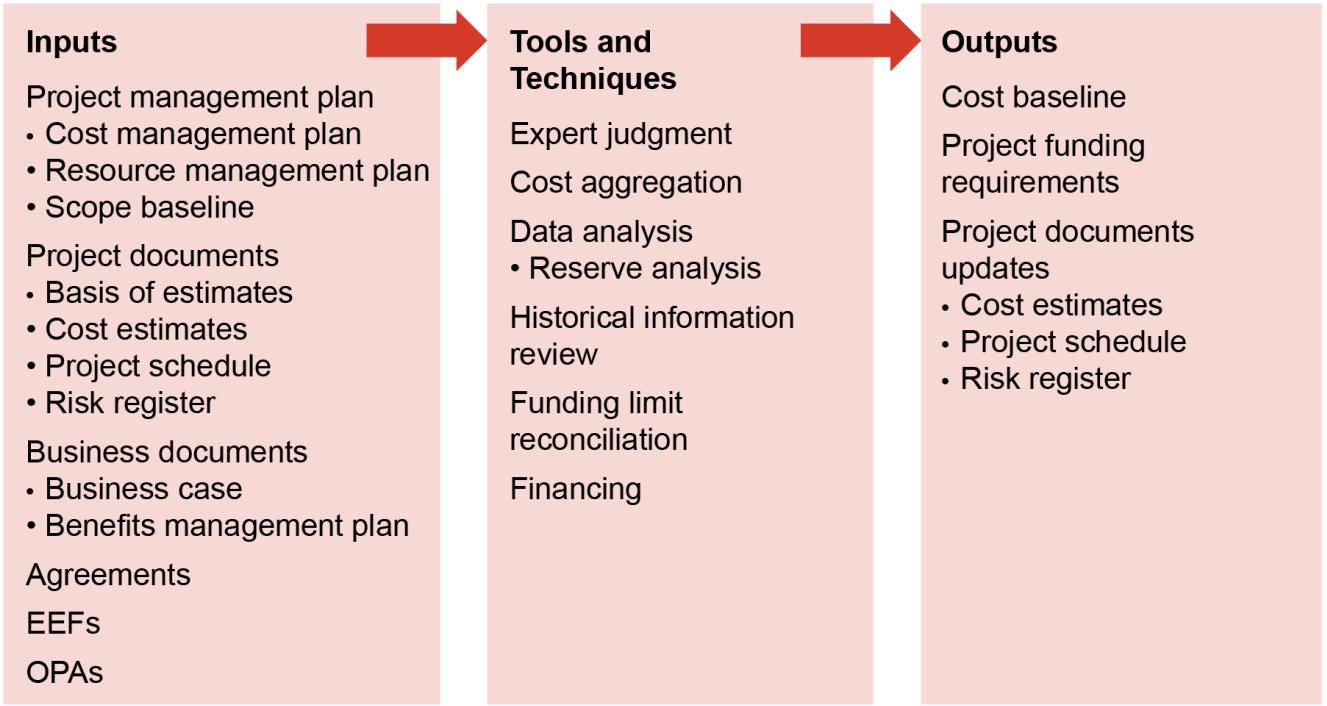
Direct expenses	e.g., labor, materials, services
Special costs	e.g., currency exchange rates
Indirect costs	e.g., space/services provided

Discussion Question

A sponsor wants to see a high-level budget before signing the agile charter. The scope will likely expand. Which is the best way to provide a budget?

A. Estimate costs in detail for the first iteration and multiply by the fixed number of iterations.
B. Create a rough order of magnitude (ROM) budget and multiply it by 1.5 to account for scope change.
C. Create dummy tasks and add them to the scope.
D. Multiply the project's run rate by the project's velocity.

