Chapter 4
Project Cost Management

Note: read PMBOK 6th edition

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** (the additional percentage or dollar amount by which actual costs exceed estimates) ranged from 180 percent in 1994 to 43 percent in 2010
- A 2011 Harvard Business Review study reported an average cost overrun of 27 percent. The most important finding was the discovery of a large number of gigantic overages or “black swans”

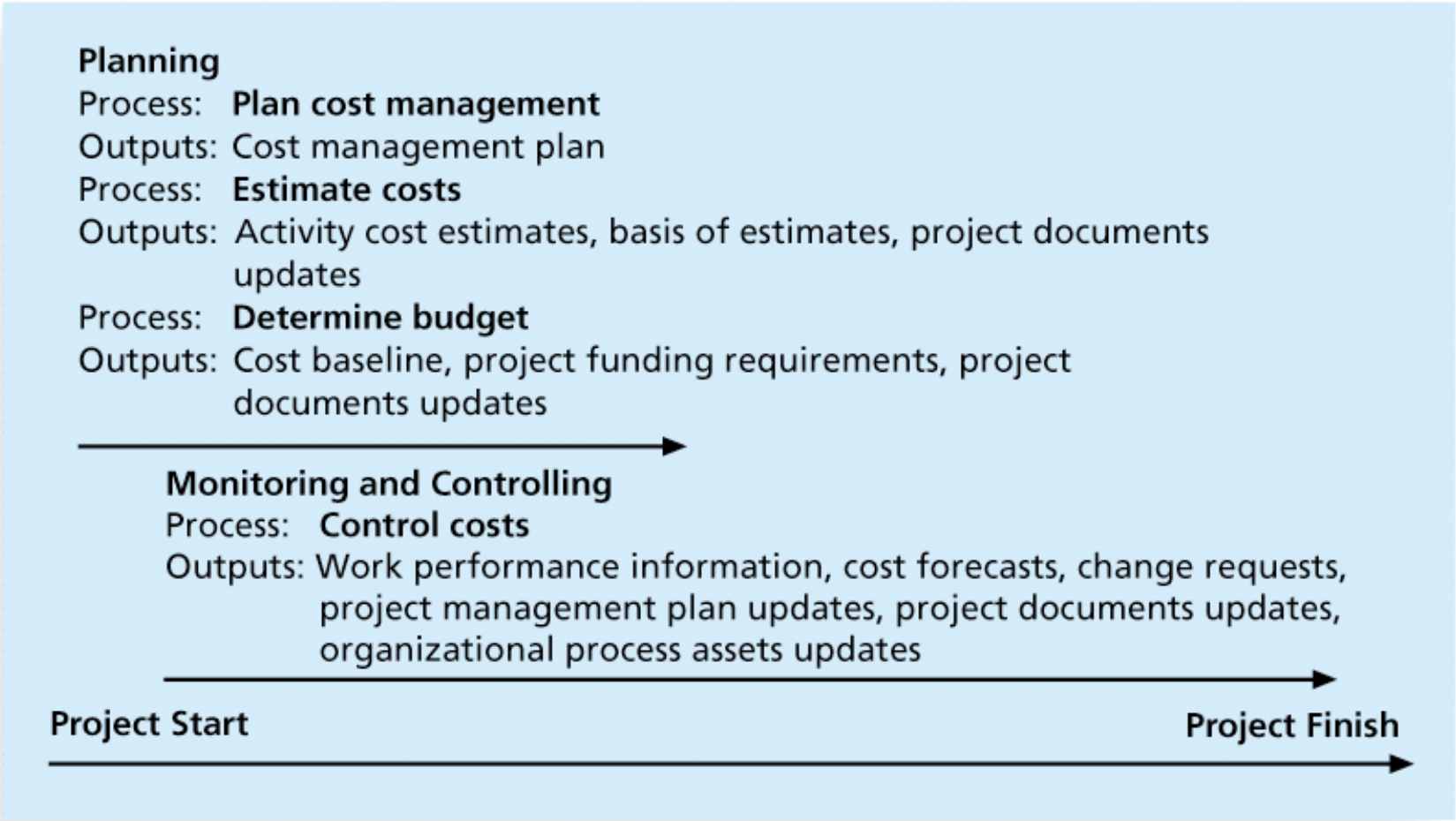
What is Cost and Project Cost Management?

