unit IV

7

Project Cost Management

OPENING CASE

Juan Gonzales was a systems analyst and network specialist for a major city's waterworks department in Mexico. He enjoyed helping the city develop its infrastructure. His next career objective was to become a project manager so he could have even more influence. One of his colleagues invited him to attend an important project review meeting for large government projects, including the Surveyor Pro project, in which Juan was most interested. The Surveyor Pro project was a concept for developing a sophisticated information system that included expert systems, object-oriented databases, and wireless communications. The system would provide instant, graphical information to government surveyors to help them do their jobs. For example, after a surveyor touched a map on the screen of a handheld device, the system would prompt him or her for the type of information needed for that area. This system would help in planning and implementing many projects, from laying fiber-optic cable to laying water lines.

Juan was very surprised, however, when the majority of the meeting was spent discussing cost-related issues. The government officials were reviewing many existing projects to evaluate their performance to date and the potential impact on their budgets before discussing the funding for any new projects. Juan did not understand many of the terms and charts the presenters were showing. What was this earned value term they kept referring to? How were they estimating what it would cost to complete projects or how long it would take? Juan thought he would learn more about the new technologies the Surveyor Pro project would use, but he discovered that the cost estimate and projected benefits were of most interest to the government officials at the meeting. It also seemed as if a lot of effort would go toward detailed financial studies before any technical work could even start. Juan wished he had taken some accounting and finance courses so he could understand the acronyms and concepts people were discussing. Although Juan had a degree in electrical engineering, he had no formal education, and little experience in finance. If Juan could understand information systems and networks, he was confident that he could understand financial issues on projects, too. He jotted down questions to discuss with his colleagues after the meeting.

THE IMPORTANCE OF PROJECT COST MANAGEMENT

Just as information technology projects have a poor track record in meeting project goals, they also have a poor track record in meeting budget goals. The Standish Group's CHAOS studies reported an average cost overrun—the additional percentage or dollar amount by which actual costs exceed estimates—for unsuccessful IT projects ranged from 180 percent in 1994 to 43 percent in 2002. Although academic researchers question the validity of these numbers, more rigorous, scientifically reviewed studies still acknowledge the problem of cost overruns for IT projects. For example, three separate surveys of software project cost overruns done by Jenkins, Phan, and Bergeron in 1984, 1988, and 1992, respectively, found that the average cost overrun for all of the projects in their survey samples (not just unsuccessful projects) were 33–34 percent.[1] Obviously, there is room for improvement in meeting cost goals for IT projects. This chapter describes important concepts in project cost management, particularly, creating good estimates and using earned value management (EVM) to assist in cost control.

What is Cost?

A popular cost accounting textbook states, "Accountants usually define cost as a resource sacrificed or foregone to achieve a specific objective."[7] Webster's dictionary defines cost as "something given up in exchange." Costs are often measured in monetary amounts, such as dollars, that must be paid to acquire goods and services. Because projects cost money and consume resources that could be used elsewhere, it is very important for project managers to understand project cost management.

Many information technology professionals, however, often react to cost overrun information with a smirk. They know that many of the original cost estimates for information technology projects are low to begin with or based on very unclear project requirements, so naturally there will be cost overruns. Not emphasizing the importance of realistic project cost estimates from the outset is only one part of the problem. In addition, many information technology professionals think preparing cost estimates is a job for accountants. On the contrary, preparing good cost estimates is a very demanding, important skill that many professionals need to acquire.

Another perceived reason for cost overruns is that many information technology projects involve new technology or business processes. Any new technology or business process is untested and has inherent risks. Thus, costs grow and failures are to be expected, right? Wrong. Using good project cost management can change this false perception.

What is Project Cost Management?

Recall from Chapter 1 that the triple constraint of project management involves balancing scope, time, and cost goals. Chapters 5 and 6 discuss project scope and time management, and this chapter describes project cost management. Project cost management includes the processes required to ensure that a project team completes a project within an approved budget. Notice two crucial phrases in this definition: "a project" and "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. It is the project manager's job to satisfy project stakeholders while continuously striving to reduce and control costs. There are three project cost management processes:

1. Cost estimating involves developing an approximation or estimate of the costs of the resources needed to complete a project. The main outputs of the cost estimating process are activity cost estimates and supporting detail, requested changes, and updates to the cost management plan. According to the

PMBOK® Guide Third Edition, the cost management plan should be created as part of the project management plan under project integration management.

