# Lecture 7
# Project Cost Control

# Learning Objectives

- Understand the importance of project cost management
- Explain basic project cost management principles, concepts, and terms
- Discuss different types of cost estimates and methods for preparing them

# Learning Objectives (continued)

- Understand the processes involved in cost budgeting and preparing a cost estimate, and budget for an information technology project
- Understand the benefits of earned value management and project portfolio management to assist in cost control
- Describe how project management software can assist in project cost management

# The Importance of Project Cost Management

- IT projects have a poor track record for meeting budget goals
- Some studies found the average cost **overrun** (the additional percentage or dollar amount by which actual costs exceed estimates) ranged from 180 percent in 1994 to 43 percent in 2002; other studies found overruns to be 33-34 percent

# What Went Wrong?

- The U.S. Internal Revenue Service (IRS) continues to provide examples of how not to manage costs
  - A series of project failures in the 1990s cost taxpayers more than $50 billion a year
  - In 2004, CIO Magazine reported problems with the IRS's $8 billion modernization project
  - In 2006, the IRS was in the news for a botched upgrade to its fraud-detection software, costing $318 million in fraudulent refunds that didn't get caught
- The United Kingdom's National Health Service IT modernization program was called the greatest IT disaster in history by a London columnist, with an estimated $26 billion overrun
  - Incompatible systems; resistance from physicians who felt they were not consulted enough about system features; arguments amoung contractors regarding responsibility

# 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 sestimates and have a realistic budget that they were involved in approving

