Project Cost Management

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Some of the contents are adapted from "Software Engineering" by Theodore P. Baker.

Objectives

- Understand the basics of IT project financial planning analysis and cost management concepts, principles, and terms
- Discuss different types of cost estimates and methods for preparing them
- Understand the processes involved in cost budgeting and preparing a cost estimate, and budget for an information technology project

The Importance of Project Cost Management

- IT projects have a poor track record for meeting budget goals.
- The CHAOS studies found the average cost **overrun** ranged from 180 percent in 1994 to 43 percent in 2002.
- Other studies found overruns to be 33-34 percent

Cost Overrun Examples

- The U.S. Internal Revenue Service (IRS)
  - 1990s: A series of project failures cost taxpayers more than **$50 billion** a year (=annual net profit of the entire computer industry)
  - In 2004, CIO Magazine reported problems with the IRS's $8 billion modernization project, resulting in > **$200 million** cost overrun
  - In 2006, the IRS tried to upgrade its fraud-detection software but project was delayed costing **$318 million** in fraudulent refunds that didn't get caught
  - in 2008, a report stated that more than 400 U.S. government agency IT projects, worth an estimated **$25 billion**, suffer from poor planning and underperformance
- Obama's Healthcare.org -> 600 million dollars overrun
- The UK's National Health Service IT modernization program
  - the greatest IT disaster in history with an estimated **$26 billion** overrun

What is Cost and Project Cost Management?

- **Cost** is a resource sacrificed or foregone to achieve a specific objective or something given up in exchange
  - Costs are usually measured in monetary units like dollars
- **Project cost management** includes the processes required to ensure that the project is completed within an approved budget
  - Project managers must make sure their projects are well defined, have accurate time and cost estimates and have a realistic budget that they were involved in approving

Reasons for Cost Overruns

- Not emphasizing the importance of realistic project cost estimates from the outset
  - Many of the original cost estimates for IT projects are low to begin with and based on very unclear project requirements
- Many IT professionals think preparing cost estimates is a job for accountants when in fact it is a very skill that project managers need to acquire.
- Many IT projects involve new technology or business processes which involve **untested products** and **inherent risks**

Basic Principles & Terminology

- ***Profits*** are revenues minus expenditures
- ***Profit margin*** is the ratio of revenues to profits
- ***Life cycle costing***
  - Considers the total cost of ownership, or development plus support costs, for a project when making financial decisions
  - E.g. Buying a low-cost but low-quality equipment may cost less initially but require a high maintenance fee later on.
- ***Cash flow analysis*** determines the estimated annual costs and benefits for a project and the resulting annual cash flow

Basic Principles & Terminology

- ***Tangible costs*** or ***benefits*** are those costs or benefits that an organization can easily measure in dollars

- ***Intangible costs*** or ***benefits*** are costs or benefits that are difficult to measure in monetary terms, e.g improved company image

- ***Direct costs*** are costs that can be directly related to producing the products and services of the project

- ***Indirect costs*** are costs that are not directly related to the products or services of the project

- ***Sunk cost*** is money that has been spent in the past; when deciding what projects to invest in or continue, you should *not* include sunk costs

Basic Principles of Cost Management

- ***Learning curve theory*** states that when many items are produced repetitively, the unit cost of those items **decreases** in a regular pattern as more units are produced

- ***Reserves*** are dollars included in a cost estimate to mitigate cost **risk** by allowing for future situations that are difficult to predict

Types of Reserves

- ***Contingency reserves*** allow for future situations that may be partially planned for
  - To cater for ***known unknowns***
  - E.g. increase in labor and material cost
  - Included in the cost baseline
  - E.g. $10M (Project Budget) + $1M (Contingency Reserve) = $11M (Cost Baseline)

- ***Management reserves*** allow for future situations that are unpredictable
  - To cater for ***unknown unknowns***
  - E.g. supplier goes bankrupt, hurricane
  - Not included in the cost baseline, but included in the total cost budget
  - E.g. $11M (Cost Baseline) + $1.1M (Management Reserve) = $12.1M (Cost Budget)

Project Cost Management Processes

- ***Financial Planning Analysis/Estimate costs***: developing an approximation or estimate of the costs of the resources needed to complete a project

- ***Determine budget***: allocating the overall cost estimate to individual work items to establish a **baseline** for measuring performance

