Project Cost Management

Richard Boser

Project Cost Management

Introduction

Course Objectives

- Upon completing today's activities you will be knowledgeable of tools and techniques to:
  - Allocate overall costs to WBS work packages
  - Develop a project estimate and budget
  - Use Earned Value Analysis to control budget
  - Immediately apply PM principles on the job

Your Objectives

- What do you want to get out of the course?
  - 1
  - 2
  - 3
  - 4
  - 5
  - 6

Tentative Agenda

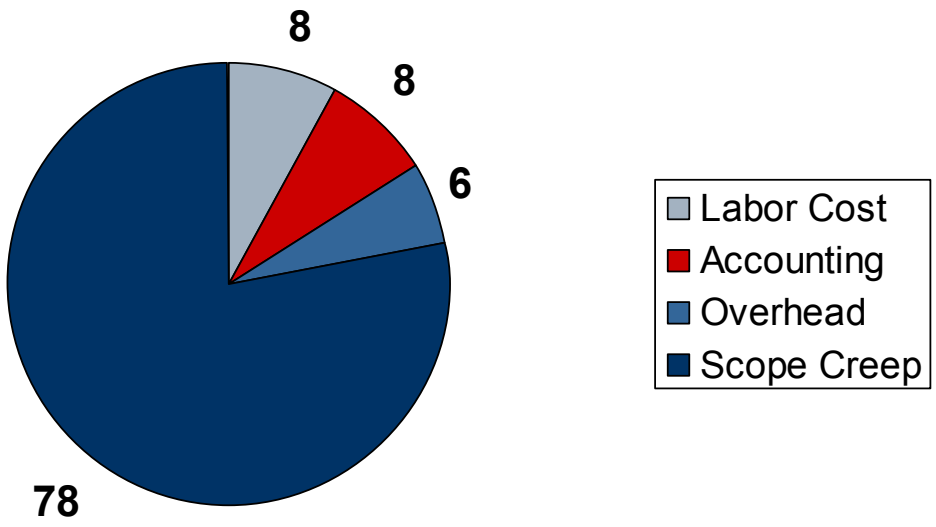
Hour	Topic/Activity	Slide #
1	Introduction	
2	Estimating	
3	Budgets & Cost Control	
4	Earned Value Analysis	
5	Accounting Issues	

Worried About Budget Cuts?

Source: http://californiamondioring.org/images/budgetcut.jpg

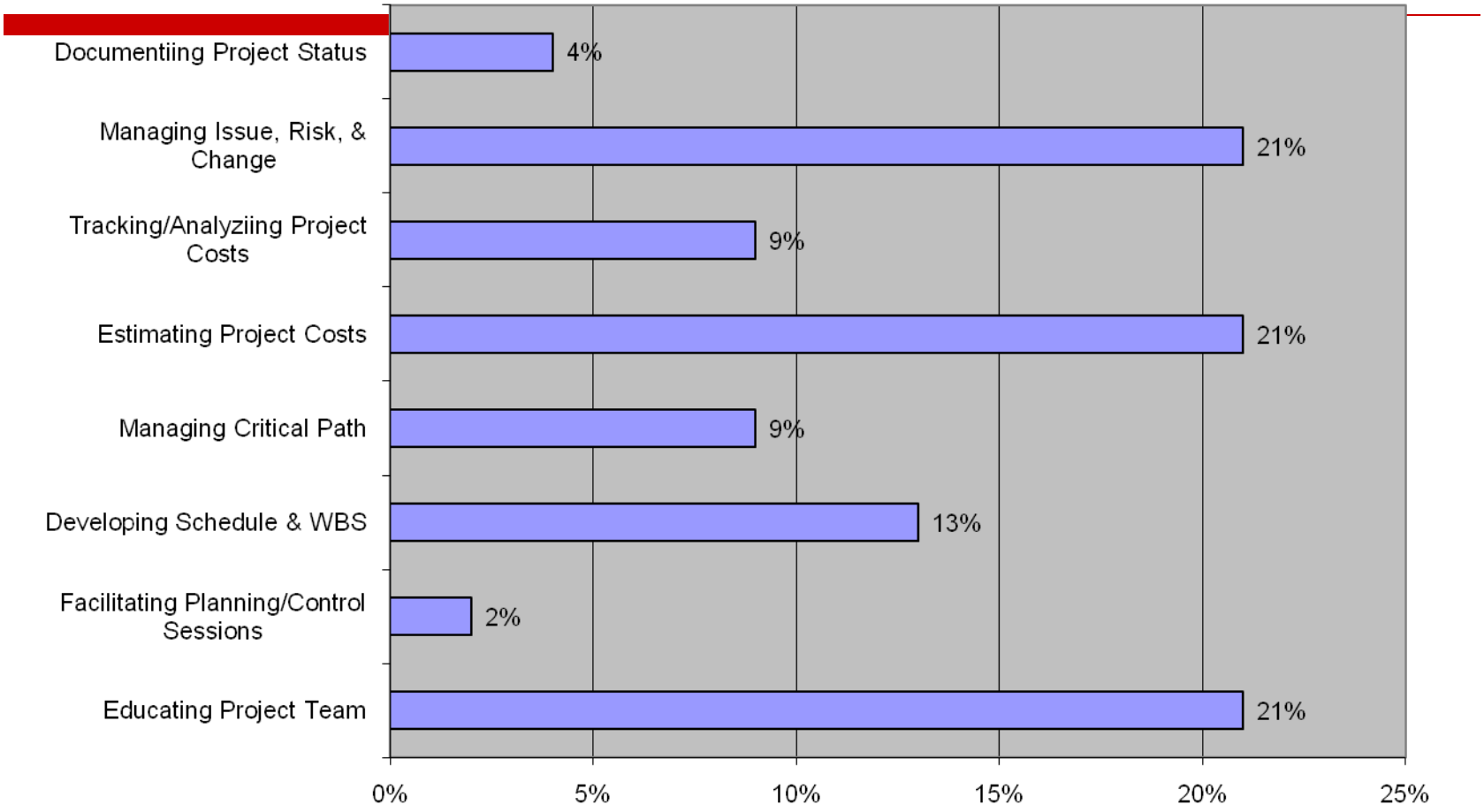
Controlling Project Costs

- What is the most difficult aspect of controlling project costs?
  - Predicting labor costs
  - Cost accounting process
  - Establishing overhead costs
  - Scope creep



August 2004 *PM Network* Magazine member survey

Which Project Control Functions Need the Most Improvement?



Source: Project Control Functions: Cited in PM Network January 2005.

Cost Management Components

(PMBOK)

- Cost Estimating
  - Costs for each resource
- Cost Budget
  - Allocating overall cost estimates to individual work activities to establish cost baseline
- Cost Control
  - Controlling changes to project budget
  - Earned Value and variance analysis

Estimating Basics – 1 (PMBOK)

- Time treated separately by PMBOK, obvious inter-connection between time and cost.
- On small projects resource planning, estimating, and budgeting may be same activity!
- If project cost performance linked to incentives/rewards, then separate controllable and uncontrollable costs.

Estimating Basics - 2

- To improve accuracy:
  - Base cost on WBS
  - Estimate developed by the person doing the work
- Baseline estimate should only be updated for "approved" changes.
- PM needs to determine costs, even if budget is set by senior mgmt AND reconcile any differences.

Budget Estimates – Is their Common Ground?

- Assuming that ALL parties are reasonably honest:
  - Jobs looks easier, faster, & cheaper to mgmt than to person doing the work.
  - Mgmt is optimistic and not prone to admitting errors or omissions.
  - Subordinates are naturally pessimistic & want to build in cost/time protection.

Mantel et al. (2001). Core Concepts in PM

Estimate Politics - Construction

- Vast majority of construction mega-projects over past 70 yrs had significant cost overruns.
  - Sydney Opera House – 1,400%
  - Boston – Big Dig/CAT – Can't count that high!
- Formula deciding which projects get built:

  Project approval equals underestimated cost, plus overestimated revenue, plus undervalued environmental impact, plus overvalued economic development effect."

Source - *Viewpoint: Misrepresentation Drives Projects,* p. 87 ENR, 1/5/04.

Major PM Outputs To Date

- Project Charter
- Scope Statement
- WBS
- Activity List
- Network Diagram
- Activity Duration Estimates
- Schedule

Questions/Notes

Project Cost Management

Estimating

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Resource Planning

Inputs	Tools & Techniques	Outputs
■ Enterprise Environ Factors ■ Org Process Assets ■ Activity List ■ Activity Attributes ■ Resources Availability ■ PM Plan	■ Expert Judgment ■ Alternative Analysis ■ Published Est Data ■ PM Software ■ Bottom-up Estimate	■ Resource Req ■ Activity Attrib UP ■ Resource Breakdown Struct ■ Resource Calendar UP ■ Requested Changes

Resource Planning Concerns 1

- Organizations internal & external resource pool, capacity, & demand?
- Where can necessary availability of knowledge and skills be found?
- Type and capacity needed for project?
- Are most knowledgeable and skilled resources working on most strategic initiatives?

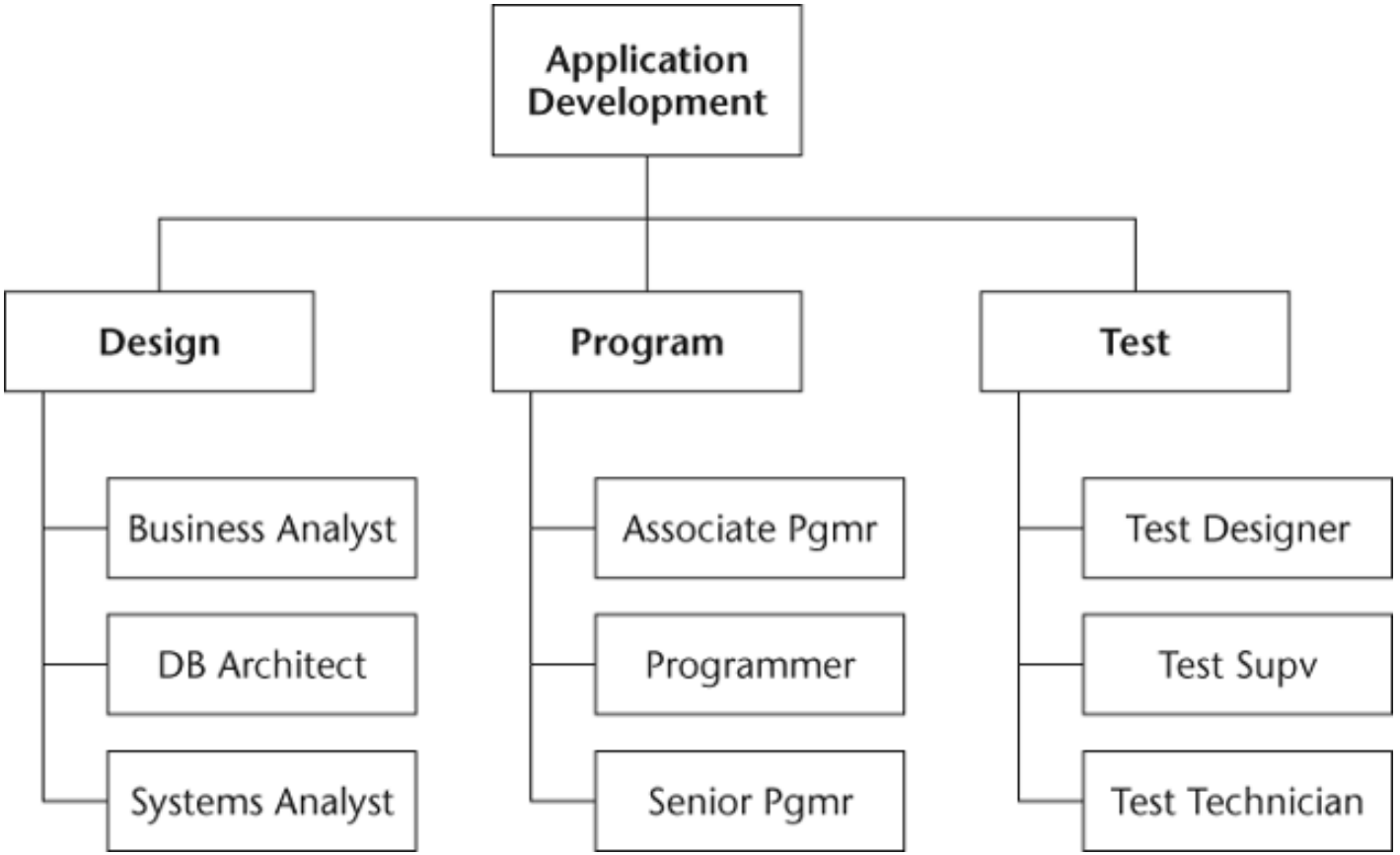
Resource Planning Concerns 2

- What is the availability of a given resource for a specific period of time?
- How are resources performing on a given project, program, or business area?
- What are resource utilizations, realization, and profitability?