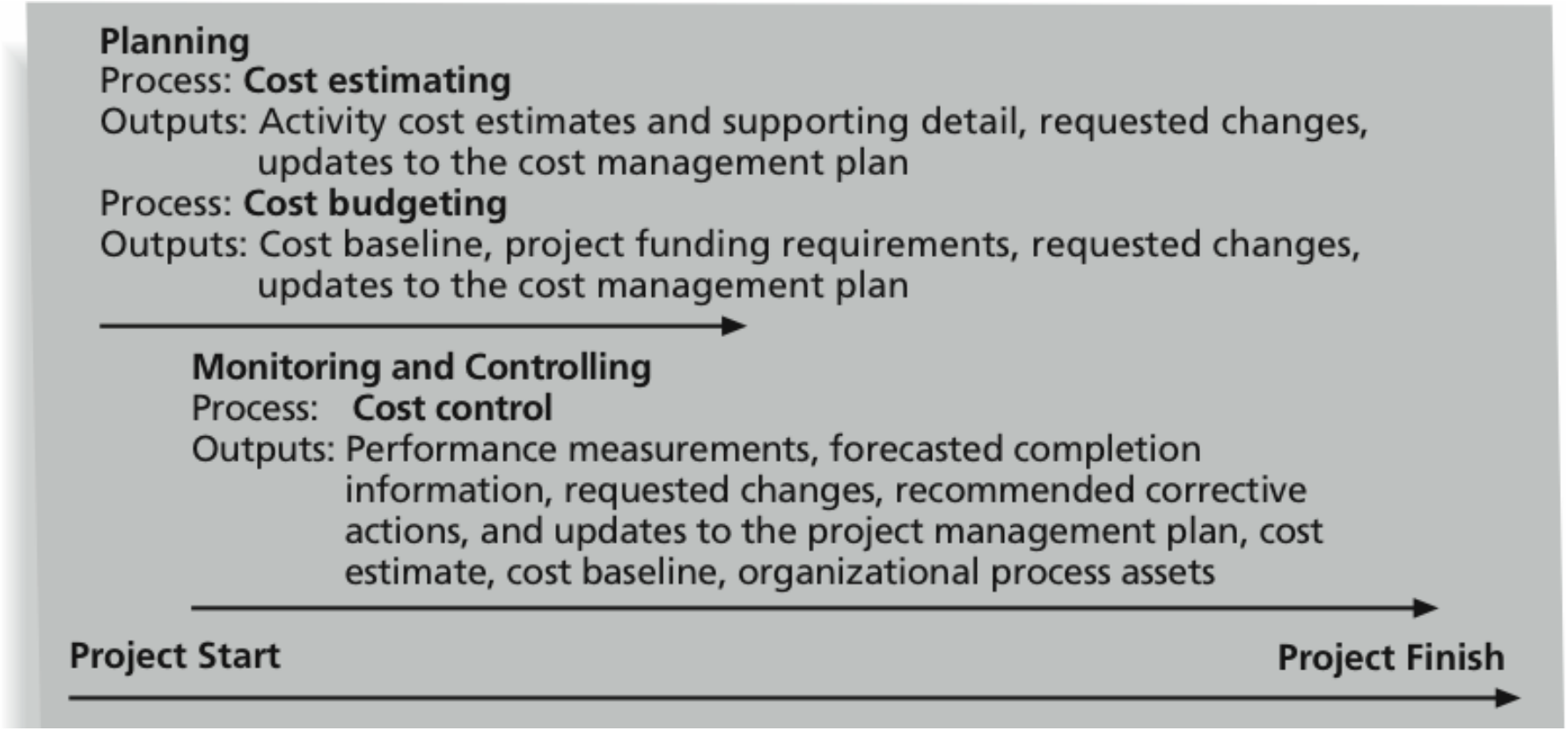
# Reasons for Cost Overruns

- 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 demanding and important skill that project managers need to acquire
- Many IT projects involve new technology or business processes which involve untested products and inherent risks

# Project Cost Management Processes

- There are three project cost management processes:
  - **Cost estimating**: developing an approximation or estimate of the costs of the resources needed to complete a project
  - **Cost budgeting**: allocating the overall cost estimate to individual work items to establish a baseline for measuring performance
  - **Cost control**: controlling changes to the project budget

# Project Cost Management Summary



# Basic Principles of Cost Management

- Most members of an executive board better understand and are more interested in financial terms than IT terms, so IT project managers must speak their language
  - **Profits** are revenues minus expenditures
  - **Profit margin** is the ratio of revenues to profits
    - $2 profit per $100 revenue → 2% profit margin
  - **Life cycle costing** considers the total cost of ownership, or development plus support costs, for a project
    - A project could take 2 years to build and be in place for 10 years; costs and benefits must be estimated for the entire lifetime of the project

# Cost of Software Defects

| Phase of Software Development | Relative Cost to Repair Defects |
|---|---|
| Requirements and Analysis | 1X |
| Coding and Unit Test | 5X |
| Integration and System Test | 10X |
| Beta Test | 15X |
| Post-Product Release | 30X |

*Note: X is a normalized unit of cost and can be expressed in dollars, person-hours, etc.

- It is much more cost-effective to spend money on defining user requirements and doing early testing on IT projects than to wait for problems to appear after implementation
  - If it would cost $1,000 to repair a software defect in the requirements and analysis phase but it would cost $30,000 to fix it in the post-product release phase

# What Went Right?

- A leading telecommunications company estimated the cost of a software bug or defect at three stages: after coding, after manual inspection, and after beta release
- The costs to correct the defect increased with each stage from $2,000 to $10,000 to $100,000
- The company estimated that when it released one million lines of new code, it had an average of 440 defects in the early stage, 250 in the middle stage, and 125 in the late stage, costing more than $15 million
- They decided to implement an automated inspection process, which reduced costs for fixing bugs by more than $11 million

# Basic Principles of Cost Management

- **Cash flow analysis** determines the estimated annual costs and benefits for a project and the resulting annual cash flow
  - Too many projects with high cash flow needs in the same year may not be able to be supported which will impact profitability
- **Tangible costs** or **benefits** are those costs or benefits that an organization can easily measure in dollars
- A task that was allocated $150,000 but actually costs $100,000 would have a tangible benefit of $50,000 if the assets allocated are used for other projects
- **Intangible costs** or **benefits** are costs or benefits that are difficult to measure in monetary terms
- Costs – resources used to research related areas of a project but not billed to the project
- Benefits – goodwill, prestige, general statements of improved productivity not easily translated in dollars

# Basic Principles of Cost Management

- **Direct costs** are costs that can be directly related to producing the products and services of the project
  - Salaries, cost of hardware and software purchased specifically for the project
- **Indirect costs** are costs that are not directly related to the products or services of the project, but are indirectly related to performing the project
  - Cost of electricity, paper towels
- **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
  - To continue funding a failed project because a great deal of money has already been spent on it is not a valid way to decide on which projects to fund
  - Sunk costs should be forgotten

# Basic Principles of Cost Management

- **Learning curve theory** states that when many items are produced (or tasks are performed) repetitively, the unit cost of those items decreases in a regular pattern as more units are produced (or more tasks performed)
- **Reserves** are dollars included in a cost estimate to mitigate cost risk by allowing for future situations that are difficult to predict
  - **Contingency reserves** allow for future situations that may be partially planned for (sometimes called **known unknowns**) and are included in the project cost baseline
    - Recruiting and training costs for expected personnel turnover during a project
  - **Management reserves** allow for future situations that are unpredictable (sometimes called **unknown unknowns**)
    - Extended absence of a manager; supplier goes out of business