- ***Control cost***: controlling changes to the project budget

Financial Planning Analysis

- Four primary methods for determining the projected financial value of projects
  - ***Net present value (NPV) analysis***
  - ***Return on investment (ROI)***
  - ***Internal Rate of Return (IRR)***
  - ***Payback analysis***

Discounted Cash Flow

- Money in the future is worth less than money received today

- The ***future value (FV)*** is calculated as

  $FV = PV(1+i)^n$ where i is the interest rate, PV the present value, n is the no. of periods (e.g., months, years)

  $PV = FV/(1+i)^n$

- Example:
  - FV of $2000 is $2315.25 if i = 5%, n = 3 (years)

Net Present Value Analysis

- ***Net present value (NPV)*** analysis is a method of calculating the expected net monetary gain or loss from a project by discounting all expected future cash inflows and outflows to the **present point** in time

- ***Net present value (NPV) = Total discounted benefits – Total discounted costs***

Choose A Project to Invest

- NPV of Project A = 87K;
  NPV of Project B = 57K ??

- NPV of Project A = -87K;
  NPV of Project B = 57K ??

- NPV of Project A = -87K;
  NPV of Project B = -57K ??

Net Present Value Analysis

- The **higher** the NPV, the better

- Projects with a **positive NPV** should be considered if financial value is a key criterion

JWD Consulting NPV Example

Multiply by the discount factor each year, then take cum. benefits – costs to get NPV

Discount rate	**8%**					
Assume the project is completed in Year 0			**Year**			
	0	**1**	**2**	**3**	**Total**	
Costs	140,000	40,000	40,000	40,000		
Discount factor	1	0.93	0.86	0.79		
Discounted costs	**140,000**	**37,200**	**34,400**	**31,600**	**243,200**	
Benefits	0	200,000	200,000	200,000		
Discount factor	1	0.93	0.86	0.79		
Discounted benefits	**0**	**186,000**	**172,000**	**158,000**	**516,000**	
Discounted benefits - costs	(140,000)	148,800	137,600	126,400	**272,800**	← **NPV**
Cumulative benefits - costs	(140,000)	8,800	146,400	272,800		
ROI →	**112%**					
	Payback In Year 1					

Return on Investment (ROI)

- ***ROI = (total discounted benefits - total discounted costs) / discounted costs***

- The **higher** the ROI, the better

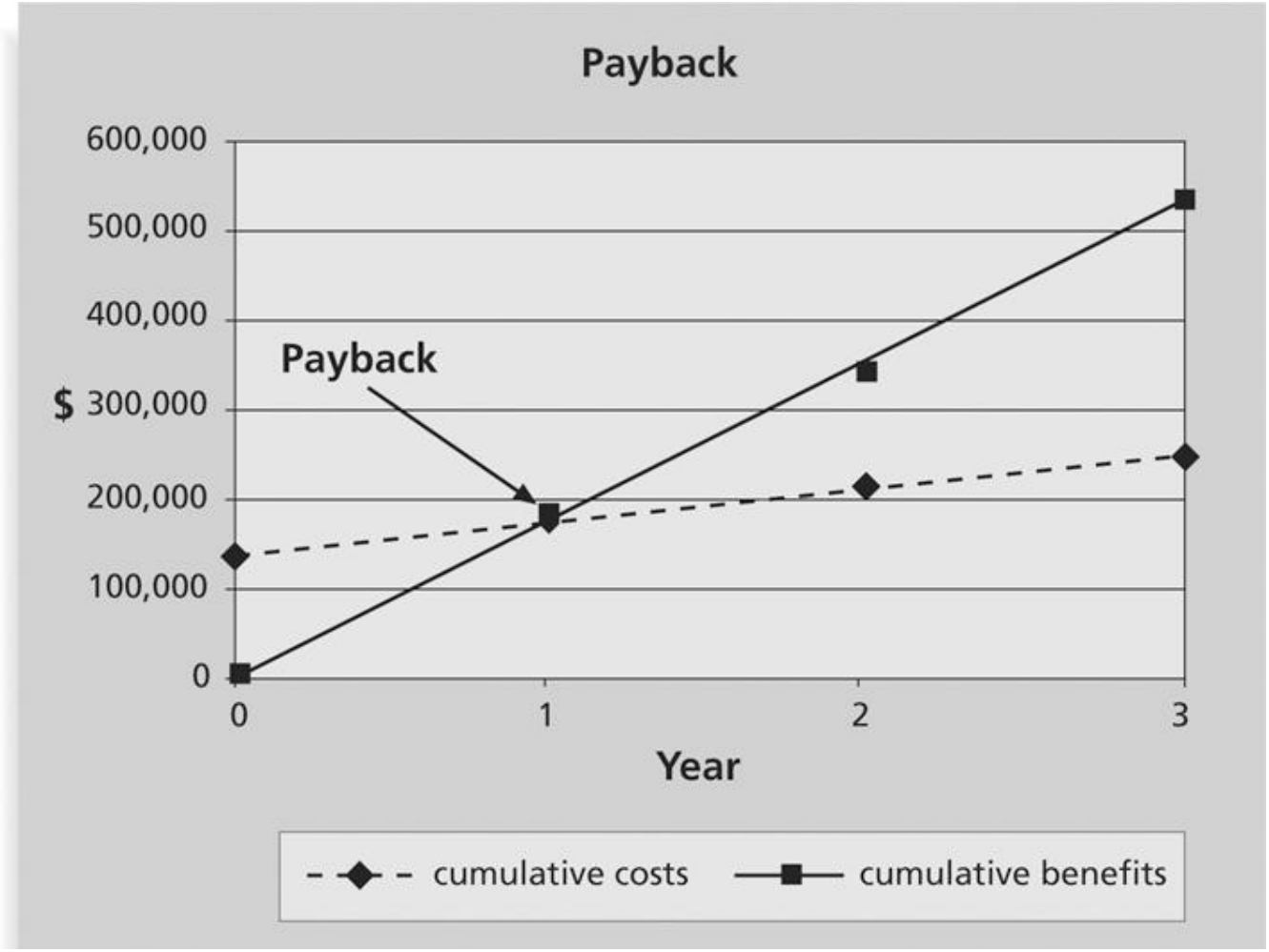
Internal Rate of Return (IRR)