Resource Factors

- Labor
- Material
- Supplies
- Equipment
- Contingency & Escalation

Resource Breakdown Structure

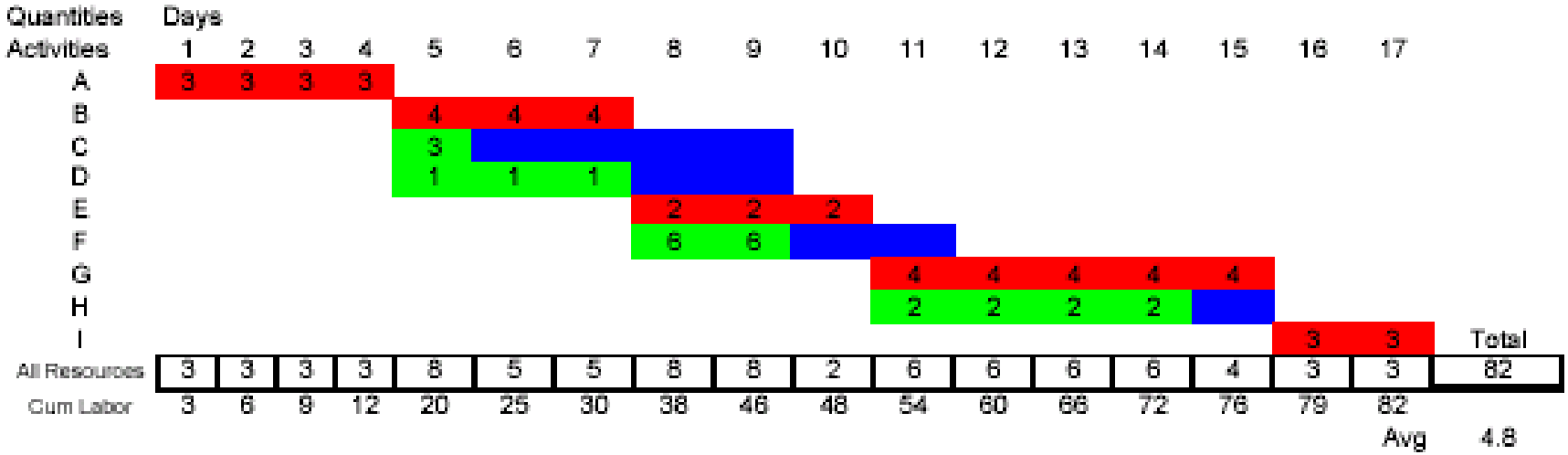


Resource Leveling

- Any form of network analysis in which scheduling decisions are driven by resource management concerns.
  - Limited resource availability
  - Difficult to manage changes in resource levels
- Rescheduling activities so the requirement for resources on the project does not exceed resource limits.

(Source: Max Wideman's PM Glossary)

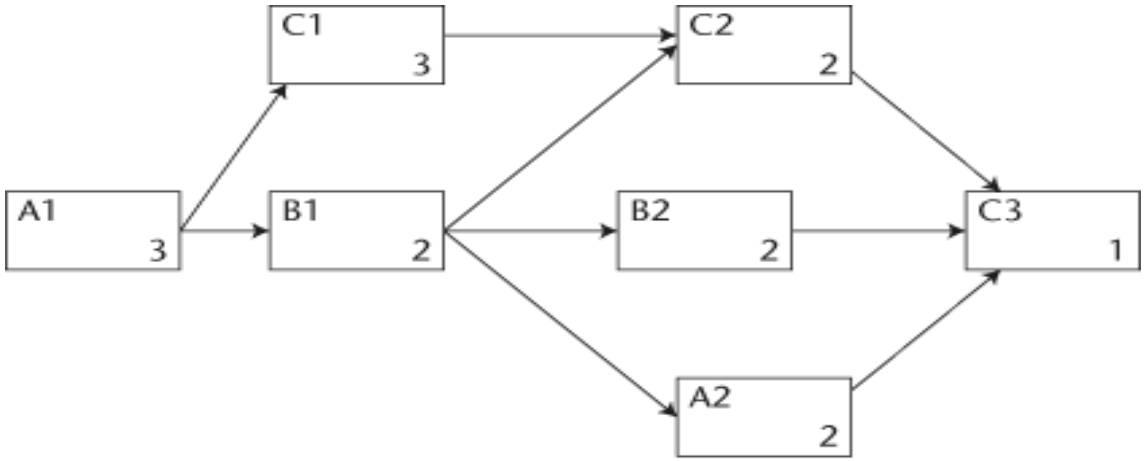
Resource Leveling Example



Red = Critical Path
Green = Activities with float
Blue = Available float

Would it be useful to level the resources?

Time Scaled Dependencies



	M	T	W	R	F	S	S	M	T	W	R	F	S	S
Duffy	a1	a1	a1					a2	a2					
Ernie				b1	b1			b2	b2	b2				
Fran				c1	c1			c1	c2	c2	c2 c3	c3		

Source: Robert Wysocki (2003). Effective Project Management.

Resource Leveling Activity

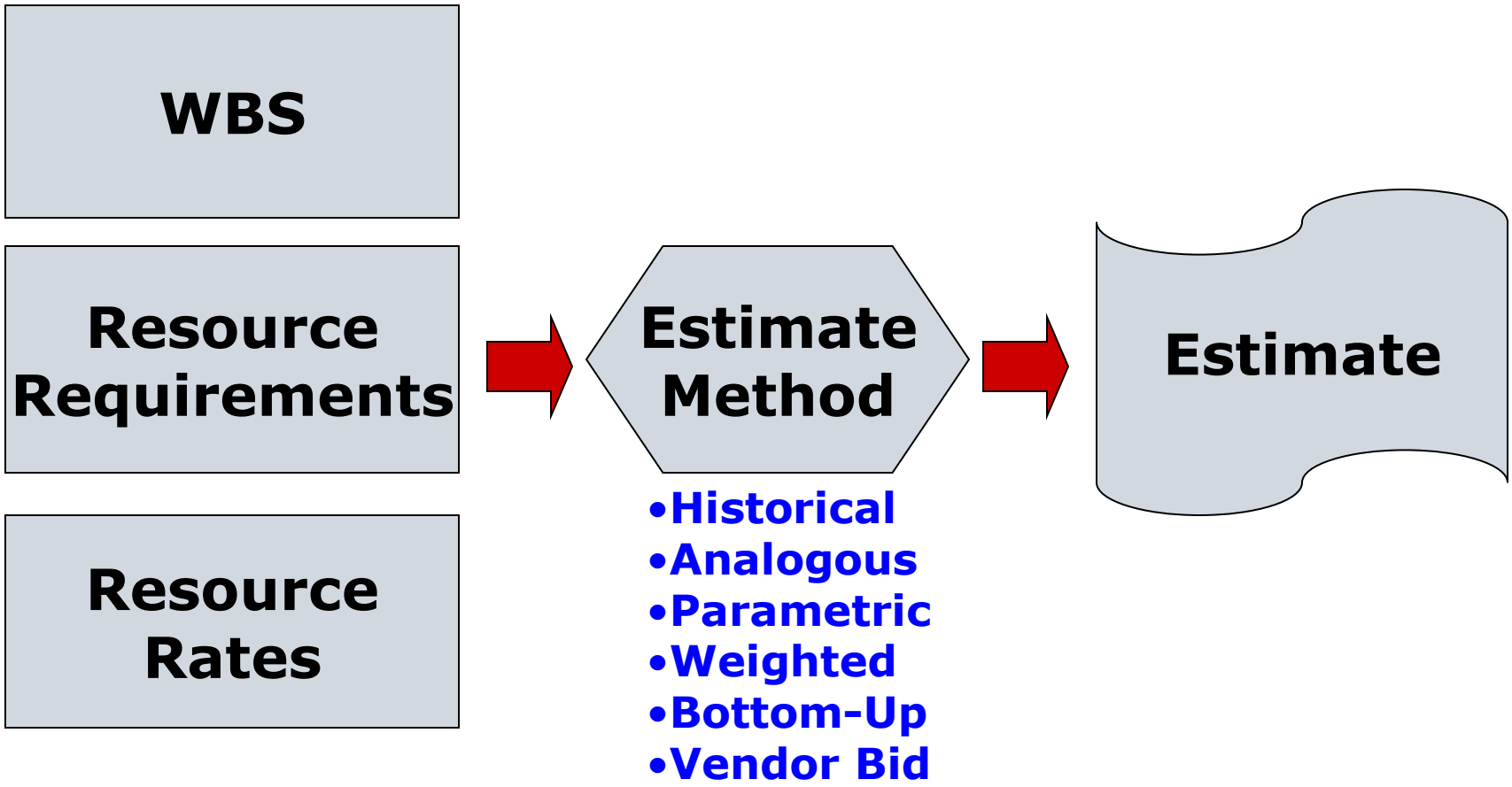
- See hand out
- Enter critical resources first
- How can float be applied to balance worker loading?

Resource Planning	**Cost Estimating**	Cost Budgeting	Cost Control

7.1 Cost Estimating

Inputs	**Tools & Techniques**	**Outputs**
☐ Enterprise Envir Factors ☐ Org Proc Assets ☐ Scope Statement ☐ WBS & Dictionary ☐ PM Plan - Schedule plan - Staff plan - Risk register	☐ Analogous Est ☐ Resource costs ☐ Parametric Est. ☐ Bottom-up Est. ☐ PM Software ☐ Vendor bids ☐ Reserve analysis ☐ Cost of quality	☐ Activity cost estimate ☐ Supporting detail ☐ Requested changes ☐ Cost mgmt plan UP

Cost Estimating Process



Estimate

- Estimate vs. Pricing
  - Estimate is an "Approximation" of resources needed to complete the project (quantification)
  - Pricing is a business decision with estimate just one input. Other factors:
    - Supply & Demand, Risk, etc.
- Budget – Planned allocation of resources, based on estimate.