Predictive: Determine Budget



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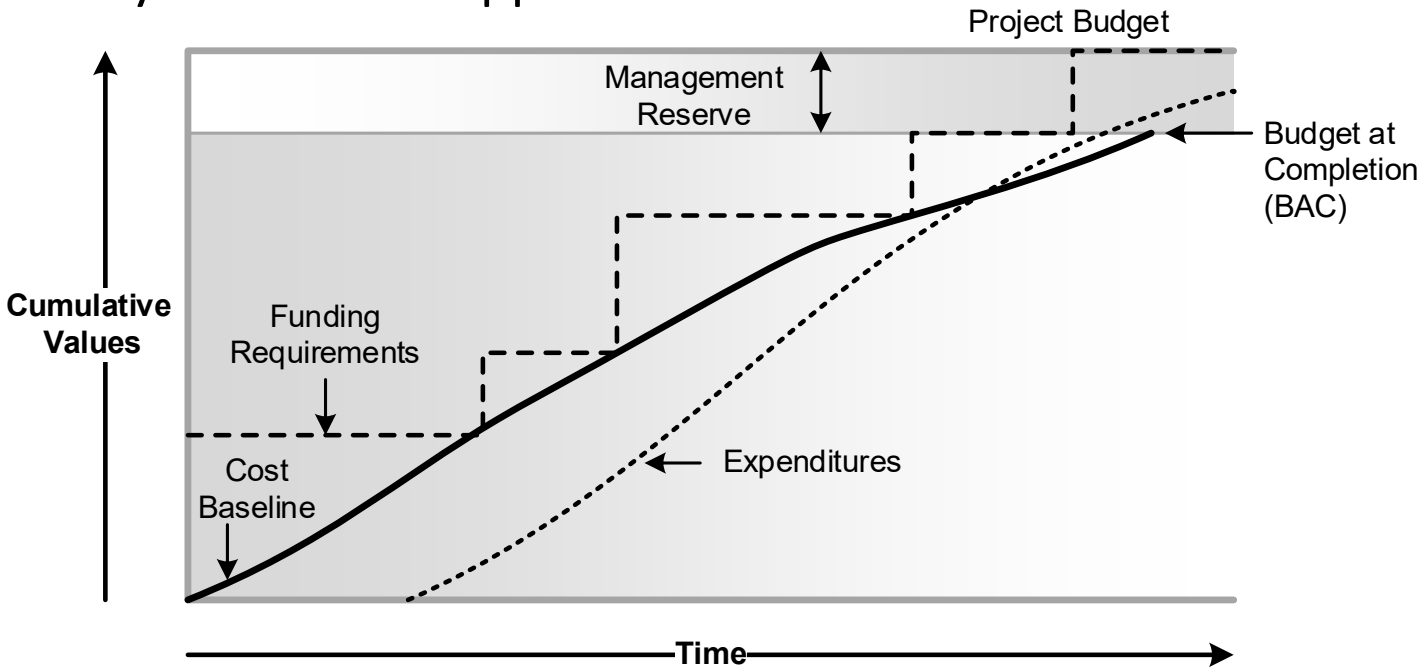
- Estimates are aggregated and reserves added to create a cost baseline, which becomes the basis for assessing project cost performance.

Cost Baseline

S-curve chart provides a **time-phased** view of the cost baseline—how activities may have to be reconciled with funding infusion and when reserves may have to be tapped.



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Key Points about the Cost Baseline

- The project manager is responsible for controlling spending and releasing funds within the cost baseline.
- Funds are usually released over time, and funding schedules must be reconciled with work schedules.
- The cost baseline includes both contingency and reserves and work package cost estimates.
- It is the benchmark for project cost performance.
- All changes must be made through the integrated change control process.

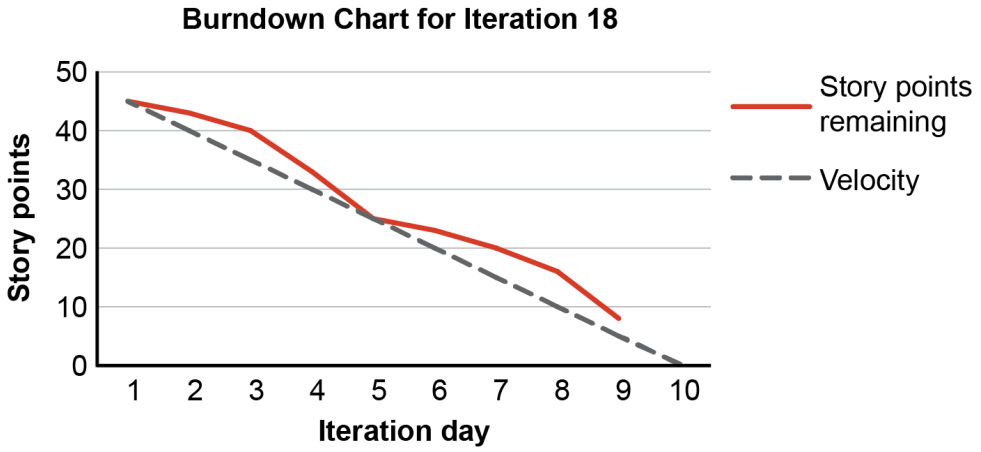
Project Manager Cost Control Responsibility