- Rate at which the total discounted benefits and total discounted costs are equal
- The discount **rate** when **NPV = 0**
- Difficult to calculate
- The **higher** the better

Payback Analysis

- The ***payback period*** is the amount of time it will take to recoup, in the form of net cash inflows, the total dollars invested in a project
- **Time** when **NPV = 0**
- The **shorter** the better

Charting the Payback Period



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ROI	**112%**					
	Payback in Year 1					

Cost Estimation Tools and Techniques

- Basic tools and techniques for cost estimates
  - ***Analogous*** or ***top-down estimates***: use the actual cost of a previous, similar project as the basis for estimating the cost of the current project. E.g. cost of renovating a house
  - ***Bottom-up estimates***: involve estimating individual work items or activities and summing them to get a project total
  - ***Parametric modeling***: uses project characteristics (parameters) in a mathematical model to estimate project costs. E.g. no. of workstations x cost of installation per workstation

Surveyor Pro Project Cost Estimate

Surveyor Pro Project Cost Estimate Created October 5, 2008

	# Units/Hrs.	Cost/Unit/Hr.	Subtotals	WBS Level 1 Totals	% of Total
WBS Items					
1. Project Management				**$306,300**	**20%**
Project manager	960	$100	$96,000		
Project team members	1920	$75	$144,000		
Contractors (10% of software development and testing)			$66,300		
2. Hardware				**$76,000**	**5%**
2.1 Handheld devices	100	$600	$60,000		
2.2 Servers	4	$4,000	$16,000		
3. Software				**$614,000**	**40%**
3.1 Licensed software	100	$200	$20,000		
3.2 Software development*			$594,000		
4. Testing (10% of total hardware and software costs)			$69,000	**$69,000**	**5%**
5. Training and Support				**$202,400**	**13%**
Trainee cost	100	$500	$50,000		
Travel cost	12	$700	$8,400		
Project team members	1920	$75	$144,000		
6. Reserves (20% of total estimate)			$253,540	**$253,540**	**17%**
Total project cost estimate				**$1,521,240**	