Methods of Estimating

- Top-Down (Analogous)
  - Collective judgment based on previous similar projects: Used when limited detail exists, Less costly, but less accurate
- Parametric
  - Mathematical models (linear regression, learning curves) to predict project costs – e.g. cost per line of code, cost per linear foot, and cost per installation.
- Bottom-Up
  - Based on WBS – Resource requirements estimated by those responsible for execution

Analogous Estimate - NASA

- **RFQ And Historical Data**
  - PDQ Inc., has received an RFQ for 84 XYZ Systems to be built and delivered in 2005. A 120-lot of this same system was delivered in 2001.
    - How will the proposed 84-lot be different from the historical (baseline) of 120-lot?
      - Plant now at full capacity
      - Shortage of skilled workers
      - New manufacturing processes reduced cycle time to 100 hours.
      - Inflation adjustment, etc.

Source: http://www.jsc.nasa.gov/bu2/PCEHHTML/pceh.htm

Analogues Estimate Example: Tunnel Costs for Chunnel Project

- Consulting engineers hired by Banks concluded tunneling estimates 20% too high.
  - Based on 50 German railroad tunnels ranging from 400m to 11K
    - Cost range of £55 to £140 per Cu M
- What was different about the Chunnel that might justify higher costs

PERT or Weighted Average $

- E = (O + 4m + P) / 6 = Expected Cost
- O = Optimistic time
  - Expected duration in only 1 of 20 repetitions
- m = Most likely
- P = Pessimistic time
  - Expected duration in only 1 of 20 repetitions
- Note: Assumes “Normal” distribution

Support Details for Estimate

- WBS Dictionary/Description
- How estimate was developed?
- Assumptions
- Cost range, e.g. $20,000 +/- $2,000
  - Level of confidence
- Audit trail of estimate development

Direct Costs

- Costs that are specifically attributable to an activity or group of activities without apportionment.
- Costs such as labor, material, equipment, travel that can be consistently related to work performed on a particular project.
- Direct costs are best contrasted with indirect costs that cannot be identified to a specific project.

Source: Max Wideman's PM Glossary

Indirect Costs

- Also known as Overhead, General & Administrative (G&A), or Burden.
- Resources expended which are not directly identified to a specific contract, project, product, service, or activity.
  - e.g. taxes, accounting, HR
- Costs may be allocated to projects on a prorated basis.

Source: Max Wideman's PM Glossary

Fixed Costs

Costs that do not vary with the volume of work such as set-up, rental fees, accommodation, insurance, depreciation, security and utilities.

Variable Cost

- Cost that changes with the production quantity or the performance of services.
- Cost that changes over time, such as an hourly rate for resources that rises as the resource continues to work.
- Materials, supplies, wages

Estimating Activity

- For one activity or work package, identify and estimate the cost of:

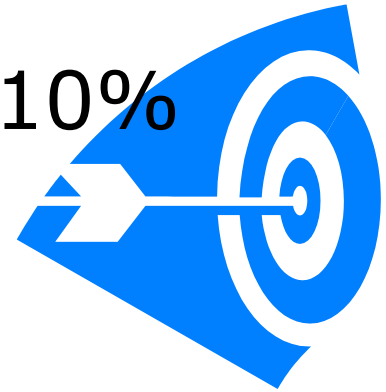
Direct Costs	Indirect Costs	Fixed Costs	Variable Costs
1. Labor	1. Overhead	1. Set-up	1. Materials
2. Material	2. G&A	2. Rentals	2. Supplies
3. Equip	3. Utilities	3. Insurance	3. Wages
4.	4.	4. Utilities	4.
5.	5.	5.	5.
6.	6.	6.	6.

Accuracy of Estimates

- Rough Order of Magnitude Estimate
  - Guestimate range at project initiation
    - -50% to +100% from actual
- Budget Estimate
  - Developed during planning phase
    - -10% to +25% from actual
- Definitive Estimate
  - Developed during planning
    - -5% to +10% from actual

Estimate Activity Cost $10,000

- Rough Order of Magnitude Estimate
  - SWAG 50% to +100% from actual
  - Range: $5,000 to $20,000
- At planning phase -10% to +25%
  - Range: $9,000 - $12,500
- Finalized Estimate -5% to +10%
  - Range: $9,500 - $11,000

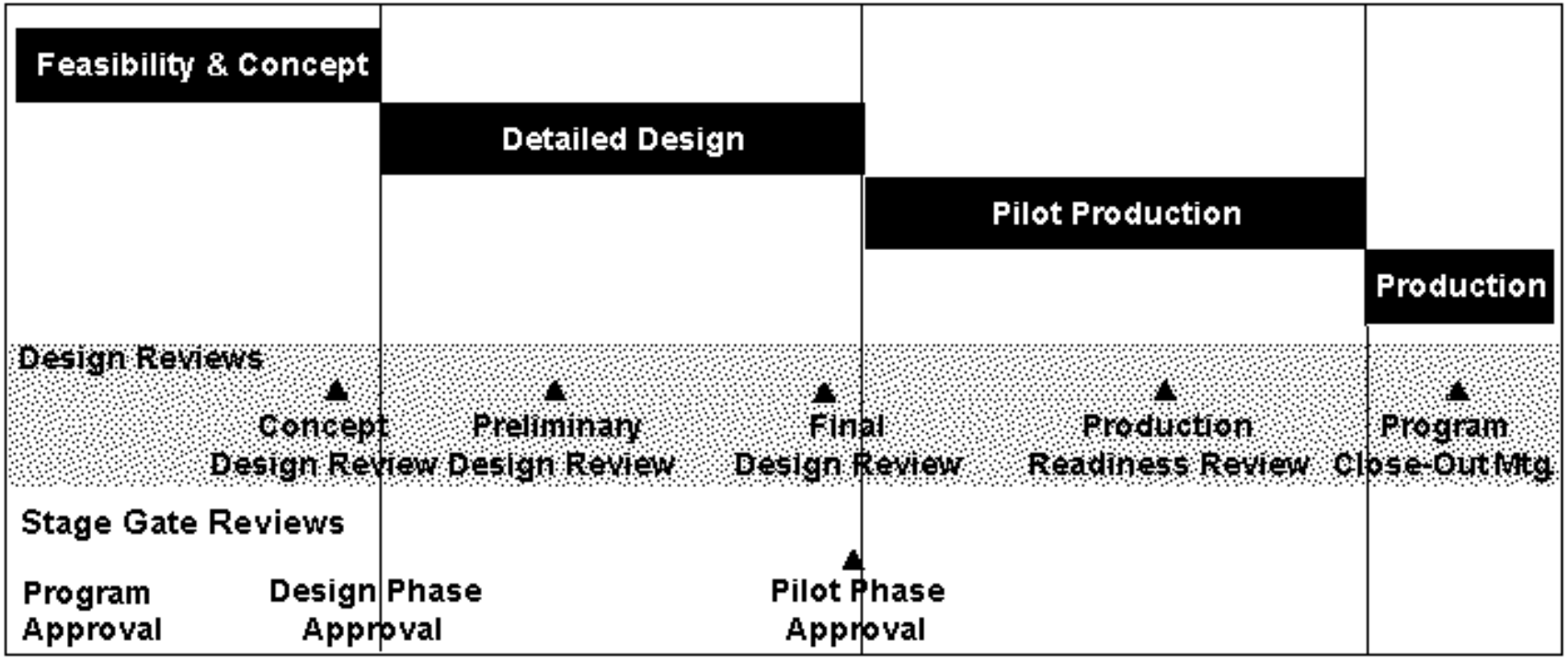


Variation in Cost & Schedule Estimates by Phase

	Effort and Size		*Schedule*	
Phase	*Optimistic*	*Pessimistic*	*Optimistic*	*Pessimistic*
Initial concept	0.25	4.0	0.60	1.60
Approved concept	0.50	2.0	0.80	1.25
Req. Specs	0.67	1.5	0.85	1.15
Product specs.	0.80	1.25	0.90	1.10
Detailed specs.	0.90	1.10	0.95	1.05

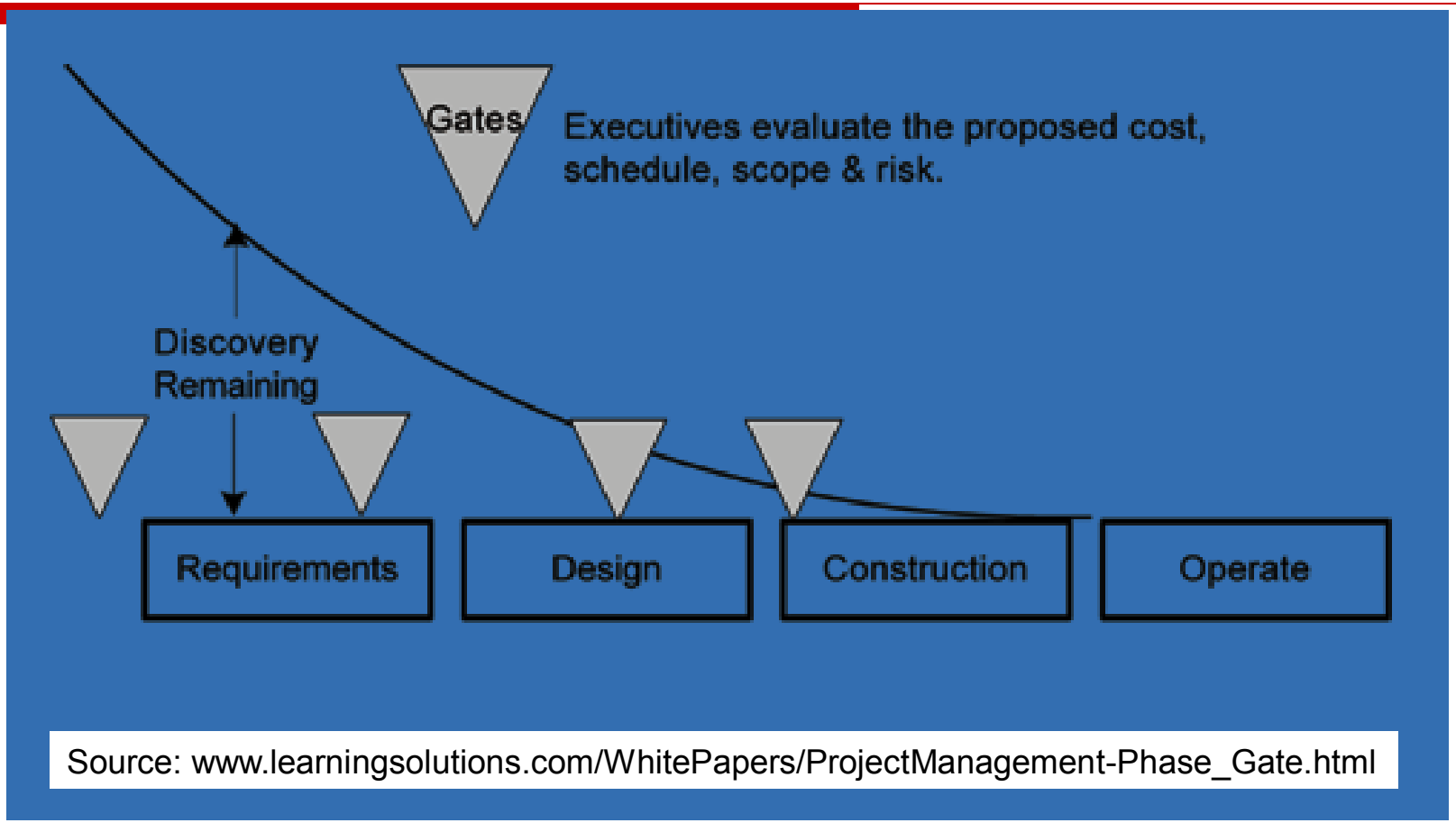
Source: Barry Boehm, www.learningsolutions.com