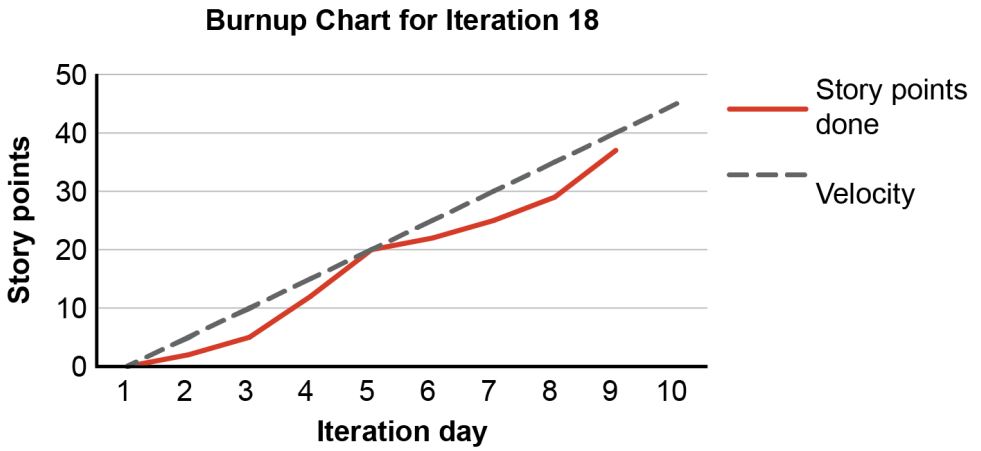
Early detection of variances and trends and proactive influence over root causes are critical in controlling project costs. It's better not to have to work your way out of a deep hole.

- **Lead and manage** to ensure that the project meets scope, time, and cost baselines.
- **Develop solutions** that address root causes.
- **Ensure that costs comply** with defined budgets for control accounts and with calendar periods. No forward borrowing.
- **Prevent unapproved changes,** which add cost without value.

Anticipating/Controlling Costs on Agile/Hybrid Projects

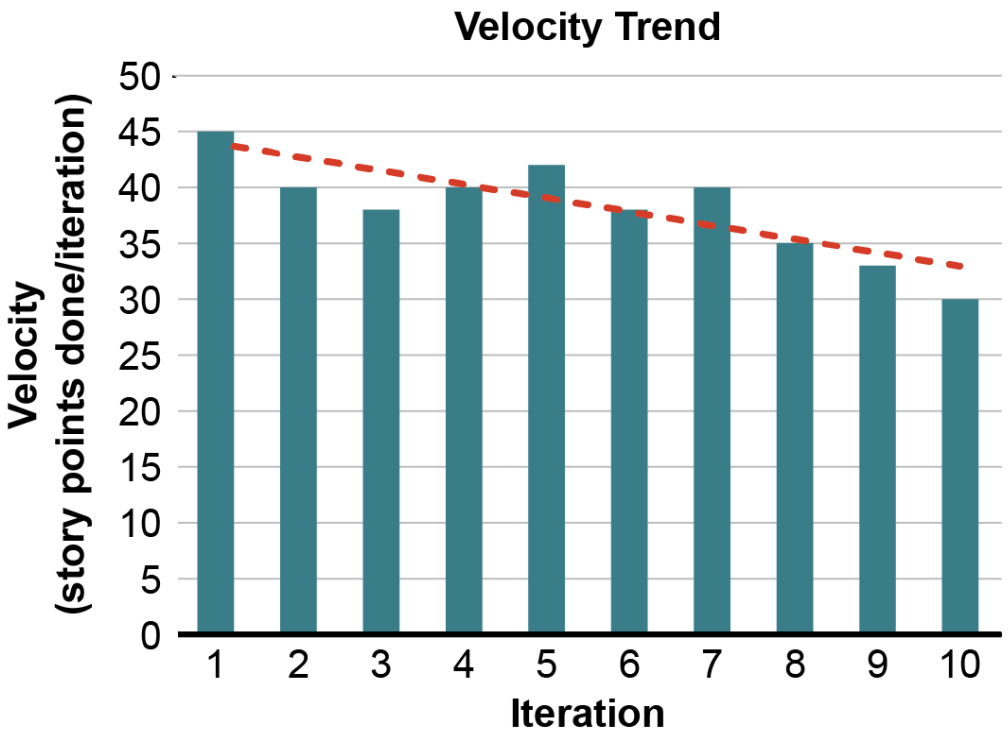
- Iteration metrics:
  - Kanban board
  - Ceremonies, especially daily standups
- Average velocity (45 points/iteration in example).
- Team may input data and charts update automatically.
- Work consistency (sustainable hours?)
- Only done stories show (chart may lag progress).