* See software development estimate

Surveyor Pro Software Development Estimate

Surveyor Pro Software Development Estimate Created October 5, 2008*

1. Labor Estimate	# Units/Hrs.	Cost/Unit/Hr.	Subtotals	**Calculations**
Contractor labor estimate	3000	$150	$450,000	3000*150
Project team member estimate	1920	$75	$144,000	1920*75
Total labor estimate			**$594,000**	Sum above two values
2. Function point estimate**	Quantity	Conversion Factor	Function Points	**Calculations**
External inputs	10	4	40	10*4
External interface files	3	7	21	3*7
External outputs	4	5	20	4*5
External queries	6	4	24	6*4
Logical internal tables	7	10	70	7*10
Total function points			**175**	Sum above function point values
Java 2 languange equivalency value			46	Assumed value from reference
Source lines of code (SLOC) estimate			8,050	175*46
Productivity*KSLOC^Penalty (in months)			29.28	3.13*8.05^1.072 (see reference)
Total labor hours (160 hours/month)			4,684.65	29.28*160
Cost/labor hour ($120/hour)			$120	Assumed value from budget expert
Total function point estimate			**$562,158**	4684.65*120

*Approach based on paper by William Roetzheim, "Estimating Software Costs," Cost Xpert Group, Inc. (2003) using the COCOMO II default linear productivity factor (3.13) and penalty factor (1.072).

Determine Budget

- An important goal is to produce a ***cost baseline***
  - A **time-phased budget** that project managers use to measure and monitor cost performance

Surveyor Pro Project Cost Baseline

Surveyor Pro Project Cost Baseline Created October 10, 2008*

WBS Items	1	2	3	4	5	6	7	8	9	10	11	12	Totals
1. Project Management													
Project manager	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	8,000	96,000
Project team members	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	144,000
Contractors		6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	6,027	66,300
2. Hardware													
2.1 Handheld devices				30,000	30,000								60,000
2.2 Servers				8,000	8,000								16,000
3. Software													
3.1 Licensed software				10,000	10,000								20,000
3.2 Software development		60,000	60,000	80,000	127,000	127,000	90,000	50,000					594,000
4. Testing			6,000	8,000	12,000	15,000	15,000	13,000					69,000
5. Training and Support													
Trainee cost									50,000				50,000
Travel cost									8,400				8,400
Project team members							24,000	24,000	24,000	24,000	24,000	24,000	144,000
6. Reserves				10,000	10,000	30,000	30,000	60,000	40,000	40,000	30,000	3,540	253,540
Totals	20,000	86,027	92,027	172,027	223,027	198,027	185,027	173,027	148,427	90,027	80,027	53,567	1,521,240

*Numbers are rounded, so some totals appear to be off.

How to Control Costs?

- Monitoring cost performance
- Ensuring that only appropriate project changes are included in a revised cost baseline
- Informing project stakeholders of authorized changes to the project that will affect costs

Media Snapshot

- **Australia**: problems with the installation of an ERP system at Crane Group Ltd. led to an estimated cost overrun of $11.5 million
- **India**: as many as 274 projects currently under implementation in the Central sector are suffering serious cost and time overruns. Only 65 are being monitored on a regular basis
- **Pakistan**: Pakistan has sustained a cost overrun of Rs 1.798 billion (over $30 million U.S. dollars) in the execution of the 66.5 megawatt Jagran Hydropower Project in the Neelum Valley. Caused by massive mismanagement, embezzelment of funds and unapproved changes in the project
- **United States**: Northern California lawmakers were outraged over Governor Arnold Schwarzenegger's announcement that commuters should have to pay construction costs on Bay Area bridges. Cost of one of the bridges has grown from $1.1 billion to $5.1 billion *Maybe it takes the Terminator to help control costs!*

Cost Control

- Performance review meetings can be a powerful tool to help control project costs
  - Knowing you have to report on your progress is an incentive for people to perform better
- Performance measurement is another important tool for cost control
  - There are many general accounting approaches for measuring cost performance but **earned value management** is a tool unique to project management

Earned Value Management (EVM)

- ***EVM*** is a project performance measurement technique that integrates scope, time, and cost data

- Given a **baseline** (original plan plus approved changes), you can determine how well the project is meeting its goals

- You must enter **actual** information periodically to use EVM

Earned Value Management (EVM)

Planned Value (PV)	How much work should have been done?
Earned Value (EV)	How much work has been done?
Actual Cost (AC)	How much has been spent?
Budget At Completion (BAC)	What was the entire project supposed to cost?
Estimate At Completion (EAC)	What is the project expected to cost now?

Earned Value Management (EVM)

Cost Variance (CV)	Deviation from the original budget (in monetary terms)?
Schedule Variance (SV)	Deviation from the original schedule (in monetary terms)?
Cost Performance Index (CPI)	How well is the WBS component doing in terms of cost?
Schedule Performance Index (SPI)	How well is the WBS component doing in terms of schedule?