Phase Gate Criteria



Source: New Product Development
http://www.npd-solutions.com/reviews.html

Phase Gates in Development Life Cycle



Source: www.learningsolutions.com/WhitePapers/ProjectManagement-Phase_Gate.html

Issues in Budget Types

- Top-Down
  - Accurate overall
  - Variance in details
  - Most common
- Bottoms-Up
  - More accurate
  - Creates buy-in
  - Rare in true form

- Upper-level managers reluctant to let workers set budget
  - Fear natural tendency to overstate costs
  - Budget is mgmt's primary tool for project control
  - Reluctant to let other set control limits

Mantel et al. (2001). Core Concepts in PM

Types of Estimating Errors

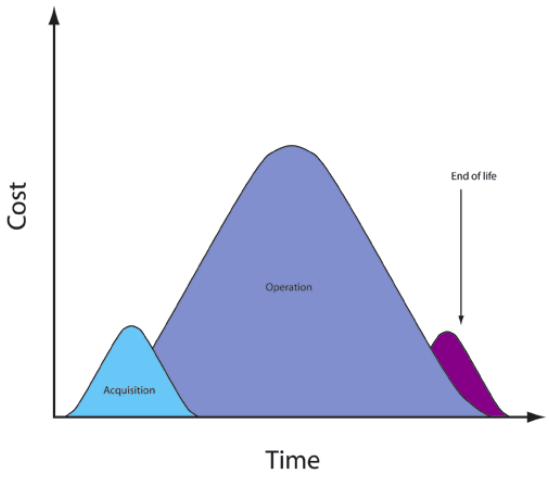
- Random errors cancel out – often called compensating error
- Bias – consistent high or low costing

Potential Estimating Problems

- Misinterpretation of **scope** - poorly defined requirements.
- Inaccurate **WBS**
- Failure to account for **risks**
- Poorly defined or overly optimistic **schedule**
- Shortage of qualified **resources**
- Failure to account for cost escalation and inflation
- Failure to use the correct **estimating techniques**
- **Inaccurate pricing** rates for overhead, general and administrative, and indirect costs
- Inexperienced **project managers**

Costing Alternatives

- **Life Cycle Costing**
  - Project cost alternatives include acquisition, operating, and disposal.
  - Total costs to organization for ownership and acquisition of the product over its full life.



Costing Alternatives

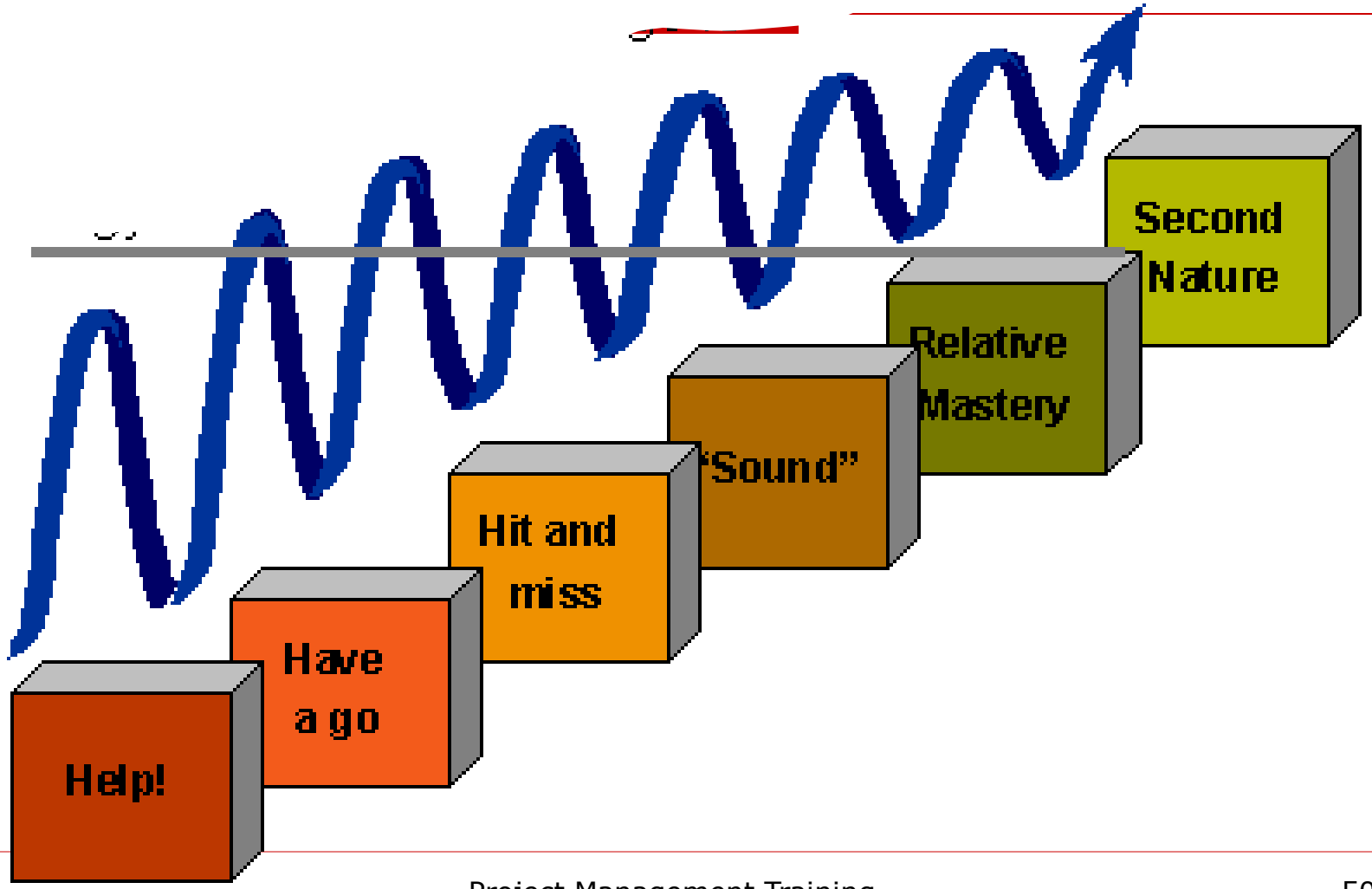
Value Engineering

Organized effort to analyze the functions of systems, equipment, facilities, services, and supplies for the purpose of achieving the essential functions at the lowest life cycle cost consistent with required performance, reliability, quality, and safety. (Max Wideman's PM Glossary)

Lifecycle Cost Elements

- ***R & D Costs***: The cost of feasibility studies; cost-benefit analysis; system analysis; design detail and development; fabrication, assembly; testing of engineering models; and associated documentation.
- ***Production Costs***: The cost of fabrication, assembly and testing of production models; operation and maintenance of the production capability; and associated logistical support requirements.
- ***Construction Costs***: The cost of new manufacturing facilities or upgrading of existing structures to accommodate production and operation of support requirements.
- ***Operation and Maintenance Costs***: The cost of sustaining operational personnel and maintenance support. Examples include: spare/repair parts, test and support equipment, transportation and handling, facilities modifications, and technical data changes.
- **Product retirement and phase-out costs**: The cost of phasing the product out of inventory due to obsolescence or wear out, and subsequent equipment item recycling and reclamation as appropriate.

Learning Curve Impact on Estimate



Learning Curve Steps

- Unconscious incompetence
- Conscious incompetence
- Conscious competence
- Unconscious competence

Typically, unit performance improves by a fixed % each time total production quantity doubles.

Atherton, J. S. (2003) *Learning and Teaching: Learning Curve* [On-line] UK: Available: http://www.dmu.ac.uk/~jamesa/learning/lerncrv.htm

Learning Curve Example

A firm wins a contract to supply 30 units of a complex electronic device. The firm is competent to produce the device, but has never produced one this complex.

Learning Curve in Action

Typical manufacturing learning curve = 80%

- First unit estimated to take 10 hours to produce.
- Second unit would require: 0.80 x 10 = 8 hours
- Fourth unit: 0.80 x 8 = 6.4 hours
- Eighth unit: 0.80 x 6.4 = 5.12 hours

Eventually time levels out and no further gains accrued.

Review Questions

1. What are the pros & cons of top-down and bottoms-up budgeting?
2. How can the learning curve be applied to the time/cost estimate?
3. What is the expected range of accuracy of Definitive estimates?
4. Provide an example of fixed costs? Variable costs?
5. Explain the difference between and analogous and parametric estimate?
6. What is the purpose of value engineering?

Questions/Notes

Project Cost Management

Budgeting

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Cost Budgeting

Total cost baseline for measuring project performance

Traffic Enforcement Budget?

Source: http://www.lacp.org/Graphics/PoliceBike.jpg

7.2 Cost Budgeting

Inputs	Tools & Techniques	Outputs
☐ Scope ☐ WBS ☐ WBS Dictionary ☐ Cost Estimate & Supporting detail ☐ Schedule ☐ Res. Calendars ☐ Contracts ☐ Cost Mgmt Plan	☐ Cost aggregates ☐ Reserve analysis ☐ Parametric Est. ☐ Fund limiting reconciliation (Cost leveling)	☐ Cost baseline ☐ Funding req. (Progress Pay) ☐ Cost Mgmt Plan UP ☐ Req. changes

What Elements Do Estimate & Budget Have in Common?

- Direct Costs of Resources
- Indirect Costs
  - Project Overhead
  - General & Administrative
- Contingency and Escalation
- Profit (Market factors)
- Above sums into baseline budget

Contingency & Escalation

- Contingency:
  - Specific provision(s) to mitigate random or unknown project risks from causing project failure or frequent baseline changes.
  - Reserves (2 Types): Provision in project plan to mitigate cost and/or schedule risk.
- Escalation (Inflation)
  - Anticipated rise in uncommitted costs of resources (labor, material, equipment) over duration of project.