# Cost Estimating

- After developing a good resource requirements list, PMs and their teams must develop several estimates of the costs for these resources
- Project managers must take cost estimates seriously if they want to complete projects within budget constraints
- It's important to know the types of cost estimates, how to prepare cost estimates, and typical problems associated with IT cost estimates

# Cost Estimating

- A **rough order of magnitude** (ROM) estimate provides an estimate of what a project will cost.
  - Also referred to as a ballpark estimate, a guesstimate, a swag, or a broad gauge.
  - Done very early in a project, often three or more years prior to project completion, or even before a project is officially started to help PMs make project selection decisions.
  - Accuracy is typically -50 percent to +100 percent, meaning the project's actual costs could be 50 percent below the ROM estimate or 100 percent above.
    - A ROM estimate that actually cost $100,000 would range between $50,000 to $200,000. The accuracy range is often much wider for IT projects.
      - Often IT project estimates for software development are doubled because of the history of cost overruns

# Cost Estimating

- A **budgetary estimate** is used to allocate money into an organization's budget.
  - Many organizations develop budgets at least two years into the future.
    - Budgetary estimates are made one to two years prior to project completion.
  - The accuracy of budgetary estimates is typically -10% to +25%
    - A budgetary estimate that actually costs $100,000 would range between $90,000 to $125,000.

# Cost Estimating

- A **definitive estimate** provides an accurate estimate of project costs (most accurate of the three types).
  - Definitive estimates are used for making many purchasing decisions for which accurate estimates are required and for estimating final project costs.
  - For example, if a project involves purchasing 1000 personal computers from an outside supplier in the next three months, a definitive estimate would be required to aid in evaluating supplier proposals and allocating the funds to pay the chosen supplier.
  - Definitive estimates are made one year or less prior to project completion
  - Accuracy range is normally -5% to +10%

# Types of Cost Estimates

| Type of Estimate | When Done | Why Done | How Accurate |
|---|---|---|---|
| **Rough Order of Magnitude (ROM)** | Very early in the project life cycle, often 3–5 years before project completion | Provides estimate of cost for selection decisions | –50% to +100% |
| **Budgetary** | Early, 1–2 years out | Puts dollars in the budget plans | –10% to +25% |
| **Definitive** | Later in the project, less than 1 year out | Provides details for purchases, estimates actual costs | –5% to +10% |

- It is important to provide supporting details (assumptions, project scope, WBS, etc) used in computing estimates so that it will be easier to prepare updates as needed or similar estimates on other projects.

# Cost Management Plan

- A **cost management plan** is a document that describes how the organization will manage cost variance on the project
  - For example, how to respond to proposals from suppliers that are higher or lower than estimates
  - A large percentage of total project costs are often labor costs, so project managers must develop and track estimates for labor
    - Many organizations estimate the number of people or hours they need by department or skill over the life cycle of a project

# Maximum Departmental Headcounts by Year

- The table below shows the maximum number of people Northwest Airlines determined to assign to each year of the project by department
  - Note the small number of contractors; contractors generally have higher labor costs than in-house employees

| DEPARTMENT | 1994 | 1995 | 1996 | 1997 | 1998 | TOTALS |
|---|---|---|---|---|---|---|
| Information Systems | 24 | 31 | 35 | 13 | 13 | 116 |
| Marketing Systems | 3 | 3 | 3 | 3 | 3 | 15 |
| Reservations | 12 | 29 | 33 | 9 | 7 | 90 |
| Contractors | 2 | 3 | 1 | 0 | 0 | 6 |
| Totals | 41 | 66 | 72 | 25 | 23 | 227 |

# Cost Estimation Tools and Techniques

- **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
  - How similar the current and previous project are determines the accuracy of the estimate. Using a different language or hardware can skew the estimate
- **Bottom-up estimates** or **Activity Based Costing** : involve estimating individual work items or activities and summing them to get a project total
  - The smaller the work items, the better the estimate but these estimates are usually time intensive and expensive to develop

# Cost Estimation Tools and Techniques

- **Parametric modeling**: uses project characteristics (parameters) in a mathematical model to estimate project costs
  - For example, a model might provide an estimate of $50 per line of code for a development project based on the programming language, level of expertise of the programmers, size and complexity of the data involved, etc
  - Some models may be simpler such as a $10,000 ballpark estimate per workstation in a large office automation project based on history of similar projects during the same time period