2. Cost budgeting involves allocating the overall cost estimate to individual work items to establish a baseline for measuring performance. The main outputs of the cost budgeting process are a cost baseline, project funding requirements, requested changes, and updates to the cost management plan.
3. Cost control involves controlling changes to the project budget. The main outputs of the cost control process are performance measurements, forecasted completion information, requested changes, recommended corrective actions, and updates to the project management plan (which includes the cost management plan), cost estimate, cost baseline, and organizational process assets.

Figure 7-1 summarizes these processes and outputs, showing when they occur in a typical project.

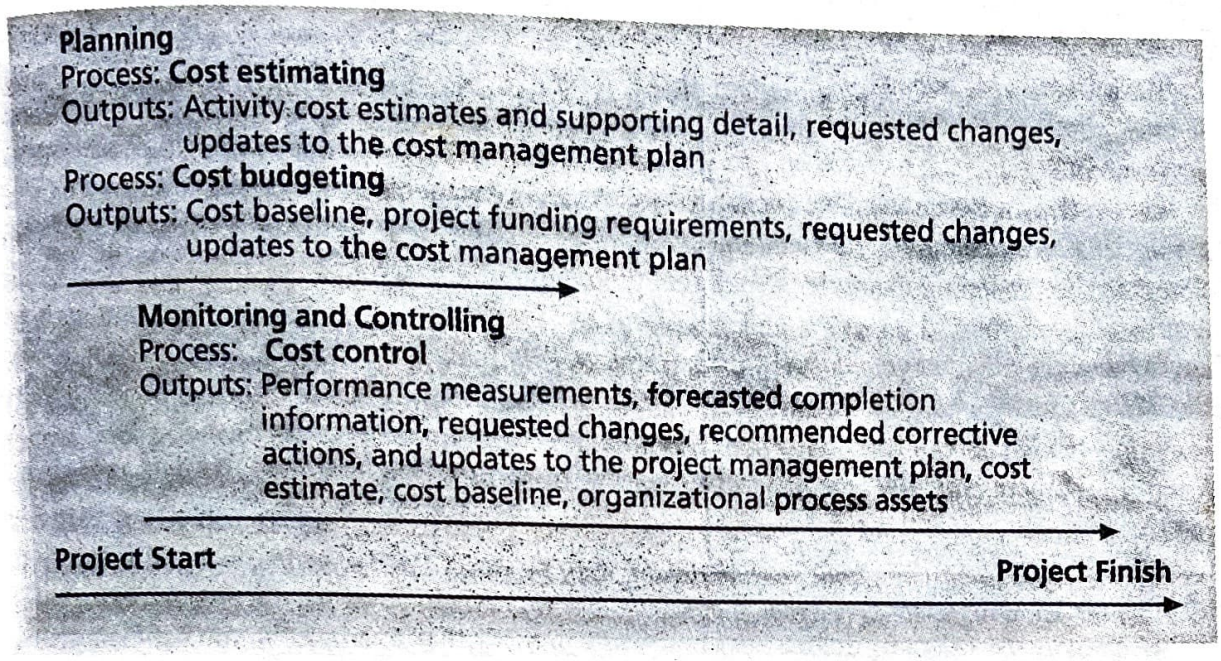

Figure 7-1. Project Cost Management Summary

To understand each of the project cost management processes, you must first understand the basic principles of cost management. Many of these principles are not unique to project management; however, project managers need to understand how these principles relate to their specific projects.

BASIC PRINCIPLES OF COST MANAGEMENT

Many information technology projects are never initiated because information technology professionals do not understand the importance of basic accounting and finance principles. Important concepts, such as net present value analysis, return on investment, and payback analysis were discussed in Chapter 4, Project Integration Management. Likewise, many projects that are started never finish because of cost management problems. Most members of an executive board have a better understanding of and are more interested in financial terms than information technology terms. Therefore, information technology project managers need to be able to present and discuss project information in financial terms as well as in technical terms. In addition to net present value analysis, return on investment, and payback analysis, project managers must understand several other cost management principles, con-cepts, and terms. This section describes general

topics such as profits, life cycle costing, cash flow analysis, tangible and intangible costs and benefits, direct costs, sunk costs, learning curve theory, and reserves. Another important topic and one of the key tools and techniques for controlling project costs—earned value management—is described in detail in the section on cost control.