- **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 Cost Management Processes

- **Planning cost management** :determining the policies, procedures, and documentation that will be used for planning, executing, and controlling project cost.
- **Estimating costs:** developing an approximation or estimate of the costs of the resources needed to complete a project
- **Determining the budget:** allocating the overall cost estimate to individual work items to establish a baseline for measuring performance
- **Controlling costs:** controlling changes to the project budget

Figure 7-1.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
  - **Life cycle costing** considers the total cost of ownership, or development plus support costs, for a project
  - **Cash flow analysis** determines the estimated annual costs and benefits for a project and the resulting annual cash flow

Types of Costs and Benefits

- **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
- **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, but are indirectly related to performing 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

More 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
- It is used for predicting cost reductions, estimating future performance, and improving processes.
- **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
  - **Management reserves** allow for future situations that are unpredictable (sometimes called **unknown unknowns**

Planning Cost Management

- The project team uses expert judgment, analytical techniques, and meetings to develop the cost management plan
- A cost management plan includes:
  - Level of accuracy and units of measure
  - Organizational procedure links
  - Control thresholds
  - Rules of performance measurement
  - Reporting formats
  - Process descriptions

Estimating Costs

- 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

Table 7-2. 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%

Example Table 7-2

- A ROM estimate s 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. For example, the actual cost for a project with a ROM estimate of $100,000 could range between $50,000 to $200,000.

Example Table 7-2

- The accuracy of budgetary estimates is typically -10 percent to +25 percent, meaning the actual costs could be 10 percent less or 25 percent more than the budgetary estimate.
- For example, the actual cost for a project with a budgetary estimate of $100,000 could range between $90,000 to $125,000.

Example Table 7-2

- The accuracy of this type of estimate is normally -5 percent to +10 percent, meaning the actual costs could be 5 percent less or 10 percent more than the definitive estimate.
- For example, the actual cost for a project with a definitive estimate of $100,000 could range between $95,000 to $110,000. Table 7-2 summarizes the three basic types of cost estimates.

More on Cost Estimates

- The number and type of cost estimates vary by application area. The Association for the Advancement of Cost Engineering International identifies five types of cost estimates for construction projects: order of magnitude, conceptual, preliminary, definitive, and control
- Estimates are usually done at various stages of a project and should become more accurate as time progresses
- A large percentage of total project costs are often labor costs

Table 7-3. Maximum FTE by Department by Year

Department	Year 1	Year 2	Year 3	Year 4	Year 5	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(1)

- 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
  - For example, estimators often try to find a similar project and then customize/modify it for known differences. However, if the project to be estimated involves a new programming language or working with a new type of hardware or network, the analogous estimate technique could easily result in too low an estimate.

Cost Estimation Tools and Techniques(2)

- **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

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- A parametric model might provide an estimate of $50 per **line of code called KLCO(Kilo Lines of Code)** for a software development project based on the programming language the project is using, the level of expertise of the programmers, the size and complexity of the data involved, and so on.
- Parametric models are most **reliable** when the historical information that was used to create the model is **accurate**, the **parameters are readily quantifiable**, and the model is **flexible** in terms of the size of the project.

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- Parametric models that are more complicated are usually computerized.
- See the Suggested Readings on the companion Web site for examples of parametric models, such as the **COCOMO (Constructive Cost Model) model.**

➢ The COCOMO (Constructive Cost Model) is a software cost estimation model developed by Dr. Barry Boehm. It helps predict the effort, cost, and schedule required for a software development project based on the size of the software and a set of cost drivers. The model has two main versions: COCOMO I (developed in 1981) and the more advanced COCOMO II (developed in the 1990s).