# Typical Problems with IT Cost Estimates

- Estimates are done too quickly
  - Many estimates must be done quickly, before clear system requirements have been produced
- Lack of estimating experience
  - The people developing the costs estimates often don't have much experience, especially on large projects
  - There is not enough accurate, reliable project data available on which to base estimates
- Human beings are biased toward underestimation
  - Senior team members make estimates based on their skill level but should take into account the junior people on the project
- Management desires accuracy but wants to spend less in order to win a bid or internal funding
  - Top management never forgets the first estimate and rarely, if ever, remembers how approved changes affect the estimate.
    - The PM must keep the communication lines open at all times

# 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).

# Cost Budgeting

- Cost budgeting involves allocating the project cost estimate to individual work items over time
- The WBS is a required input to the cost budgeting process since it defines the work items
- An important goal is to produce a **cost baseline**
  - A time-phased budget that project managers use to measure and monitor cost performance
  - Estimating costs for each major project activity over time provides management with a foundation for project cost control
  - Cost budgeting also provides info for project funding requirements –at what point(s) in time will the money be needed

# Surveyor Pro Project Cost Baseline

- The Surveyor Pro project team could use the cost estimate along with the project schedule and other info to allocate costs for each month as below

**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.

# Cost Control

- Project cost control includes:
  - 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
- Many organizations around the globe have problems with cost control

# 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
  - Was a WBS item completed or approximately how much of the work was completed
  - Actual start and end dates
  - Actual cost
- More and more organizations around the world are using EVM to help control project costs

# Earned Value Management Terms

- The **planned value (PV),** formerly called the budgeted cost of work scheduled (BCWS), also called the budget, is that portion of the approved total cost estimate planned to be spent on an activity during a given period
- **Actual cost (AC),** formerly called actual cost of work performed (ACWP), is the total of direct and indirect costs incurred in accomplishing work on an activity during a given period
  - $20,000 AC to accomplish task over two weeks - $15K AC week 1and $5K week 2
- The **earned value (EV),** formerly called the budgeted cost of work performed (BCWP), is an estimate of the value of the physical work actually completed
  - EV is based on the original planned costs for the project or activity and the rate at which the team is completing work on the project or activity to date

# Rate of Performance

- **Rate of performance (RP)** is the ratio of actual work completed to the percentage of work planned to have been completed at any given time during the life of the project or activity
- Brenda Taylor, Senior Project Manager in South Africa, suggests this term and approach for estimating earned value
  - For example, suppose the server installation was halfway completed by the end of week 1; the rate of performance would be 50% because by the end of week 1, the planned schedule reflects that the task should be 100% complete and only 50% of that work has been completed
  - The EV would thus be $5,000 after week 1 ($10,000*50%)

# Earned Value Calculations for One Activity After Week One

| Activity | Week 1 |
|---|---|
| Earned Value (EV) | 5,000 |
| Planned Value (PV) | 10,000 |
| Actual Cost (AC) | 15,000 |
| Cost Variance (CV) | –10,000 |
| Schedule Variance (SV) | –5,000 |
| Cost Performance Index (CPI) | 33% |
| Schedule Performance Index (SPI) | 50% |