EVM Example – A Programming Project

- Plan
  - 10 months to complete the project
  - 10 programs to write
  - Each requires 1 month to write
  - Each costs $10K to write

- Actual after 3 months
  - Has written 2 programs
  - Has spent $16K

Summary of Formulae

PV	**Planned Value**	Budgeted cost for the work **scheduled**
EV	**Earned Value**	Budgeted amount for the work **actually** completed
AC	**Actual Cost**	The total cost incurred
BAC	**Budget at Completion**	Original budget
CV	**Cost Variance**	EV – AC
CPI	**Cost Performance Index**	EV / AC
SV	**Schedule Variance**	EV – PV
SPI	**Schedule Performance Index**	EV / PV
ETC	**Estimate to Complete**	(BAC - EV) / CPI (*assuming typical variances*)
EAC	**Estimate at Completion**	AC + ((BAC – EV) / CPI) or simply BAC / CPI
VAC	**Variance at Completion**	BAC – EAC
	Estimated Time to Complete	Original time estimate / SPI

Performance of Programming Project

PV	**Planned Value**	$10K x 3 = $30K
EV	**Earned Value**	$10K x 2 = $20K
AC	**Actual Cost**	$16K
BAC	**Budget at Completion**	$10K x 10 = $100K
CV	**Cost Variance**	$20K – $16K = $4K
CPI	**Cost Performance Index**	$20K / $16K = 1.25
SV	**Schedule Variance**	$20K – $30K = $-10K
SPI	**Schedule Performance Index**	$20K / $30K = 0.67
ETC	**Estimate to Complete**	($100K - $20K) / 1.25 = $64K
EAC	**Estimate at Completion**	$16K + $64K = $80K $100K / 1.25 = $80K
VAC	**Variance at Completion**	$100K - $80K = $20K
	Estimated Time to Complete	

Rate of Performance

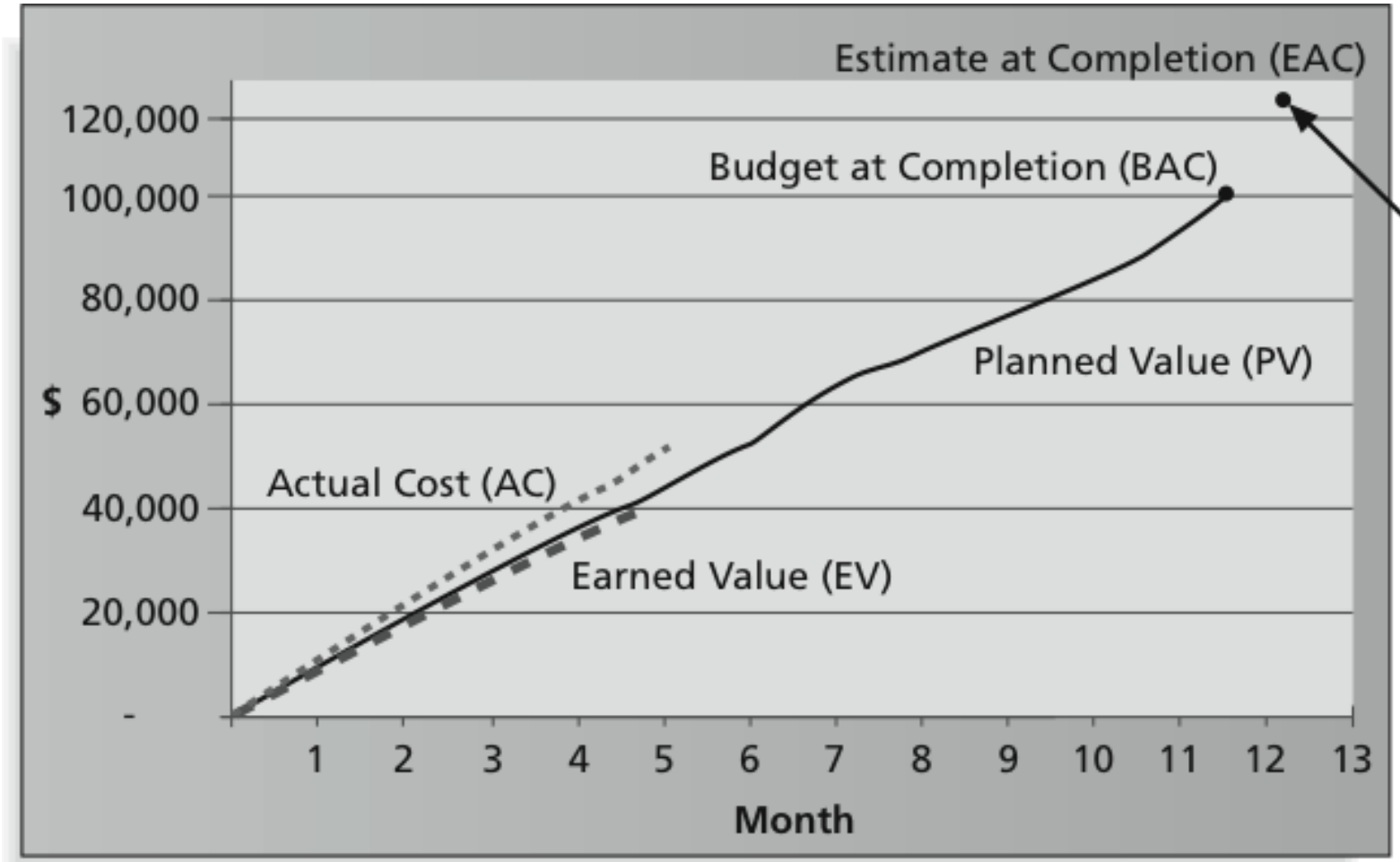
- ***Rate of performance (RP)*** **=**
  - Actual work completed / work planned to have been completed