Agile Whole Project Schedule/Cost Metrics

- Track trends in velocity over time.
- Retrospect on how to improve.
- Redline (cut) least important scope to get back on schedule/budget.



Predictive: Control Costs

Inputs

Project management plan
- Cost management plan
- Cost baseline
- Performance measurement baseline

Project documents
- Lessons learned register

Project funding requirements

Work performance data

OPAs

Tools and Techniques

Expert judgment

Data analysis
- Earned value analysis
- Variance analysis
- Trend analysis
- Reserve analysis

To-complete performance index

Project management information system

Outputs

Work performance information

Cost forecasts

Change requests

Project management plan updates
- Cost management plan
- Cost baseline
- Performance measurement baseline

Project documents updates
- Assumptions log
- Basis of estimates
- Cost estimates
- Lessons learned register
- Risk register

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Earned Value Analysis (EVA)

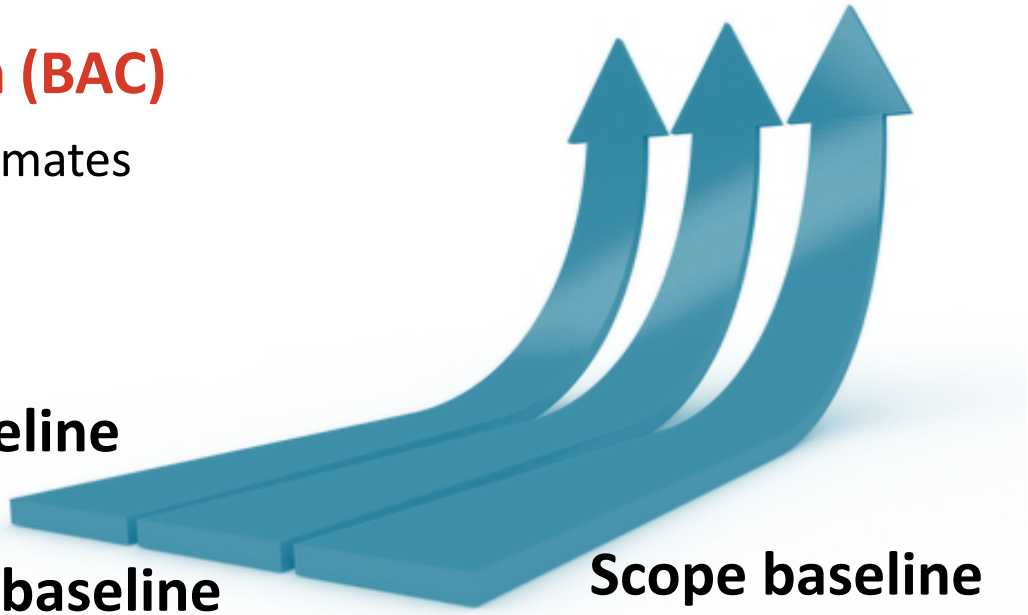
- A methodology that assesses both schedule and cost performance through the concept of earned value, the **monetary value of work actually completed.**
- Can be performed by **project, phase,** or **activity.**

Performance Measurement Baseline

The planned cumulative costs extended over time to complete the entire project

Budget at completion (BAC)

- Work package cost estimates
- Contingency reserves



Discussion Question

Match each EVA term with the correct definition.

1. Earned value
2. Planned value
3. Actual cost

a. Authorized budget for scheduled work

b. Work performed expressed in terms of budget authorized for that work

c. Realized cost for work on an activity during a specific time period

EVA Variances

Schedule Variance	Cost Variance
How does the work done compare with the work that was scheduled to be done?	How does the amount of work done compare with the budget dollars spent?
SV = EV – PV	**CV = EV – AC**
A positive result is good. The project is **ahead of schedule.**	**A positive result is good.** The project is **under budget.**

*A **variance** uses subtraction to compare baseline and actual performance. The first term is always **EV.***

EVA Performance Indices

Schedule Performance Index	Cost Performance Index
How well is the project performing against the schedule?	How is the project performing against the budget?
$SPI = \frac{EV}{PV}$	$CPI = \frac{EV}{AC}$
Above 1 is good. (Project is **ahead** of schedule.)	**Above 1 is good.** (Project is **under** budget.)