Profits are revenues minus expenditures. To increase profits, a company can increase revenues, decrease expenses, or try to do both. Most executives are more concerned with profits than with other issues. When justifying investments in new information systems and technology, it is important to focus on the impact on profits, not just revenues or expenses. Consider an e-commerce application that you estimate will increase revenues for a $100 million company by 10 percent. You cannot measure the potential benefits of the e-commerce application without knowing the profit margin. Profit margin is the ratio of revenues to profits. If revenues of $100 generate $2 in profits, there is a 2 percent profit margin. If the company loses $2 for every $100 in revenue, there is a –2 percent profit margin.

Life cycle costing allows you to see a big-picture view of the cost of a project throughout its life cycle. This helps you develop an accurate projection of a project's financial costs and benefits. Life cycle costing considers the total cost of ownership, or development plus support costs, for a project. For example, a company might complete a project to develop and implement a new customer service system in one or two years, but the new system could be in place for ten years. Project managers, with assistance from financial experts in their organizations, should create estimates of the costs and benefits of the project for its entire life cycle, or ten years in the preceding example. Recall that the net present value analysis for the project would include the entire ten-year period of costs and benefits (see Chapter 4). Top management and project managers need to consider the life cycle costs of projects when they make financial decisions.

Organizations have a history of not spending enough money in the early phases of information technology projects, which impacts total cost of ownership. For example, it is much more cost-effective to spend money on defining user requirements and doing early testing on information technology projects than to wait for problems to appear after implementation. Table 7-1 summarizes the typical costs of correcting software defects during different phases of the systems development life cycle. A report by the National Institute of Standards and Technology (NIST) supports the idea that it is better to find and fix software defects early. They suggest the relative cost to repair defects, as shown in Table 7-1. For example, if you estimate that it would cost $1000 to repair a software defect in the requirements and analysis phase, it would cost $30,000 to fix it in the post-product release phase.

Table 7-1: Costs of software defects[3]

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.

What Went Right?

A good example of how understanding costs can improve the bottom line comes from a leading telecommunications equipment company. It 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 also 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. These bugs cost the company more than $15 million. The company decided it had to reduce these costs, so it implemented an automated inspection process. The results were reduced costs for fixing bugs of more than $11 million.[4]

Organizations often purchase information technology products and services to help reduce costs and improve operations. For example, Drug Trading Company, Limited, a Canadian retail pharmacy services company, reduced information technology costs and achieved tighter customer and partner relationships by using J.D. Edwards software (an enterprise/supply chain solution now owned by Oracle). The company can now respond faster to customer requests, with a lower total cost of ownership (TCO). "We're targeting a very quick ROI and a significant reduction in TCO—by as much as 40 percent—once we're in full production with J.D. Edwards. Our strategic objectives are to improve the supply pipeline and provide convenient 24X7 communications channels for customers and vendors," says Grant Schwartz, Corporate Director of IT for Drug Trading Company.[5]

Cash flow analysis is a method for determining the estimated annual costs and benefits for a project and the resulting *annual* cash flow. Project managers must conduct cash flow analysis to determine net present value. Most consumers understand the basic concept of cash flow. If they do not have enough money in their wallets or checking accounts, they cannot purchase something. Top management must consider cash flow concerns when selecting projects in which to invest. If top management selects too many projects that have high cash flow needs in the same year, the company will not be able to support all of its projects and maintain its profitability. It is also important to define clearly the year on which the company bases the dollar amounts. For example, if a company bases all costs on 2008 estimates, it would need to account for inflation and other factors when projecting costs and benefits in future-year dollars.

Tangible and intangible costs and benefits are categories for determining how definable the estimated costs and benefits are for a project. Tangible costs or benefits are those costs or benefits that an organization can easily measure in dollars. For example, suppose the Surveyor Pro project described in the opening case included a preliminary feasibility study. If a company completed this study for $100,000, the tangible cost of the study is $100,000. If Juan's government estimated that it would have cost $150,000 to do the study itself, the tangible benefits of the study would be $50,000 if it assigned the people who would have done the study to other projects. Conversely, intangible costs or benefits are costs or benefits that are difficult to measure in monetary terms. Suppose Juan and a few other people, out of personal interest, spent some time using government-owned computers, books, and other resources to research areas related to the study. Although their hours and the government-owned materials were not billed to the project, they could be considered intangible costs. Intangible benefits for projects often include items like goodwill, prestige, and general statements of improved productivity that an organization cannot easily translate into dollar amounts. Because intangible costs and benefits are difficult to quantify, they are often harder to justify.