# Earned Value Formulas

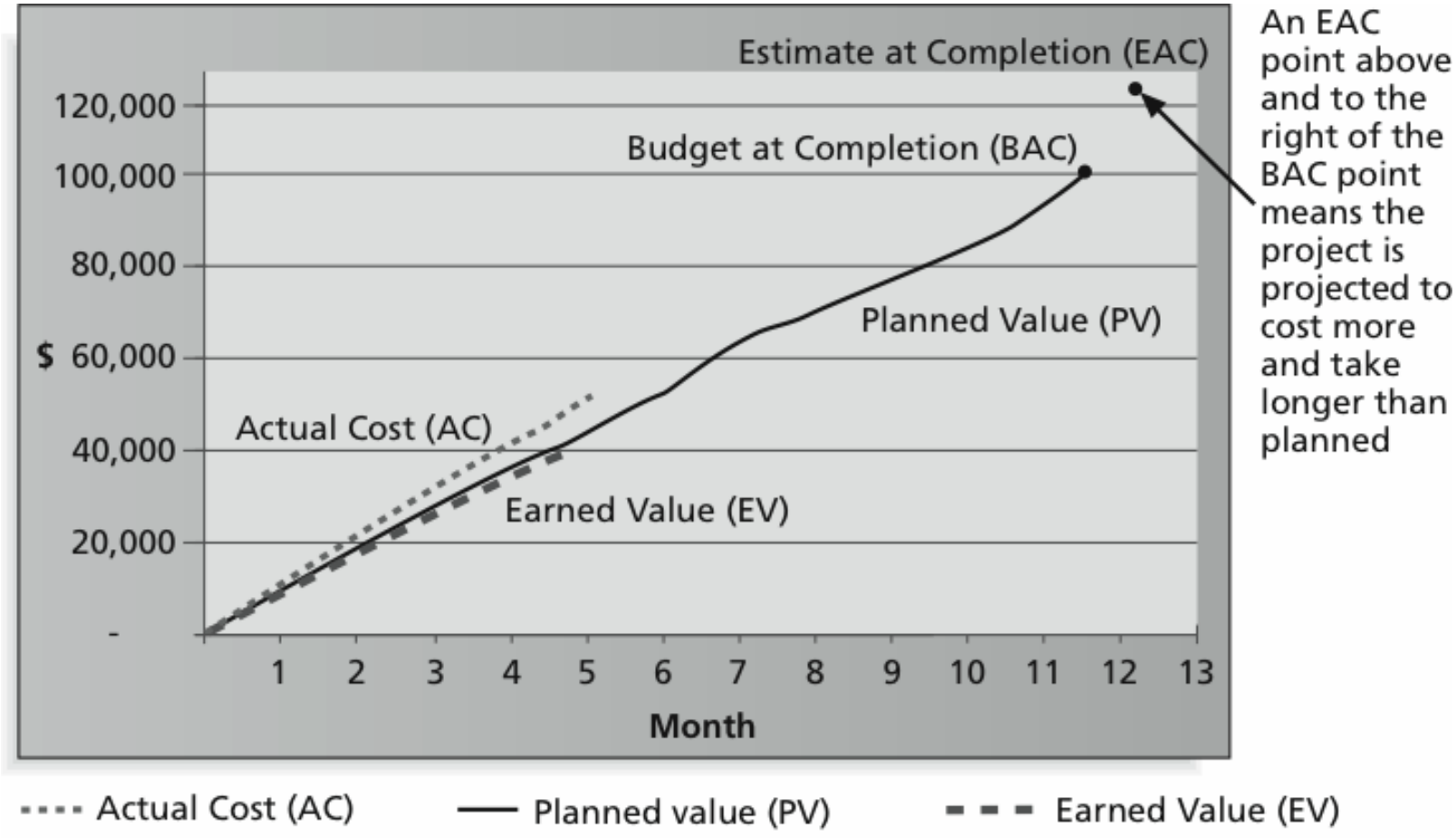
| TERM | FORMULA |
|---|---|
| Earned Value | EV = PV to date × RP |
| Cost Variance | CV = EV – AC |
| Schedule Variance | SV = EV – PV |
| Cost Performance Index | CPI = EV/AC |
| Schedule Performance Index | SPI = EV/PV |
| Estimate at Completion (EAC) | EAC = BAC/CPI |
| Estimated Time to Complete | Original Time Estimate/SPI |

# Earned Value Formulas

- Negative numbers for cost and schedule variance indicate problems in those areas
  - If CV is negative it means that performing the work cost more than planned
  - A negative SV means that it took longer than planned to perform the work
- CPI can be used to estimate the projected cost of completing the project based on performance to date (EAC)
  - =1:the planned and actual costs are the same; <1: over budget; >1: under budget
- SPI can be used to estimate the projected time to complete the project
  - =1: on schedule; <1 behind schedule; >1 ahead of schedule

# Earned Value Chart for Project after Five Months

- **EAC = $122,308 = BAC/CPI = $100,000/.81761**
- **ETC = 12.74 months = Original Time Estimate/SPI = 12 months/.94203**



# Earned Value Chart

- The chart helps visualize how the project is performing.
  - If the project goes as planned, it will finish in 12 months at a cost of $100,000
  - The actual cost line is always right on or above the earned value line.
    - Interpretation: This means costs are equal to or more than planned
  - The planned value line is pretty close to the EV line, just slightly higher in the last month
    - Interpretation: The project has been right on schedule until last month when the project fell behind schedule

# Earned Value Chart

- Many commercial organizations do not use EV management
  - Because IT projects do not have good planning information, tracking performance against a plan might produce misleading information
  - Estimating percentage completion of tasks might also produce misleading information.
    - What does it mean to say a task is 75% complete after 3 months? 1 more month is needed to finish? Will finish after spending an additional 25% of the planned budget? Could very well be no to both of those question.
  - To simply EV management,
    - Use percentage completion of 0(not started), 50 (in progress) and 100 (completed)
    - Or, enter and collect EV data at summary levels of the WBS

# 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 prjects 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

# 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