Adapted from Max Wideman's PM Glossary

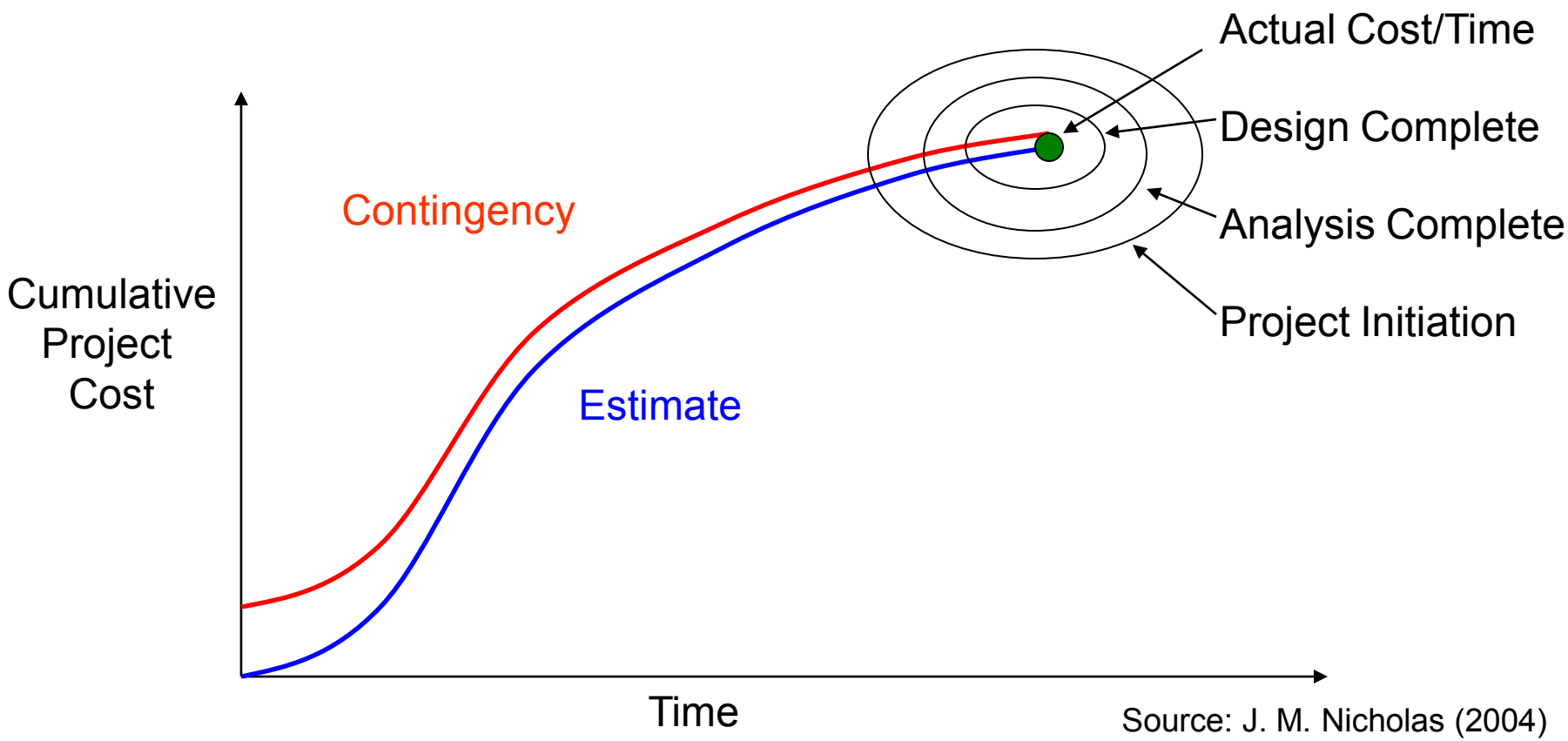
Reserves – Known Unknowns

- Cost Estimating Tool
  - Contingency allowance
  - Discretion of PM
  - Anticipated but not certain events
  - Potentially overstates costs
  - Part of project scope and baseline
    - e.g. weather, productivity…

Reserves – Unknown Unknowns

- Budgeting Tool - Mgmt Contingency
  - Unplanned but potentially required changes to scope & baseline
  - Approval needed for PM to spend
  - May result from risk register
  - NOT part of project baseline
  - NOT part of EVA
    - e.g. risks, approved changes…

Cumulative Cost, Time & Uncertainty

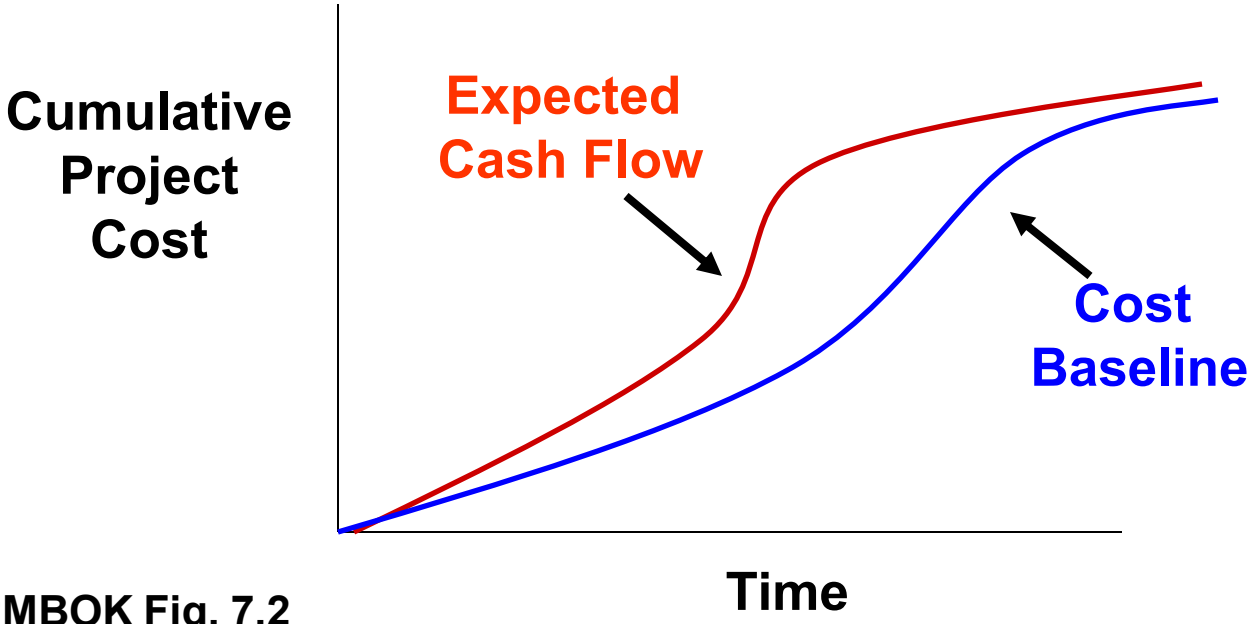


Source: J. M. Nicholas (2004)

Estimate Worksheet - Software Interface Project

1	Project Phase (From WBS)				
	Total staff hours Phase 1		120		
	Total staff hours Phase 2		92		
	Total staff hours Phase 3		52		
	Total staff hours Phase 4		166		
	Total staff hours Phase 5		80		
	Total staff hours Phase 6		20		
	Total staff hours Phase 7		440		
	Total staff hours Phase 8		40		
	Total staff hours Phase 9		80		
	Total staff hours Phase 10		60		
	Total staff hours		1150		
2	Total staff hours @ $50/hr	$	50.00		
	Total Personnel Costs			$ 57,500	
3	Misc. Costs				
	a. Materials/Furniture/Office Supplies		16,000		
	b. Equipment		46,500		
	c. Facilities		32,000		
	d. Technology		18,500		
	e. Information	n/a			
	f. External Vendors		53,000		
	g. Other:				
	Training & Development		12,000		
	Total Misc. Resource Costs			$ 178,000	
	Sub-Total Project Costs				$ 235,500
4	Contingency (Mgmt Reserve)				
	15% on Sub-Total		15%		$ 35,325
5	TOTAL PROJECT COST				$ 270,825

Budget Output - Cost Baseline



PMBOK Fig. 7.2

- Time-phased, used to measure & monitor cost performance.
- Cumulative costs typically result in S-curve.

Budget Aggregation

Cost Budget	$2,150	
Mgmt Reserve	$ 280 (e.g. 15%)	
Cost Baseline	$1,870	
Contingency Reserve	$ 170 (e.g. 10%)	
Project	$1,700	
Control Account	$1,000	
Work Packages	$ 300	$700
Activities	$100 + $100 + $100	$350 + $250 + $100

Questions & Notes

Resource Planning	Cost Estimating	Cost Budgeting	**Cost Control**

7.3 Cost Control

Inputs	**Tools & Techniques**	**Outputs**
☐ Cost baseline ☐ Funding require ☐ Performance reports ☐ Work perform info ☐ Change requests ☐ PM plan	☐ Cost change control system ☐ Performance measurements ☐ Forecasting ☐ Proj perform review ☐ PM software ☐ Variance mgmt	☐ Cost estimate UP ☐ Baseline UP ☐ Perform measure ☐ Forecast complete ☐ Req changes ☐ Corrective action ☐ Org Proc Asset UP (Lessons learned) ☐ PM plan UP

Cost Control (PMBOK)

- Monitor and document cost performance to detect and understand variance
- Ensure appropriate changes are recorded accurately on the cost baseline
- Prevent incorrect/unauthorized changes from being included on the cost baseline
- Inform stakeholders of authorized changes
- Acting to bring expected costs within acceptable limits

Change Requests

Adapted from AIA G701 (1978). For Educational Use Only

CHANGE ORDER

AIA Document G701

Distribution to:

Owner	❑
Architect	❑
Contractor	❑
Field	❑
Other	❑

Project:
(name, address)

Change Order Number:

Initiation Date:

To (Contractor):

Architect's Project No:

Contract For:

Contract Date:

You are directed to make the following changes in this Contract:

Not valid until signed by both the Owner and Architect.
Signature of the Contractor indicates his agreement herewith, including any adjustment in the Contract Sum or Contract Time.

The original Contract Sum or Guaranteed Maximum cost was	$	
Net change by previously authorized Change Orders:	$	
The Contract Sum or Guaranteed Maximum prior to this Change Order was	$	
The Contract Sum or Guaranteed Maximum will be (increased) (decreased) (unchanged) by this Change Order	$	
The new Contract Sum or Guaranteed Maximum including this Change Order will be	$	
The Contract Time will be (increased) (decreased) (unchanged) by		Days
The Date of Substantial Completion as of the date of this Change Order therefore is		

Authorized:

ARCHITECT	CONTRACTOR	OWNER
Address	Address	Address
By	By	By
Date	Date	Date

Types of Progress Reporting

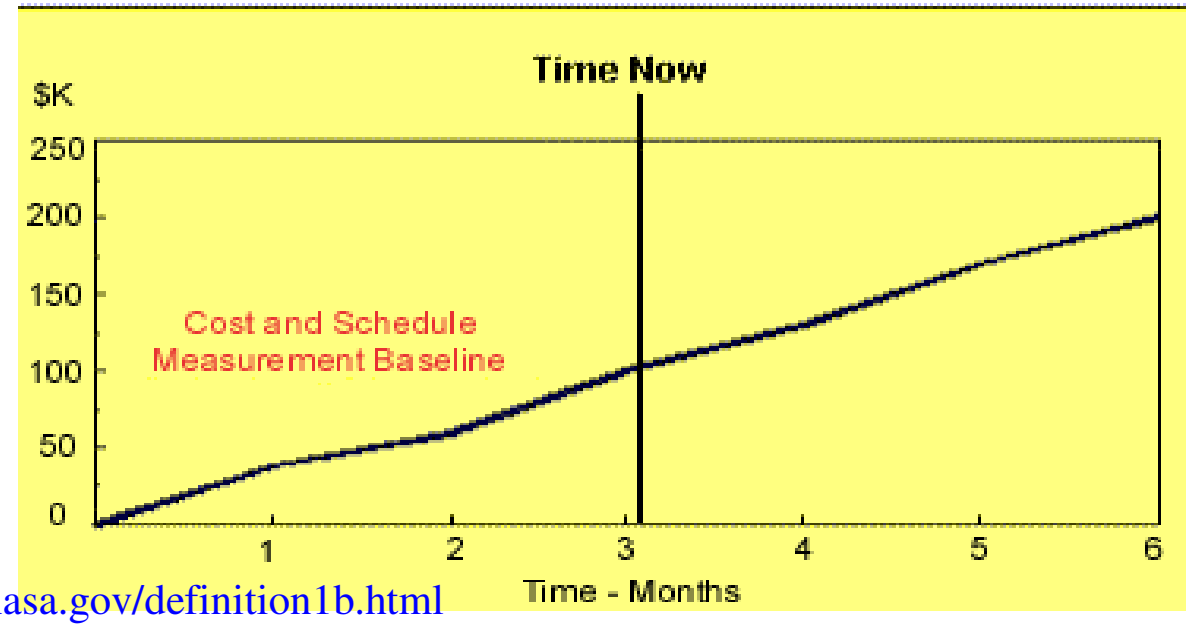
- Physical progress - % Complete
- 50/50 Rule -- A task is 50% complete once it is started and 100% complete only when finished
- 20/80 Rule -- A task is 20% complete once it is started and 100% complete only when finished
- 0/100 Rule -- A task does not get credit for partial completion it is 100% complete only when finished

Earned Value Management

- Is the project ahead/behind schedule?
- Is the project over/under budget?
- How efficiently is the project team using resources (time/money)?
- When is the project likely to be completed?
- What is the likely cost at completion?

Earned Value: Purpose

Management team can readily compare how much work has **actually** been completed against the amount of work **planned** to be accomplished. Planned work constitutes a cost and schedule measurement **baseline**.



Source: http://evm.nasa.gov/definition1b.html

EVA – 3 Key Values

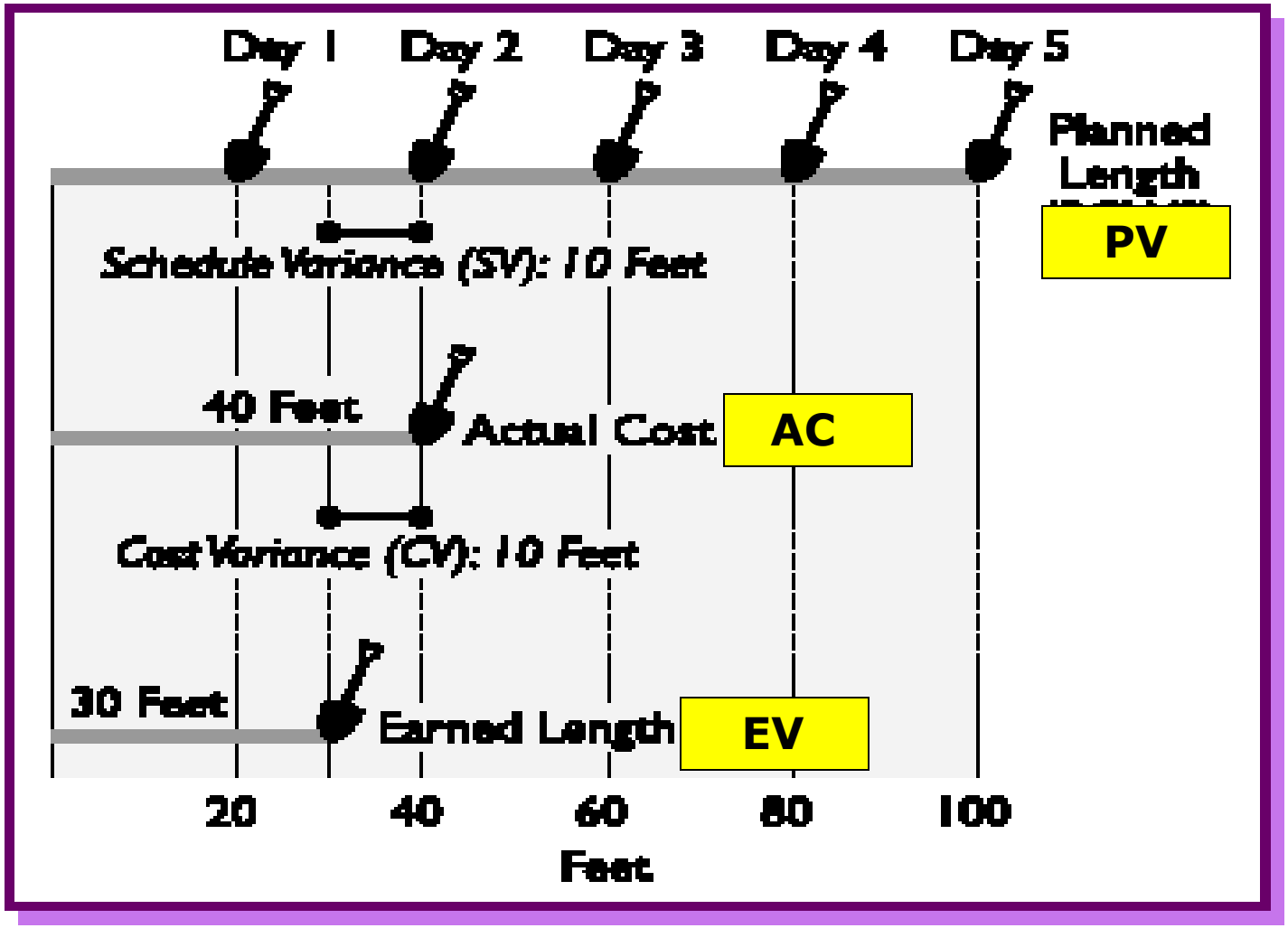
- **Planned Value** (PV)
  - Physical work scheduled to be performed and the estimated value of work
    - (old – BCWS - Budgeted Cost of Work Scheduled)
- **Earned Value** (EV) – Measured Progress
  - Physical work actually accomplished including value of work
    - (old – BCWP - Budgeted Cost of Work Performed)
- **Actual Cost** (AC)
  - Cost incurred to accomplish the Earned Value
    - (old – ACWP – Actual Cost of Work Performed)

Note: Values can be cost or time!

EVA – Key Values Examples

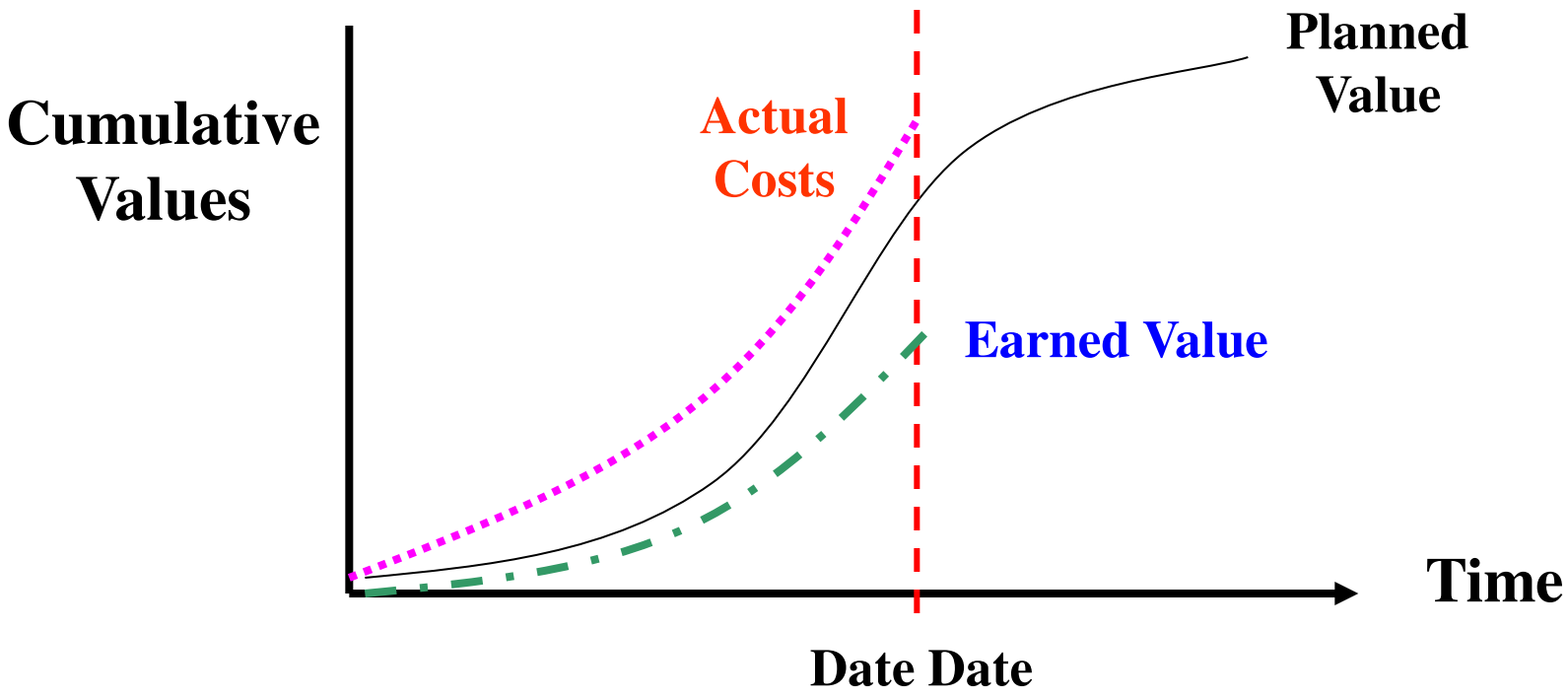
- **Planned Value**: Total planned budget for a 5-day task is $1000 and it starts on Monday. If status date is the following Wednesday (end of day 3), the PV is $600.
- **Actual Cost**: If task actually incurs a total cost of $150 during each of the first 3 days, then AC is $450.
- **Earned Value**: If after 3 days 50% percent of the work on a task has been completed, then EV is $500.

