# CHAPTER 7

## Determining Costs, Budget, and Earned Value



## Chapter Concepts

- Estimating the costs of activities
- Determining a time-phased baseline budget
- Determining the earned value of the work performed
- Analyzing cost performance
- Forecasting project cost at completion
- Controlling project costs
- Managing cash flow

## Learning Outcomes

- Estimate the cost of activities
- Aggregate the total budgeted cost
- Develop a time-phased baseline budget
- Describe how to accumulate actual costs
- Determine the earned value of work performed
- Calculate and analyze key project performance measures
- Discuss and apply approaches to control the project budget
- Explain the importance of managing cash flow



## Estimate Activity Costs

### Elements

- Labor
- Materials
- Equipment
- Facilities
- Subcontractors and consultants
- Travel
- Reserve

### Good Practices

- Have the person responsible estimate costs
- Use historical data to inform current project
- Be reasonable and realistic
- Estimate near-term activities more accurately
- Elaborate other costs as additional information known

# Consumer Market Study Project Estimated Costs

**FIGURE 7.1** Estimated Activity Costs for Consumer Market Study Project

| ACTIVITY | NAME | WORK DAYS | LABOR $ RATE | LABOR COSTS | MATERIALS COSTS | TRAVEL COSTS | TOTAL COSTS |
|---|---|---|---|---|---|---|---|
| 1. Identify Target Consumers | Susan | 3 | $260 | $780 | | | $780 |
| 2. Develop Draft Questionnaire | Susan | 10 | 260 | 2,600 | | | 2,600 |
| 3. Pilot-Test Questionnaire | Susan | 20 | 260 | 5,200 | | $3,000 | 8,200 |
| 4. Review Comments & Finalize Questionnaire | Susan | 5 | 260 | 1,300 | | | 1,300 |
| 5. Prepare Mailing Labels | Steve | 2 | 200 | 400 | | | 400 |
| 6. Print Questionnaire | Steve | 1 | 200 | 200 | $1,700 | | 1,900 |
| 7. Develop Data Analysis Software | Andy | 12 | 300 | 3,600 | | | 3,600 |
| 8. Develop Software Test Data | Susan | 2 | 260 | 520 | | | 520 |
| 9. Mail Questionnaire & Get Responses | Steve | 5 | 200 | 1,000 | 7,800 | | 8,800 |
| 10. Test Software | Andy | 5 | 300 | 1,500 | | | 1,500 |
| 11. Input Response Data | Jim | 7 | 400 | 2,800 | | | 2,800 |
| 12. Analyze Results | Jim | 8 | 400 | 3,200 | | | 3,200 |
| 13. Prepare Report | Jim | 10 | 400 | 4,000 | | | 4,000 |
| | | **90** | | **$27,100** | **$9,500** | **$3,000** | **$39,600** |



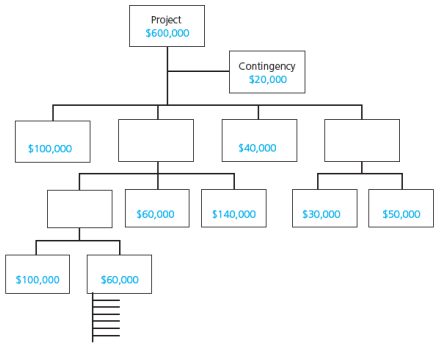
## Possible responses to Student Discussion

- Describe the two steps of the project budgeting process.
  - First step
    - Allocate costs to the work packages in the work breakdown structure
  - Second step
    - Distribute the cost of the work package over the duration of the work package

# Aggregate Total Budgeted Cost

- Establish a TBC for each work package
- Determine the process
  - Top-down
  - Bottom-up
- If sum of initial estimates exceeds sponsor budget, then reduce costs and recalculate