*A **performance index** is a ratio that uses division. The numerator is always **EV.***

Solving for Unknown Variables

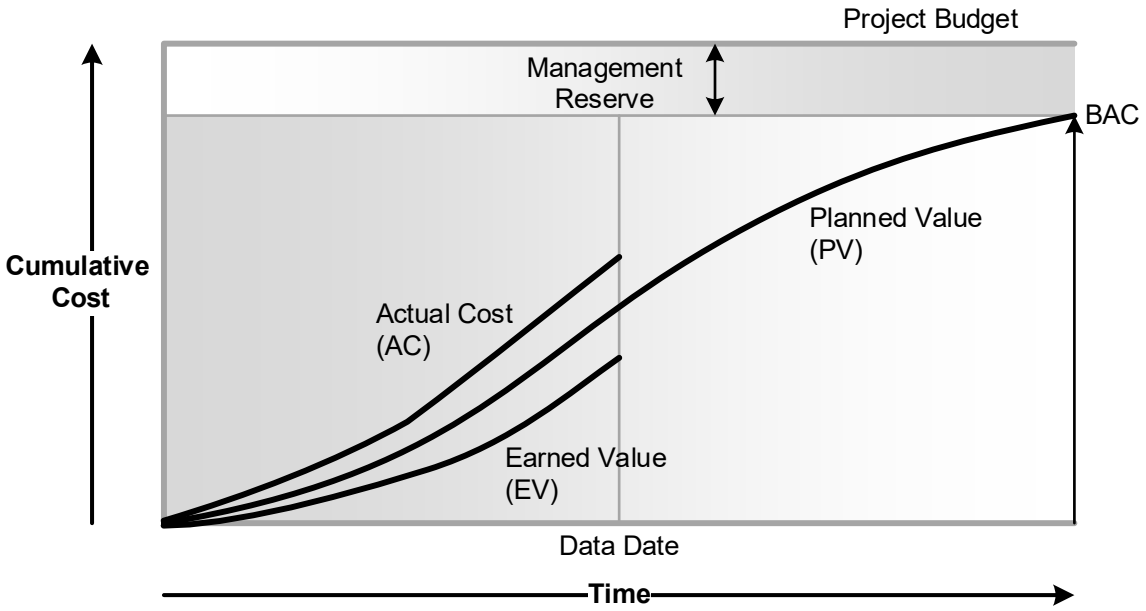
You will probably be asked to calculate an EVA value when you have only some of the values in the formula.

What should you do?

1. Write the formula for the value the question is targeting. What are you missing?
2. What formula includes that value? Do you have enough information to solve that one?
3. Repeat until you have all the values you need.

Discussion Question

S-curve charts can be used to visualize current and forecast project performance. What does this S-curve show?