Direct costs are costs that can be directly related to producing the products and services of the project. You can attribute direct costs directly to a certain project. For example, the salaries of people working full time on the project and the cost of hardware and software purchased specifically for the project are direct costs. Project managers should focus on direct costs, since they can control them.

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. For example, the cost of electricity, paper towels, and so on in a large building housing a thousand employees who work on many projects would be indirect costs. Indirect costs are allocated to projects, and project managers have very little control over them.

Sunk cost is money that has been spent in the past. Consider it gone, like a sunken ship that can never be returned. When deciding what projects to invest in or continue, you should not include sunk costs. For example, in the opening case, suppose Juan's office had spent $1 million on a project over the past three years to create a geographic information system, but they never produced anything valuable. If his government were evaluating what projects to fund next year and someone suggested that they keep funding the geographic information system project because they had already spent $1 million on it, he or she would be incorrectly making sunk cost a key factor in the project selection decision. Many people fall into the trap of

considering how much money has been spent on a failing project and, therefore, hate to stop spending money on it. This trap is similar to gamblers not wanting to stop gambling because they have already lost money. Sunk costs should be forgotten.

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. For example, suppose the Surveyor Pro project would potentially produce 1000 handheld devices that could run the new software and access information via satellite. The cost of the first handheld device or unit would be much higher than the cost of the 1000th unit. Learning curve theory should help estimate costs on projects involving the production of large quantities of items. Learning curve theory also applies to the amount of time it takes to complete some tasks. For example, the first time a new employee performs a specific task, it will probably take longer than the tenth time that employee performs a very similar task.

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. For example, if an organization knows it has a 20 percent rate of turnover for information technology personnel, it should include contingency reserves to pay for recruiting and training costs for information technology personnel. Management reserves allow for future situations that are unpredictable (sometimes called unknown unknowns). For example, if a project manager gets sick for two weeks or an important supplier goes out of business, management reserve could be set aside to cover the resulting costs.

COST ESTIMATING

Project managers must take cost estimates seriously if they want to complete projects within budget constraints. After developing a good resource requirements list, project managers and their project teams must develop several estimates of the costs for these resources. Recall from Chapter 6 that an important process in project time management is activity resource estimating, which provides a list of activity resource requirements. For example, if an activity on a project is to perform a particular type of test, the list of activity resource requirements would describe the skill level of the people needed to perform the test, the number of people and hours suggested to perform the activity, the need for special software or equipment, and so on. All of this information is required to develop a good cost estimate. This section describes various types of cost estimates, tools and techniques for cost estimation, typical problems associated with information technology cost estimates, and a detailed example of a cost estimate for an information technology project.

Types of Cost Estimates

One of the main outputs of project cost management is a cost estimate. Project managers normally prepare several types of cost estimates for most projects. Three basic types of estimates include the following:

- A rough order of magnitude (ROM) estimate provides an estimate of what a project will cost. ROM estimates can also be referred to as a ballpark estimate, a guesstimate, a swag, or a broad gauge. This type of estimate is done very early in a project or even before a project is officially started. Project managers and top management use this estimate to help make project selection decisions. The timeframe for this type of estimate is often three or more years prior to project completion. 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, a ROM estimate for a project that actually cost $100,000 would range between $50,000 to $200,000. For information technology project estimates, this accuracy

range is often much wider. Many information technology professionals automatically double estimates for software development because of the history of cost overruns on information technology projects.

- 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 percent to +25 percent, meaning the actual costs could be 10 percent less or 25 percent more than the budgetary estimate. For example, a budgetary estimate for a project that actually costs $100,000 would range between $90,000 to $125,000.
- A definitive estimate provides an accurate estimate of project costs. 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. A definitive estimate should be the most accurate of the three types of estimates. 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, a definitive estimate for a project that actually costs $100,000 would range between $95,000 to $110,000. Table 7-2 summarizes the three basic types of 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%

The number and type of cost estimates vary by application area. For example, 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. The main point is that estimates are usually done at various stages of a project and should become more accurate as time progresses.