**FIGURE 7.2** Work Breakdown Structure with Work Package Budgets






# Packaging Machine Project Aggregate Total Budgeted Cost

**FIGURE 7.3** Network Diagram for the Packaging Machine Project

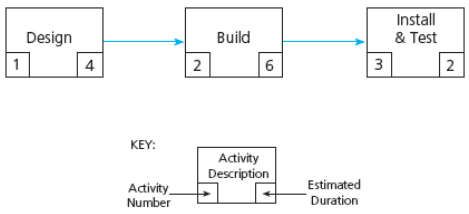
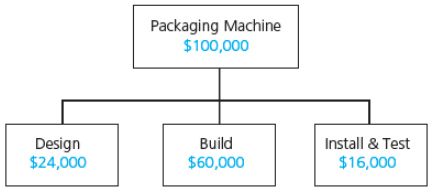



**FIGURE 7.4** Work Breakdown Structure for the Packaging Machine Project



## Develop Cumulative Budgeted Cost

- Distribute each total budgeted cost (TBC) over work package duration
- Create the time-phased budget
- Calculate cumulative budgeted cost
- Provides a baseline against which actual cost and work performance are measured



## Packaging Machine Project
## Develop Cumulative Budgeted Cost

- Determine budgeted cost by period

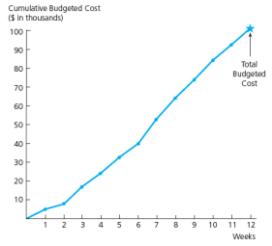
**FIGURE 7.5** Budgeted Cost by Period for the Packaging Machine Project

| | | Week | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TBC | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Design | 24 | 4 | 4 | 8 | 8 | | | | | | | | |
| Build | 60 | | | | | 8 | 8 | 12 | 12 | 10 | 10 | | |
| Install & Test | 16 | | | | | | | | | | | 8 | 8 |
| Total | 100 | 4 | 4 | 8 | 8 | 8 | 8 | 12 | 12 | 10 | 10 | 8 | 8 |
| **Cumulative** | | **4** | **8** | **16** | **24** | **32** | **40** | **52** | **64** | **74** | **84** | **92** | **100** |

Amounts are in thousands of dollars.

- Graph the cumulative budgeted cost curve

**FIGURE 7.6** Cumulative Budgeted Cost Curve for the Packaging Machine Project



# Determine Actual Cost

- Actual Cost
  - Collect data regularly for funds actually expended
  - Charge to work package numbers
- Committed Costs
  - Periodically assign portion of total cost to actual cost
  - Include costs for items that will be paid for later
- Compare Actual Cost To Budgeted Cost
  - Calculate cumulative actual cost
  - Compare to cumulative budgeted cost



# Packaging Machine Project Determine Actual Cost

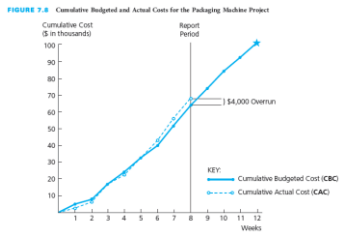
- End of Week 8
  - Planned cost = $64,000
  - Actual cost = $68,000

**FIGURE 7.7** Actual Cost by Period for the Packaging Machine Project

| | Week | | | | | | | | Total Expended |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| Design | 2 | 5 | 9 | 5 | 1 | | | | 22 |
| Build | | | | 2 | 8 | 10 | 14 | 12 | 46 |
| Install & Test | | | | | | | | | 0 |
| Total | 2 | 5 | 9 | 7 | 9 | 10 | 14 | 12 | **68** |
| **Cumulative** | **2** | **7** | **16** | **23** | **32** | **42** | **56** | **68** | **68** |

Amounts are in thousands of dollars.

- Compare CAC with CBC



# Determine Value of Work Performed

### Example Project

- Paint 10 similar rooms
- Total budgeted cost of $2,000
- Budget is $200 per room

### At Day 5

- $1,000 has been spent
- 3 rooms have been painted
- Earned value =

  0.30 X $2,000 = $600
- Have expended $400 more than the Earned Value



# Packaging Machine Project
# Determine Value of Work Performed

**FIGURE 7.9** Cumulative Percent Complete by Period for the Packaging Machine Project

| | Week | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Design | 10 | 25 | 80 | 90 | 100 | 100 | 100 | 100 |
| Build | 0 | 0 | 0 | 5 | 15 | 25 | 40 | 50 |
| Install & Test | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

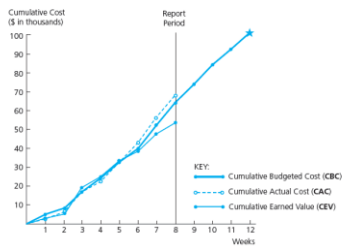
Amounts are cumulative percent complete.