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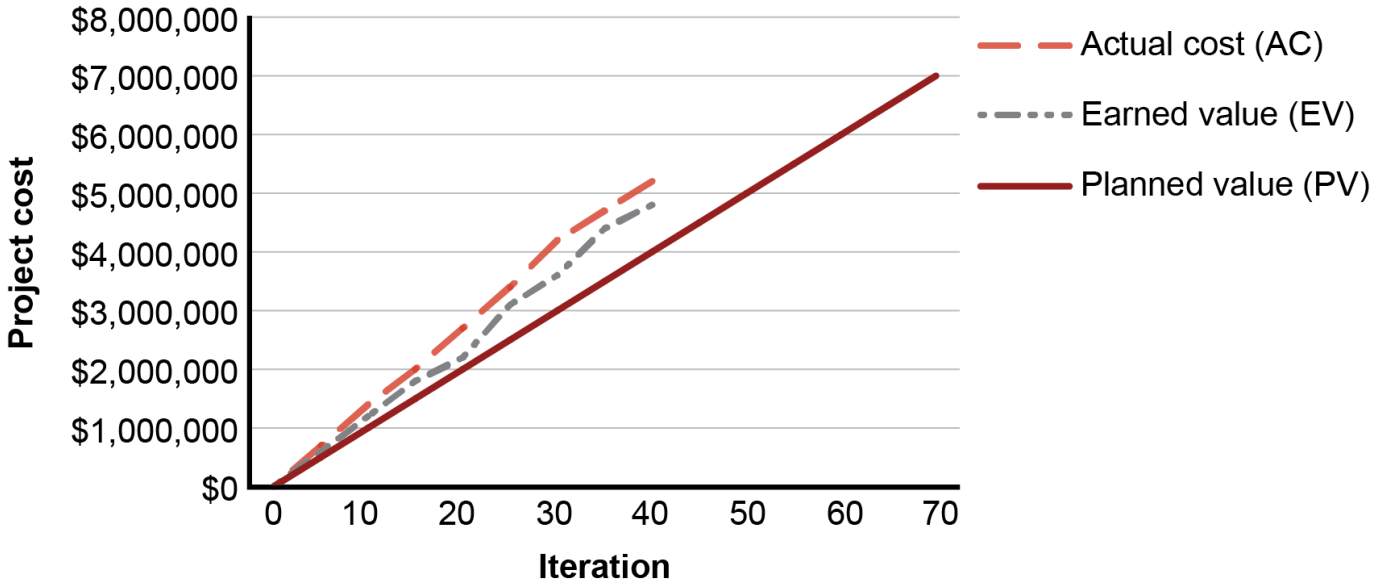
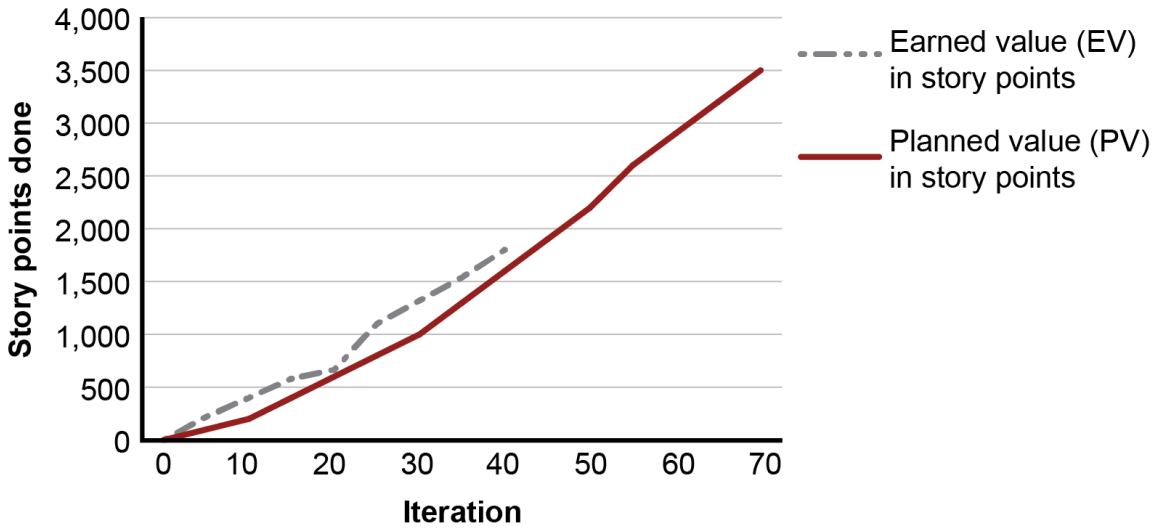
Applying EVA to Agile/Hybrid Projects

- PV can shift if scope changes but may be a straight line (given predictable run rate).
- EV is value of scope actually delivered.
- AC is same.



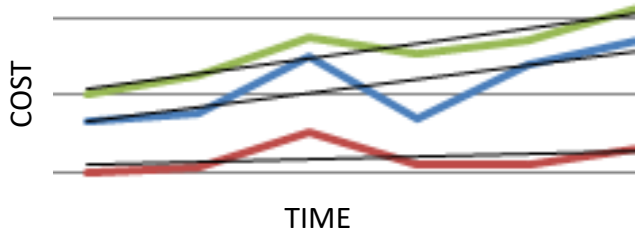
Alternative Inputs for EVA Schedule in Agile

- SPI can use story points, stories, or features.
- SPI = $\frac{\text{Completed}}{\text{Planned}}$
- EVA for schedule:
  - PV in story points.
  - EV in story points.
  - Omit AC.
    (Avoid assigning a cost per story point.)



Trend Analysis

- A forecast is an estimate of the "project's future based on information and knowledge available at the time of the forecast."
- Forecasts use trend analysis to predict future performance.
  - Past measurements of performance are plotted against time.
  - A mathematical model (such as that in Microsoft Excel®) uses the historical trend to plot future performance.