In addition to creating cost estimates, it is also important to provide supporting details for the estimates. The supporting details include the ground rules and assumptions used in creating the estimate, a description of the project (scope statement, WBS, and so on) used as a basis for the estimate, and details on the cost estimation tools and techniques used to create the estimate. These supporting details should make it easier to prepare an updated estimate or similar estimate as needed.

A cost management plan is a document that describes how the organization will manage cost variances on the project. For example, if a definitive cost estimate provides the basis for evaluating supplier cost proposals for all or part of a project, the cost management plan describes how to respond to proposals that are higher or lower than the estimates. Some organizations assume that a cost proposal within 10 percent of the estimate is acceptable and only negotiate items that are more than 10 percent higher or 20 percent lower than the estimated costs. The cost management plan is part of the overall project management plan described in Chapter 4, Project Integration Management.

Another important consideration in preparing cost estimates is labor costs, because a large percentage of total project costs are often labor costs. Many organizations estimate the number of people or hours they need by department or skill over the life cycle of a project. For example, when Northwest Airlines developed initial cost estimates for its reservation system project, ResNet, it determined the maximum number of people it could assign to the project each year by department. Table 7-3 shows this information. (Figure 9-7 in Chapter 9, Project Human Resource Management, provides similar resource information in graphical form, where the number of resources are provided by job category, such as business analyst, programmer, and so on.) Note the small number of contractors Northwest Airlines planned to use. Labor costs are often much higher for contractors, so it is important to distinguish between internal and external resources. (See the companion Web site for this text to read the detailed case study on ResNet, including cost estimates.)

Table 7-3: Maximum Departmental Headcounts 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

As you can imagine, developing a good cost estimate is difficult. Fortunately, there are several tools and techniques available to assist in creating one. Commonly used tools and techniques include analogous cost estimating, bottom-up estimating, parametric modeling, resource cost rates, project management software, vendor bid analysis, and reserve analysis.

Analogous estimates, also called top-down estimates, use the actual cost of a previous, similar project as the basis for estimating the cost of the current project. This technique requires a good deal of expert judgment and is generally less costly than others are, but it is also less accurate. Analogous estimates are most reliable when the previous projects are similar in fact, not just in appearance. In addition, the groups preparing cost estimates must have the needed expertise to determine whether certain parts of the project will be more or less expensive than analogous projects. 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.

Bottom-up estimates involve estimating individual work items or activi-ties and summing them to get a project total. It is sometimes referred to as Activity Based Costing. The size of the individual work items and the experi-ence of the estimators drive the accuracy of the estimates. If a detailed WBS is available for a project, the project manager could have each person responsible for a work package develop his or her own cost estimate for that work package, or at least an estimate of the amount of resources required. Someone in the financial area of an organization often provides resource cost rates, such as labor rates or costs per pound of materials, which can be entered into project management software to calculate costs. The software automatically calculates information to create cost estimates for each level of the WBS and finally for the entire project. See Appendix A's section on project cost management for detailed information on entering resource costs and assigning resources to tasks to create a bottom-up estimate using Project 2007. Using smaller work items increases the accuracy of the cost estimate because the people assigned to do the work

develop the cost estimate instead of someone unfamiliar with the work. The drawback with bottom-up estimates is that they are usually time-intensive and therefore expensive to develop.

Parametric modeling uses project characteristics (parameters) in a mathematical model to estimate project costs. A parametric model might provide an estimate of $50 per line 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. For example, in the 1980s, engineers at McDonnell Douglas Corporation (now part of Boeing) developed a parametric model for estimating aircraft costs based on a large historical database. The model included the following parameters: the type of aircraft (fighter aircraft, cargo aircraft, or passenger aircraft), how fast the plane would fly, the thrust-to-weight ratio of the engine, the estimated weights of various parts of the aircraft, the number of aircraft produced, the amount of time available to produce them, and so on. In contrast to this sophisticated model, some parametric models involve very simple heuristics or rules of thumb. For example, a large office automation project might use a ballpark figure of $10,000 per workstation based on a history of similar office automation projects developed during the same time period. 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 II model. 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.

Other considerations to make when preparing cost estimates are how much to include in reserves, as described earlier, the cost of quality, described in Chapter 8, Project Quality Management, and other cost estimating methods such as vendor bid analysis, as described in Chapter 12, Project Procurement Management.