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- **In practice, many people find that using a combination or hybrid approach involving analogous, bottom up, and/or parametric modeling provides the best cost estimates.**

Typical Problems with IT Cost Estimates

- Estimates are done too quickly
- People lack estimating experience
- Human beings are biased toward underestimation
- Management desires accuracy

Sample Cost Estimate

- See pages chapter-7 for a detailed example of creating a cost estimate for the Surveyor Pro project described in the opening case
- Before creating an estimate, know what it will be used for, gather as much information as possible, and clarify the ground rules and assumptions for the estimate
- If possible, estimate costs by major WBS categories
- Create a cost model to make it easy to make changes to and document the estimate

Figure 7-2. Surveyor Pro Project Cost Estimate

Surveyor Pro Project Cost Estimate Created October 5

	# Units/Hrs.	Cost/Unit/Hr.	Subtotals	WBS Level 2 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.

Figure 7-3. Surveyor Pro Software Development Estimate

Surveyor Pro Software Development Estimate Created October 5

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).

Determining the Budget

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

Figure 7-4. Surveyor Pro Project Cost Baseline

Surveyor Pro Project Cost Baseline Created October 10*

WBS Items	1	2	3	4	5	6	7	8	9	10	11	12	Totals
1. Project Management													
1.1 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
1.2 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
1.3 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													
5.1 Trainee cost									50,000				50,000
5.2 Travel cost									8,400				8,400
5.3 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

*See the lecture slides for this chapter on the companion Web site for a larger view of this and other figures in this chapter. Numbers are rounded, so some totals appear to be off.

Controlling Costs

- 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

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
- 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)/**budget**, also called the budget, is that portion of the approved total cost estimate planned to be spent on an activity during a given period

- Suppose a project included a summary activity of purchasing and installing a new Web server. Suppose further that, according to the plan, it would take one week and cost a total of $10,000 for the labor hours, hardware, and software involved. The planned value (PV) for that activity that week is, therefore, $10,000.

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- **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

- For example, suppose it actually took two weeks and cost $20,000 to purchase and install the new Web server. Assume that $15,000 of these actual costs were incurred during Week 1 and $5,000 was incurred during Week 2. These amounts are the actual cost (AC) for the activity each week.

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- 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 percent complete and only 50 percent of that work has been completed

Table 7-4. 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%

Cont'd

$$EV = 10{,}000 * 50\% = 5{,}000$$

$$CV = 5{,}000 - 15{,}000 = -10{,}000$$

$$SV = 5{,}000 - 10{,}000 = -5{,}000$$

$$CPI = 5{,}000/15{,}000 = 33\%$$

$$SPI = 5{,}000/10{,}000 = 50\%$$

Formula	
	$EV = PV * SPI$
	$CV = EV - AC$
	$SV = EV - PV$
	$CPI = \frac{EV}{AC} * 100$
	$SPI = \frac{EV}{PV} * 100$
	$EAC = = \frac{BAC}{CPI}$