Earned Value Ex. #1



Source: http://www.stsc.hill.af.mil/crosstalk/frames.asp?uri=1999/04/smith.asp

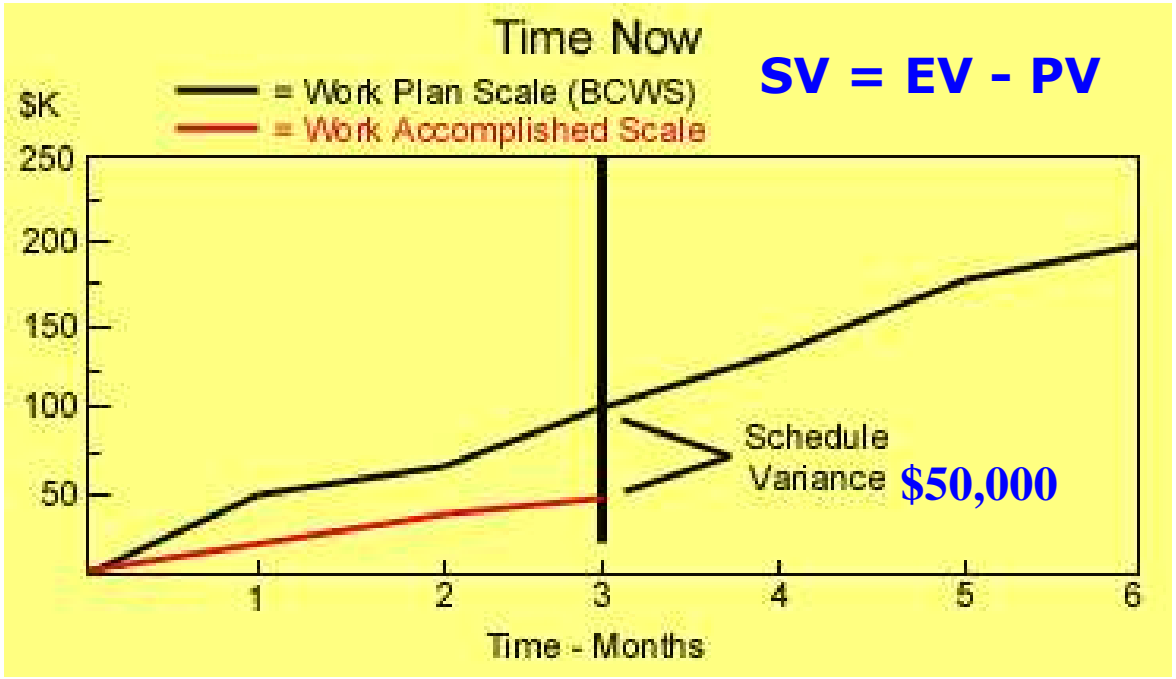
Earned Value Graphic Report



Source: Adapted from PMBOK 2000 Fig. 10-2

Schedule Variance

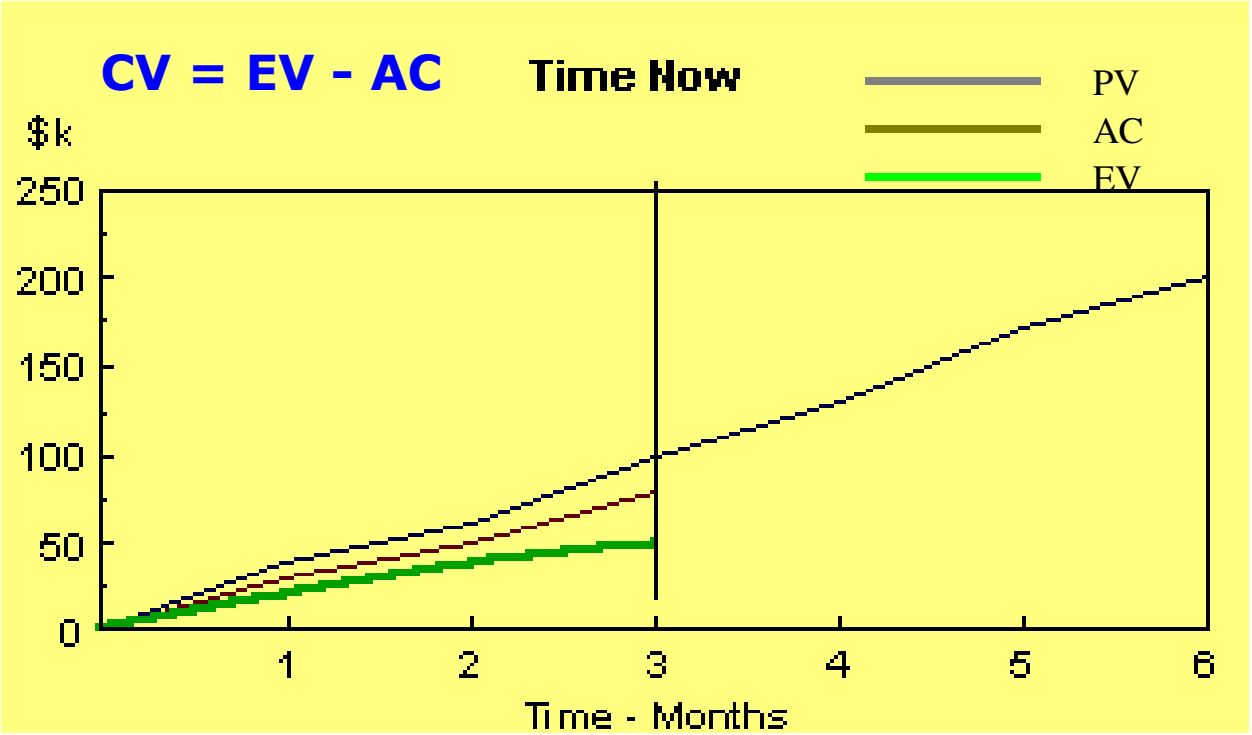
Work performed is "**earned**" on the same basis it was **planned**, i.e. dollars, work hours, or other quantifiable units. Planned value (PV) compared with earned value (EV) measures work planned vs. work accomplished. Any difference is called **schedule variance.**



Source: Earned Value Mgmt @ http://evm.nasa.gov/definition1b.html

Cost Variance

Earned Value for work performed compared with **actual cost incurred** for work performed (from accounting systems), provides objective measure of cost efficiency. Any difference is **cost variance**.



Source: Earned Value Mgmt @ http://evm.nasa.gov/definition1b.html

Variance Calculations

CV = EV – AC = 50K – 80K = -30K = Cost Overrun

SV = EV – PV = 50K – 100K = -50K = Behind Schedule

SPI = EV / PV = 50K / 100K = .50 - Progress at 50% planned rate.

CPI = EV / AC = 50K / 80K = .625 – Earning 62 cents on the $.

Source: Earned Value Mgmt @ http://evm.nasa.gov/definition1b.html

Earned Value Ex. #2

- A contractor agrees to build a 4 sided fence. The work is scheduled for ONE day per side (four consecutive days) at a cost of $1,000 per side (total $4,000). At the end of Three days work, the contractor has completed two sides of the fence and spent $2,500.
- Perform an EVM analysis at this point in the project.
  - PV = $3,000
  - EV = $2,000
  - AC = $2,500

Planned Value (PV) – Value of work scheduled to date

Earned Value (EV) – Value of work actually accomplished

Actual Cost (AC) - Cost incurred to accomplish work

Source: Rita Malcahy PMP Exam Prep

EVM Performance Measures

- Schedule Variance (SV) = EV – PV
  - Behind schedule, + Ahead of schedule
- Schedule Performance Index (SPI) = EV / PV
  - I am progressing at ___% of the planned rate.
- Cost Variance (CV) = EV – AC
  - Over budget, + Under budget
- Cost Performance Index (CPI) = EV / AC
  - I am getting $ _____ out of every $1.00 budgeted.

PC – Planned Value

EV – Earned Value

AC – Actual Cost of work performed

EVM Performance Measures

- SV = EV – PV = $2,000 - $3,000 = (- $1,000)
- SPI = EV / PV = $2,000/$3,000 = 0.667

  (Behind schedule)
  - "I am progressing at 67% of the planned rate."

- CV = EV – AC = $2,000 - $2,500 = (-$500)

  (Over budget)
- CPI = EV / AC = $2,000/$2,500 = 0.800
  - "I am getting $0.80 out of every $1.00 budgeted."

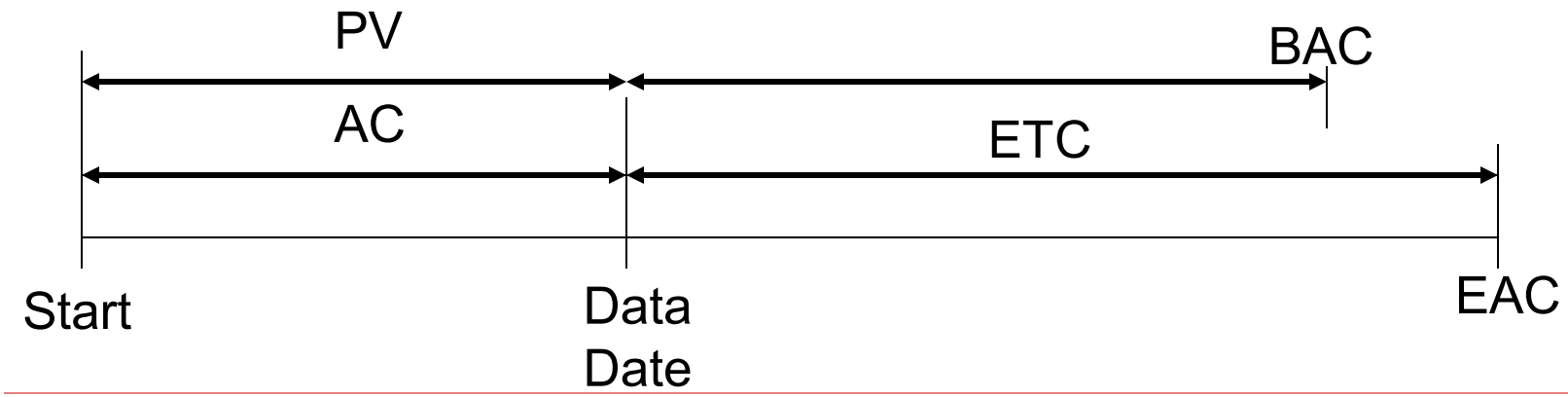
- **PV = $3,000, EV = $2,000, AC = $2,500**
- **Schedule Variance (SV) = EV – PV**
- **Schedule Performance Index (SPI) = EV / PV**
- **Cost Variance (CV) = EV – AC**
- **Cost Performance Index (CPI) = EV / AC**

Costs at Completion

- BAC = Budget at Completion
  - How much was the total project budget?
- ETC = Estimate To Completion
  - From this point forward, how much MORE will it cost to finish the project?
  - ETC = (BAC – EV) / CPI -- or = EAC - AC
- VAC = Variance at Completion
  - How much over or under budget do we expect to be a completion of the project?
  - VAC = BAC - EAC

Estimate at Completion (EAC)

- EAC is the forecast of the most likely project costs based on performance reports and risk quantification (PMBOK).
- EAC = BAC / CPI
- May be in a cost range of high to low.



EAC - Ways to Calculate

1. **EAC = BAC / CPI** (Most common method)
   - Assumes current variance will continue
2. EAC = AC + ETC
   - Original estimate flawed or changing conditions make it irrelevant.
3. EAC = AC + (BAC – EV)
   - Use if project experienced atypical variance that is not expected to continue.
4. EAC = AC + (BAC – EV) / CPI
   - Similar to #2 only modified by Cost Performance Index

- **BAC = Budget at Completion**
- **ETC = Estimate at Completion**
- **VAC = Variance at Completion**
- **PC – Planned Value**
- **EV – Earned Value**
- **AC – Actual Cost of work**

EAC – Calculation Example

Which is most likely to yield realistic answer?