Typical Problems with Information Technology Cost Estimates

Although there are many tools and techniques to assist in creating project cost estimates, many information technology project cost estimates are still very inaccurate, especially those involving new technologies or software develop-ment. Tom DeMarco, a well-known author on software development, suggests four reasons for these inaccuracies and some ways to overcome them.[6]

1. *Estimates are done too quickly:* Developing an estimate for a large software project is a complex task requiring a significant amount of effort. Many estimates must be done quickly and before clear system requirements have been produced. For example, the Surveyor Pro project described in the opening case involves a lot of complex software development. Before fully understanding what information surveyors really need in the system, someone would have to create a ROM estimate and budgetary estimates for this project. Rarely are the more precise, later estimates less than the earlier estimates for information technology projects. It is important to remember that estimates are done at various stages of the project, and project managers need to explain the rationale for each estimate.
2. *Lack of estimating experience.* The people who develop software cost estimates often do not have much experience with cost estimation, especially for large projects. There is also not enough accurate, reliable project data available on which to base estimates. If an organization uses good project management techniques and develops a history of keeping reliable project information, including estimates, it should help improve the organization's estimates. Enabling information technology people to receive training and mentoring on cost estimating will also improve cost estimates.
3. *Human beings are biased toward underestimation.* For example, senior information technology professionals or project managers might make estimates based on their own abilities and forget that many junior people will

be working on a project. Estimators might also forget to allow for extra costs needed for integration and testing on large information technology projects. It is important for project managers and top management to review estimates and ask important questions to make sure the estimates are not biased.

4. *Management desires accuracy.* Management might ask for an estimate, but really wants a more accurate number to help them create a bid to win a major contract or get internal funding. This problem is similar to the situation discussed in Chapter 6, Project Time Management, in which top managers or other stakeholders want project schedules to be shorter than the estimates. It is important for project managers to help develop good cost and schedule estimates and to use their leadership and negotiation skills to stand by those estimates.

It is also important to be cautious with initial estimates. Top management never forgets the first estimate and rarely, if ever, remembers how approved changes affect the estimate. It is a never-ending and crucial process to keep top management informed about revised cost estimates. It should be a formal process, albeit a possibly painful one.

Sample Cost Estimate

One of the best ways to learn how the cost estimating process works is by studying sample cost estimates. Every cost estimate is unique, just as every project is unique. You can see a short sample cost estimate in Chapter 3 for JWD Consulting's Project Management Intranet Site Project. You can also view the ResNet cost estimate on the companion Web site for this text.

This section includes a step-by-step approach for developing a cost estimate for the Surveyor Pro project described in the opening case. Of course, it is much shorter and simpler than a real cost estimate would be, but it illustrates a process to follow and uses several of the tools and techniques described earlier. For more detailed information on creating a cost estimate, see the NASA Cost Estimating Handbook and other references provided in the Suggested Readings on the companion Web site.

Before beginning any cost estimate, you must first gather as much information as possible about the project and ask how the organization plans to use the cost estimate. If the cost estimate will be the basis for contract awards and performance reporting, it should be a definitive estimate and as accurate as possible, as described earlier.

It is also important to clarify the ground rules and assumptions for the estimate. For the Surveyor Pro project cost estimate, these include the following:

- This project was preceded by a detailed study and proof of concept to show that it was possible to develop the hardware and software needed by surveyors and link the new devices to existing information systems. The proof of concept project produced a prototype handheld device and much of the software to provide basic functionality and link to the Global Positioning Systems (GPS) and other government databases used by surveyors. There is some data available to help estimate future labor costs, especially for the software development. There is also some data to help estimate the cost of the handheld devices.
- The main goal of this project is to produce 100 handheld devices, continue developing the software (especially the user interface), test the new system in the field, and train 100 surveyors in selected cities on how to use the new system. A follow-up contract is expected for a much larger number of devices based on the success of this project.
- There is a WBS for the project, as shown below:

It is very important to have several people review the project cost estimate. It is also helpful to analyze the total dollar value as well as the percentage of the total amount for each major WBS category. For example, a senior executive could quickly look at the Surveyor Pro project cost estimate and decide if the numbers are reasonable and the assumptions are well documented. In this case, the government had budgeted $1.5 million for the project, so the estimate was right in line with that amount. The WBS Level 1 items also seemed to be at appropriate percentages of the total cost based on similar past projects. In some cases, a project team might also be asked to provide a range estimate for each item instead of one discrete amount. For example, they might estimate that the testing costs will be between $60,000 and $80,000 and document their assumptions in determining those values. It is also import to update cost estimates, especially if any major changes occur on a project.