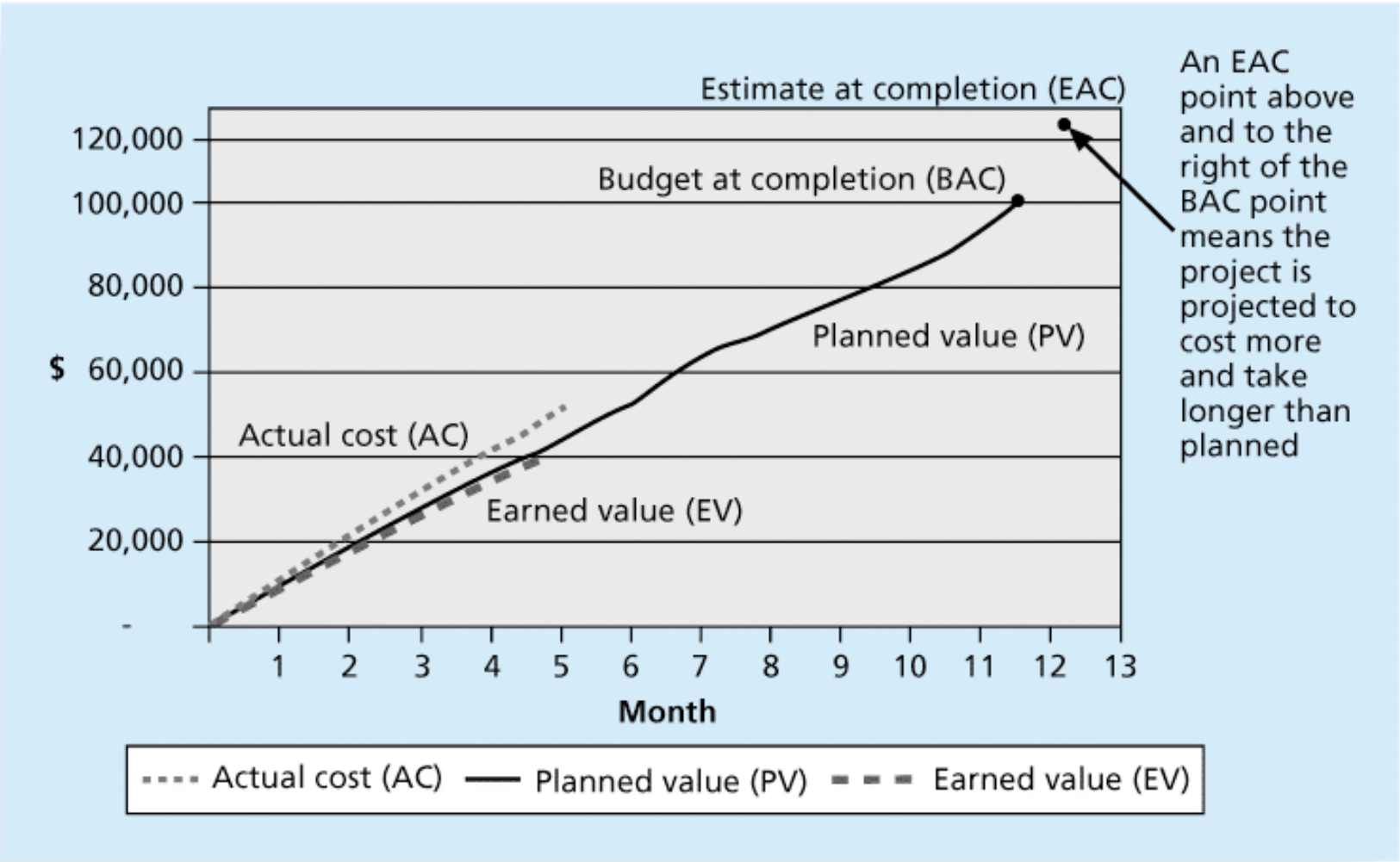
Table 7-5. Earned Value Formulas

Term	Formula
Earned value (EV)	EV = PV to date * RP
Cost variance (CV)	CV = EV – AC
Schedule variance (SV)	SV = EV – PV
Cost performance index (CPI)	CPI = EV/AC
Schedule performance index (SPI)	SPI = EV/PV
Estimate at completion (EAC)	EAC = BAC/CPI
Estimated time to complete	Original time estimate/SPI

Rules of Thumb for Earned Value Numbers

- Negative numbers for cost and schedule variance indicate problems in those areas
- CPI and SPI less than 100% indicate problems
- Problems mean the project is costing more than planned (over budget) or taking longer than planned (behind schedule)
- The CPI can be used to calculate the **estimate at completion** (EAC)—an estimate of what it will cost to complete the project based on performance to date. The **budget at completion** (BAC) is the original total budget for the project

Figure 7-5. Earned Value Chart for Project after Five Months



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
- **Portfolio management software** can help reduce costs

Chapter Summary

- Project cost management is a traditionally weak area of IT projects, and project managers must work to improve their ability to deliver projects within approved budgets
- Main processes include
  - Plan cost management
  - Estimate costs
  - Determine the budget
  - Control costs

End of chapter 4