1. **EAC = BAC / CPI = $4,000 / 0.80 = $5,000**
2. EAC = AC + ETC
3. EAC = AC + (BAC – EV)
   = $2,500 + ($4,000 - $2,000) = $4,500
4. EAC = AC + (BAC – EV) / CPI
   = $2,500 + ($4,000 - $2,000) / 0.80 = $5,000

- **PV = $3,000, EV = $2,000, AC = $2,500, CPI = 0.80**

- BAC = Budget at Completion = $4,000
- ETC = Estimate at Completion
- VAC = Variance at Completion
- PC – Planned Value
- EV – Earned Value
- AC – Actual Cost of work

Summary of EVA Formulas

- PV
- AC
- EV
- CV = EV – AC
- CPI = EV / AC
- SV = EV – PV
- SPI = EV / PV
- BAC = Baseline $

- EAC= BAC / CPI
  = AC + ETC
  = AC + BAC – EV
  = AC + (BAC – EV)/CPI
- ETC = EAC – AC
  = (BAC – EV) / CPI
- VAC = BAC - EAC

Earned Value Activity

- The Pentagon agrees to build a 5 sided fence. The work is scheduled for ONE month per side at a cost of $1,000 per side (total $5,000). At the end of 3 months work, the contractor has completed 2 sides of the fence and spent $4,000 (and seeking change orders to recoup costs).
- Perform an EVM analysis at this point in the project.

PV = _____ AC =_____ EV = _____

CV = _____ CPI = _____ BAC = _____

SV = _____ SPI = _____ EAC = _____

ETC = _____ VAC = ____

Adapted From Rita Malcahy PMP Exam Prep

EVA Ex. #3 Worksheet

EVA Item	Value	Interpretation
PV		
EV		
AC		
BAC		
CV		
CPI		
SV		
SPI		
EAC		
ETC		
VAC		

Cost Management Plan

- How will you handle cost variance?
- EVA indicates cost and schedule overruns! What now?
- Identify 4-6 corrective actions you would take.

EVA Performance Report
(PMBOK)

#	WBS Element	Budget	Earned	Cost	Cost Variance		Schedule Variance		Performance Index	
		Planned Value $ (PV)	Earned Value $ (EV)	Actual Cost $ (AC)	$ (CV=EV-AC)	% (CV / EV)	$ (SV=EV-PV)	% (SV / PV)	Cost CPI (EV / AC)	Schedule SPI (EV / PV)
1.0	Pre-Pilot Plan	63,000	58,000	62,500	(4,500)	-7.8%	(5,000)	-7.9%	0.93	0.92
2.0	Checklists	64,000	48,000	46,800	1,200	2.5%	(16,000)	-25.0%	1.03	0.75
3.0	Curriculum	23,000	20,000	23,500	(3,500)	-17.5%	(3,000)	-13.0%	0.85	0.87
4.0	Midterm Eval	68,000	68,000	72,500	(4,500)	-6.6%	-	0.0%	0.94	1.00
5.0	Implementation Support	12,000	10,000	10,000	-	0.0%	(2,000)	-16.7%	1.00	0.83
6.0	Manual of Practice	7,000	6,200	6,000	200	3.2%	(800)	-11.4%	1.03	0.89
7.0	Roll-Out Plan	20,000	13,500	18,100	(4,600)	-34.1%	(6,500)	-32.5%	0.75	0.68
	Totals	257,000	223,700	239,400	(15,700)	-7.0%	(33,300)	-13.0%	0.93	0.87
	Source: PMBOK 2000 Fig 10-3									

Earned Value Ex. #4

Earned Value Analysis Activity - Determine each of the EV values for the Project Report below

#	WBS Element	Budgeted	Planned	Earned	Cost	Cost Variance		Schedule Variance		Performance Index		Estimated Cost AT Completion	Estimated Cost TO Complete	Variance AT Completion
		Budget at Completion BAC	Planned (PV)	Earned Value $ (EV)	Actual Cost $ (AC)	$ (CV=EV-AC)	% (CV / EV)	$ (SV=EV-PV)	% (SV / PV)	Cost CPI (EV / AC)	Schedule SPI (EV / PV)	EAC (BAC/CPI)	(ETC) (EAC-AC)	(VAC) (BAC - EAC)
1.0	A	94,000	94,000	94,000	96,000									
2.0	B	36,000	36,000	36,000	34,500									
3.0	C	44,000	34,000	30,000	27,000									
4.0	D	56,000	40,000	32,000	34,000									
5.0	E	42,000	8,000	6,600	7,000									
6.0	F	64,000	24,000	21,000	22,500									
	Totals	336,000	236,000	219,600	221,000									

Review Questions

1. What is the purpose of earned value analysis?
2. What does the earned value number tell you?
3. The CPI and SPI are both > 1.0. Is this good or bad for your project?
4. What does a CPI of 0.82 mean to your project?
5. What is the difference between ETC and EAC?

Association for the Advancement of Cost Engineering (AACE) References

- Cost Estimate Classification System http://www.aacei.org/technical/rps/17r-97.pdf (Process Industries, 1997)
- COST ENGINEERING TERMINOLOGY http://www.aacei.org/technical/rps/10s-90.pdf (Glossary, 2007)

Questions/Notes

Answers to EVA Activity

EVA Item	Value
PV	3,000
EV	2,000
AC	4,000
BAC	5,000
CV	(2,000)
CPI	50%
SV	(1,000)
SPI	67%
EAC	10,000
ETC	6,000
VAC	(5,000)

The Pentagon agrees to build a 5 sided fence. The work is scheduled for ONE month per side at a cost of $1,000 per side (total $5,000). At the end of 3 months work, the contractor has completed 2 sides of the fence and spent $4,000 (and seeking change orders to recoup costs).

Project Cost Management
Accounting Issues

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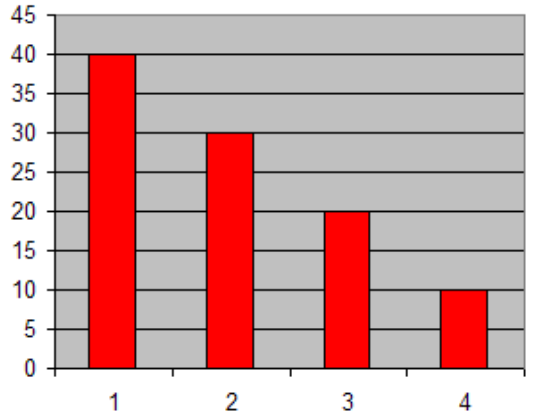
Depreciation

- Large assets (such as equipment, buildings) have a loss of value over their useful life. Funds must be set aside to replace obsolete and worn out equipment.
- Types:
  - Straight-Line Depreciation
  - Accelerated Depreciation
    - Double Declining Balance
    - Sum of the Year Digits



- Ask your account for appropriate recovery costs as overhead charges.

Straight-Line Example

- A $5,000 computer with a $200 salvage value and an estimated useful life of three years would be depreciated by $1,600 annually.
- $5,000 - $200 = $4,800/3 = $1,600

Sum of the Years Digits

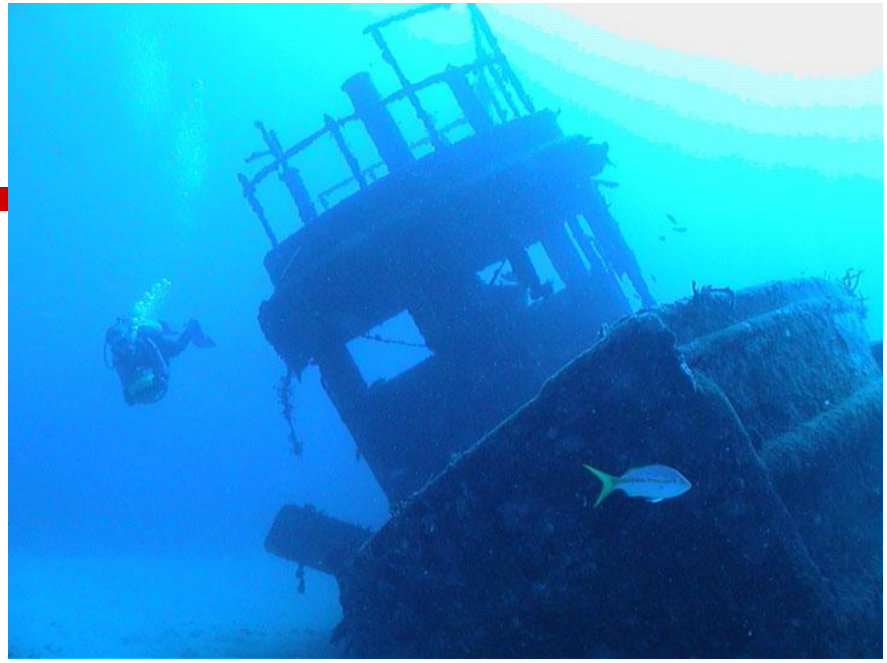
- Take expected life of an asset (in years) count back to one and add the figures together.
- Example: 10 years useful life = 10 + 9 + 8 + 7 + 6 +5 + 4 + 3 + 2 + 1 - Sum of years = 55
- First year asset depreciated 10/55 in value [the fraction 10/55 is equal to 18.18%], second year 9/55 [16.36%], etc.

Opportunity Cost

- The opportunity given up by selecting one project over another. No calculations required. Example: Project D has an NPV of $100,000 and Project H has an NPV of $180,000. What is the opportunity cost of selecting Project H?
- Answer: $100,000 – you gave up Project D

Sunk Cost

- Expended costs.
- According to accounting standards, sunk costs most considered when decided to continue with a troubled project.
- Would you throw good money after bad?



Methods of Project Selection

- Payback Period
- Present Value
- Net Present Value
- Internal Rate of Return
- Benefit Cost Ratio

Pay-Back Period

- Period over which the total cash flow receipts from a project equal the original investment, without discounting.
- Project cost $10,000 and is expected to save company $5,000/yr. Payback = _____?
- Your firm has 2 project alternatives to choose from. Which is most favorable?
  - Project A has payback = 10 months
  - Project B has payback = 18 months
    - Answer: Project A – Investment recovered faster

Present Value (Not for Cash Flows)

PV = FV/(1+r)n

- FV = future value
- r = interest rate
- n = # of time periods

Present value of $700,000 received 4-years from now if expect interest rate is 6% is:

ANSWER = $700,000/(1 +.06)^4

= $700,000/ 1.262477

= $554,465.50

Net Present Value (NPV) Discounted Cash Flows

- You have two projects to choose from. Project A will take 3 years to complete and has a NPV of US $ 1,200,000. Project B will take 4 years to complete and has a NPV of US $ 1,500.000. Which Project would you prefer?
  - Answer: Project B – the number of years was already taken into account when calculating the NPV

Internal Rate of Return (IRR)

- Interest rate at which inflows = outflows
- Return earned on the capital invested in the project
  - Discount rate which gives an NPV of zero.
  - Equivalent to the yield on the investment.
- You have two Projects to choose from. Project A with an IRR of 23% or Project B with an IRR of 45%. Which one would you prefer?
  - Answer: Project B (Bigger is better!)

Benefit Cost Ratio (BCR)

- If BCR > 1 then benefits greater then cost
- If BCR < 1 then benefits are less then cost

- A BCR of 1.5 means that
  - A. Costs are greater than benefits
  - B. Payback is 1.5 times cost
  - C. Profit is 1.5 times cost
  - D. Costs are 1.5 times profit
    - Answer: B - BCR focuses on revenue

Review Questions

1. What financial tools can be used to aid in project selection?
2. What do you need to know about depreciation?
3. Project cost $10,000 and is expected to save company $10,000/yr. Payback = _____?
4. How do sunk costs differ from opportunity costs?

Project Cost Management

The End!

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