Cumulative CPI

Month	EV	Cumulative EV	AC	Cumulative AC	Cumulative CPI
1	$1,000	$1,000	$1,100	$1,100	$1,000/$1,100 = 0.909
2	$1,000	$2,000	$1,100	$2,200	$2,000/$2,200 = 0.909
3	$1,000	$3,000	$1,100	$3,300	$3,000/$3,300 = 0.909
4	$1,200	$4,200	$1,300	$4,600	$4,200/$4,600 = 0.913
5	$1,200	$5,400	$1,300	$5,900	$5,400/$5,900 = 0.915
Total	**$5,400**	**$5,400**	**$5,900**	**$5,900**	**$5,400/$5,900 = 0.915**

(US$)

Cumulative CPI = Sum of EVs to Date/Sum of ACs to Date

Estimate at Completion (EAC)

How much will this project cost us when we're done?

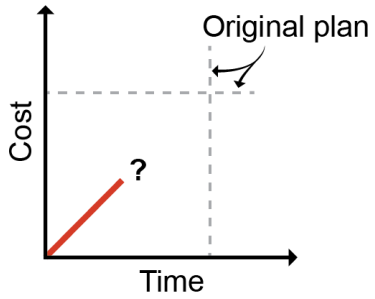
EAC = Actual Costs (AC) + Estimated Cost to Finish All Remaining Work (ETC)

- **An early warning signal that a threshold may be violated**
- **A tool to determine proactive behavior (e.g., changes in staffing, less-expensive materials)**

Four Types of Estimates at Completion (EAC)

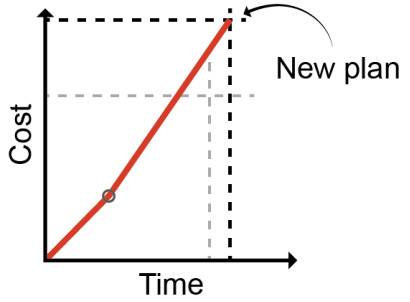
EAC_{New}

- Prior estimates are useless.
- Re-planning is needed.



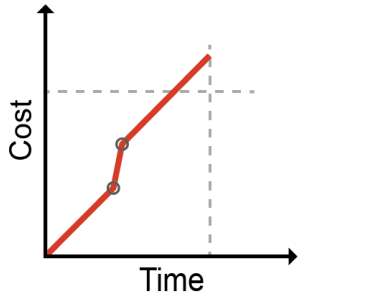
EAC_{CPI}

- Cost rate is expected to continue.
- Variances are typical.



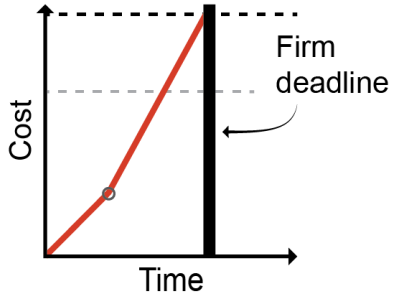
EAC_{BAC}

- Cost rate is not expected to continue.
- Variances are atypical.



$EAC_{CPI*SPI}$

- Cost rate is expected to continue.
- There is a firm deadline to meet.



EAC_{New}

EAC_{New} = AC + Bottom-Up ETC

Example:

US$280K + (US$200K + US$420K + US$70K) = US$970K

- Prior estimates are no longer reliable.
- Remaining activity costs are re-estimated and aggregated.
- Common approach but time-consuming and expensive.

EAC_{CPI}

For ETC work performed at present CPI (typical variances)

$$EAC_{CPI} = \frac{BAC}{CPI}$$

Example:

US$1,000,000/1.071 = US$933,707

Note that the CPI is above 1; the project is under budget.

- CPI is reliable indicator of future performance.
- If future is likely to follow past performance, this method is used.

EAC_{BAC}

For ETC work performed at budgeted rate (atypical variances)

$$EAC_{BAC} = AC + (BAC - EV)$$

Example:

US$280K + (US$1,000K – US$300K)

= US$280K + US$700K

= US$980K

- When variances were due to identifiable events that are now in the past (i.e., the increased costs are in the past).
- When future estimates are probably accurate.

$EAC_{CPI * SPI}$

$$EAC_{CPI \times SPI} = AC + \frac{(BAC - EV)}{(CPI \times SPI)}$$

Example:

$$US\$280K + \frac{(US\$1{,}000K - US\$300K)}{(1.071 \times 0.517)}$$

$$= US\$280K + \frac{US\$700K}{0.554}$$

$$= US\$280K + US\$1{,}264K = US\$1{,}544K$$

- CPI is considered accurate.
- There is a milestone or deadline constraint (e.g., "*We have to finish the project on schedule. What will it take?*").