- For example, suppose the server installation was halfway completed by the end of week 1 but planned schedule shows the task should be 100% completed
  - Actual work completed 50%
  - Work planned to have been completed 100%
  - → Rate of performance = 50%

Rules of Thumb for Earned Value Numbers

- Problem appears when:
  - **Negative** numbers for cost or schedule variance
  - CPI or SPI **less than 100%**
- Problems mean
  - the project is costing more than planned (over budget) or
  - taking longer than planned (behind schedule)

Earned Value Chart for Project after Five Months



An EAC point above and to the right of the BAC point means the project is projected to cost more and take longer than planned

Actual Cost (AC) — Planned value (PV) — Earned Value (EV)

Project Portfolio Management

- Many organizations collect and control an entire suite of projects or investments as one set of interrelated activities in a portfolio

- Five levels for project portfolio management
  1. Put all your projects in one database
  2. Prioritize the projects in your database
  3. Divide your projects into two or three budgets based on type of investment
  4. Automate the repository
  5. Apply modern portfolio theory, including risk-return tools that map project risk on a curve

Benefits of Portfolio Management

- Schlumberger saved $3 million in one year by organizing 120 information technology projects into a portfolio
  - 80% of the projects overlapped
  - 14 separate projects were trying to accomplish the same thing

- META Group research shows that:
  - Organizations that evaluate information technology projects by what their business impacts are and what their potential business values will be implement projects that result in 25 percent more improvement to the bottom line
  - Business executives state that using project portfolio management allows managers to make decisions faster and with more confidence

Best Practice

- A global survey released by Borland Software suggests that many organizations are still at a low level of maturity in terms of how they define project goals, allocate resources, and measure overall success.

- Some of the findings include the following:
  - Only 22 percent of survey respondents reported that their organization either effectively or very effectively uses a project plan for managing projects
  - Only 17 percent have either rigorous or very rigorous processes for project plans, which include developing a baseline and estimating schedule, cost, and business impact of projects
  - Only 20 percent agreed their organizations monitor portfolio progress and coordinate across interdependent projects
  - The most successful organizations are taking a holistic view of focusing, managing and measuring their IT efforts with an integrated combination of best practice processes, training and technology

Best Practice

- The most successful organizations are taking a holistic view of focusing, managing and measuring their IT efforts with an integrated combination of best practice processes, training and technology
  - Unfortunately, most organizations today are not taking that approach

Using Software to Assist in Cost Management

- Spreadsheets are a common tool for resource planning, cost estimating, cost budgeting, and cost control
- Many companies use more sophisticated and centralized financial applications software for cost information
- Project management software has many cost-related features, especially enterprise PM software
  - Several companies have developed methods to link data between their project management software and their main accounting systems