After the total cost estimate is approved, the team can then allocate costs for each month based on the project schedule and when costs will be incurred. Many organizations also require that the estimated costs be allocated into certain budget categories, as described in the next section.

COST BUDGETING

Project cost budgeting involves allocating the project cost estimate to individual work items over time. These work items are based on the work breakdown structure for the project. The WBS, therefore, is a required input to the cost budgeting process. Likewise, the project scope statement, WBS dictionary, activity cost estimates and supporting detail, project schedule, resource calendars, contracts, and cost management plan also provide useful information for cost budgeting. The main goal of the cost budgeting process is to produce a cost baseline for measuring project performance and project funding requirements. It may also result in requested changes to the project and updates to the cost management plan to help meet project cost constraints.

For example, the Surveyor Pro project team could use the cost estimate from Figure 7-2 along with the project schedule and other information to allocate costs for each month. Figure 7-4 provides an example of a cost baseline for this project. Again, it's important for the team to document assumptions they made when developing the cost baseline and have several experts review it.

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

*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.

Figure 7-4. Surveyor Pro Project Cost Baseline

Most organizations have a well-established process for preparing budgets. For example, many organizations require budget estimates to include the number of full-time equivalent (FTE) staff, often referred to as headcount, for each month of the project. This number provides the basis for estimating total

compensation costs each year. Many organizations also want to know the amount of money projected to be paid to suppliers for their labor costs or other purchased goods and services. Other common budget categories include travel, depreciation, rents/leases, and other supplies and expenses. It is important to understand these budget categories before developing an estimate to make sure data is collected accordingly. Organizations use this information to track costs across projects and non-project work and look for ways to reduce costs. They also use the information for legal and tax purposes.

In addition to providing input for budgetary estimates, cost budgeting provides a cost baseline. A cost baseline is a time-phased budget that project managers use to measure and monitor cost performance. Estimating costs for each major project activity over time provides project managers and top management with a foundation for project cost control, as described in the next section. See Appendix A for information on using Project 2007 for cost control.

Cost budgeting, as well as requested changes or clarifications, may result in updates to the cost management plan, a subsidiary part of the project management plan. Cost budgeting also provides information for project funding requirements. For example, some projects have all funds available when the project begins, but others must rely on periodic funding to avoid cash flow problems. If the cost baseline shows that more funds are required in certain months than are expected to be available, the organization must make adjustments to avoid financial problems.

COST CONTROL

Project cost control includes monitoring cost performance, ensuring that only appropriate project changes are included in a revised cost baseline, and informing project stakeholders of authorized changes to the project that will affect costs. The cost baseline, performance reports, change requests, and project funding requirements are inputs to the cost control process. Outputs of this process are project management plan updates, corrective action, revised estimates for project completion, requested changes, and updates to organizational process assets, such as lessons-learned documents.

Several tools and techniques assist in project cost control. As shown in Appendix A, Project 2007 has many cost management features to help you enter budgeted costs, set a baseline, enter actuals, calculate variances, and run various cost reports. In addition to using software, however, there must be some change control system to define procedures for changing the cost baseline. This cost control change system is part of the integrated change control system described in Chapter 4, Project Integration Management. Since many projects do not progress exactly as planned, new or revised cost estimates are often required, as are estimates to evaluate alternate courses of action. Performance review meetings can be a powerful tool for helping to control project costs. People often perform better when they know they must report on their progress. Another very important tool for cost control is performance measurement. Although many general accounting approaches are available for measuring cost performance, earned value management (EVM) is a very powerful cost control technique that is unique to the field of project management.

Earned Value Management

Earned value management (EVM) is a project performance measurement technique that integrates scope, time, and cost data. Given a cost performance baseline, project managers and their teams can determine how well the project is meeting scope, time, and cost goals by entering actual information and then comparing it to the baseline. A baseline is the original project plan plus approved changes. Actual information includes whether or not a WBS item was completed or approximately how much of the work was completed, when the work actually started and ended, and how much it actually cost to do the completed work.