Discussion Question

A bridge must be in operation by a certain date. At the data date, half of the work has been completed.

- BAC = US$15M
- CPI = 0.8
- SPI = 0.7

Calculate EAC.

Estimate to Complete (ETC)

ETC = EAC – AC

Example:

US$934K – US$280K = US$654K

Once the EAC is known, we can calculate the estimate to complete by subtracting the budget already spent (AC) from the estimated cost of the project at completion.

Variance at Completion (VAC)

A projection of the probable budget deficit or surplus

VAC = BAC – EAC

Example:

US$1,000K – US$934K = US$66K

To-Complete Performance Index (TCPI)

- What CPI will we need to achieve to meet the project goal with our remaining resources?
- Is the BAC achievable?

NOTE:

Future CPI will probably not vary by more than ±10% from historic CPI. So an increase in future CPI of more than 10% will probably indicate the need for a change request.

TCPI Scenarios

Budget is achievable.

*Use **BAC**.*

$$TCPI_{BAC} = \frac{(BAC - EV)}{(BAC - AC)}$$

Budget is clearly not viable.

*Use **EAC**.*

$$TCPI_{EAC} = \frac{(BAC - EV)}{(EAC - AC)}$$

NOTE:

Unlike CPI and SPI, a TCPI **above** 1 is bad and **below** 1 is good.

A TCPI above 1 indicates that CPI must improve, which may be hard to achieve.

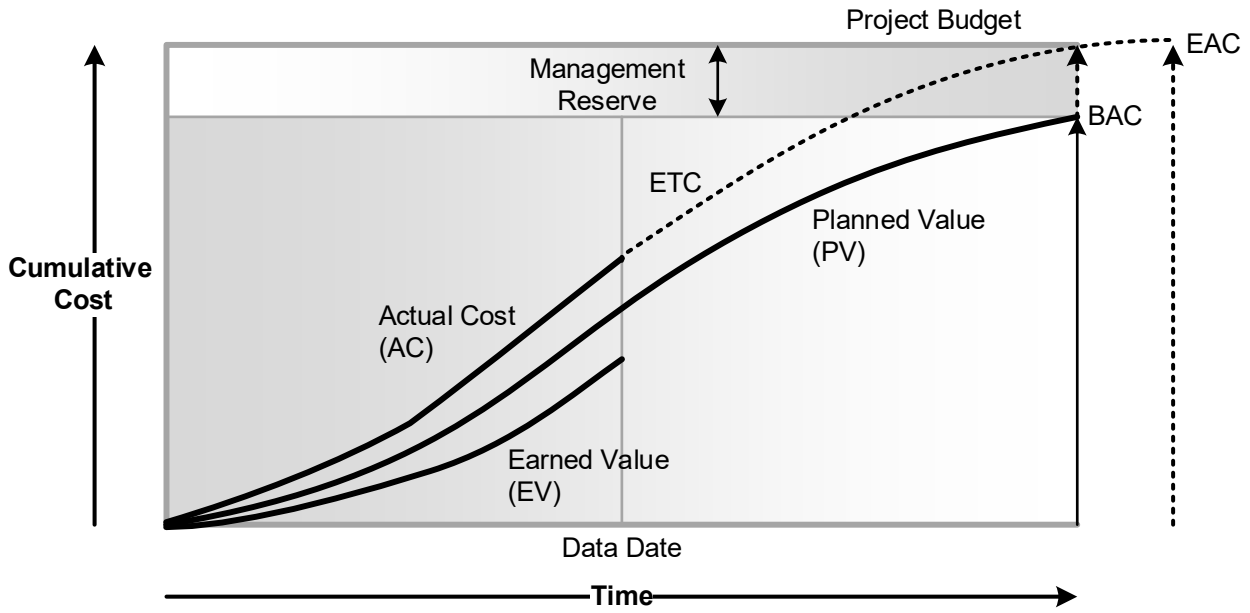
Discussion Question

The BAC is US$10M. EV is US$4M, and AC is US$5M. What should the project manager do?

A. Take no action. The budget is achievable.
B. Prepare a change request to change the schedule or cost baseline.
C. Motivate the team to work harder.
D. Add team members.

S-Curve Forecasts

Forecast information can be displayed on an S-curve chart to visualize project cost performance.



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