**FIGURE 7.10** Cumulative Earned Value by Period for the Packaging Machine Project

| | | Week | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | TBC | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Design | 24 | 2.4 | 6 | 19.2 | 21.6 | 24 | 24 | 24 | 24 |
| Build | 60 | | | | 3 | 9 | 15 | 24 | 30 |
| Install & Test | 16 | | | | | | | | |
| **Cumulative** | 100 | **2.4** | **6** | **19.2** | **24.6** | **33** | **39** | **48** | **54** |

Amounts are in thousands of dollars.

**FIGURE 7.11** Cumulative Budgeted and Cumulative Actual Costs and Cumulative Earned Value for the Packaging Machine Project



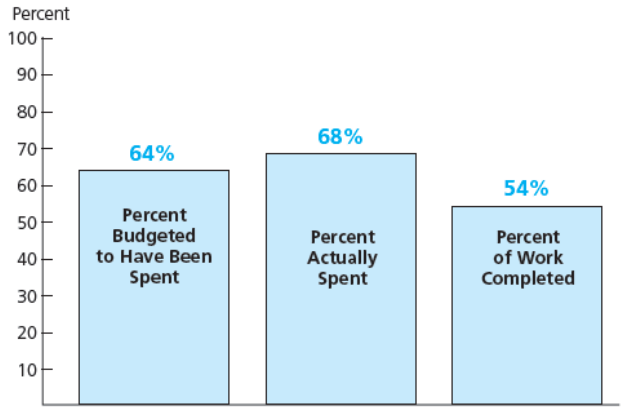
## Analyze Cost Performance

- Four cost-related measures
  - TBC – total budgeted cost
  - CBC – cumulative budgeted cost
  - CAC – cumulative actual cost
  - CEV – cumulative earned value
- Use to analyze project cost performance
- Plot CBC, CAC, and CEV curves on the same graph
  - Reveal any trends toward improving or deteriorating cost performance



## Packaging Machine Project Analyze Cost Performance

**FIGURE 7.12** Packaging Machine Project Status as of Week 8



## Cost Performance Index

- Measure of the cost efficiency with which the project is being performed
- Cost performance index =

  Cumulative earned value/Cumulative actual cost

  CPI = CEV/CAC



## Packaging Machine Project Cost Performance Index

**End of Week 8**

- $64,000 was budgeted
- $68,000 was actually expended
- $54,000 was the earned value of work actually performed
- CEV = $54,000
- CAC = $68,000

**Determine CPI**

- CPI = CEV/CAC
  = $54,000/$68,000
  = 0.79

  For every $1.00 actually expended, only $0.79 of earned value was received.

## Cost Variance

- Indicator of cost performance
- Difference between the cumulative earned value of the work performed and the cumulative actual cost

- Cost variance =

  Cumulative earned value – Cumulative actual cost

$$CV = CEV - CAC$$



## Packaging Machine Project Cost Variance

**End of Week 8**

- $64,000 was budgeted
- $68,000 was actually expended
- $54,000 was the earned value of work actually performed

- CEV = $54,000
- CAC = $68,000

**Determine CV**

- CV = CEV – CAC

  = $54,000 – $68,000

  = –$14,000

  The value of the work performed through week 8 is $14,000 less than the amount actually expended.

## Estimate Cost at Completion

- Forecast what the total costs will be at the completion of the project or work package
- 3 different methods
  - FCAC = TBC/CPI
  - FCAC = CAC + (TBC – CEV)
  - FCAC = CAC + Re-estimate of remaining work
- Another method
  - TCPI = (TBC – CEV)/(TBC – CAC)



## Packaging Machine Project Estimate Cost at Completion

### End of Week 8

- $64,000 was budgeted
- $68,000 was actually expended
- $54,000 was the earned value of work actually performed

- CEV = $54,000
- CAC = $68,000
- CPI = 0.79
- TBC = $100,000

### Determine FCAC

- FCAC = TBC / CPI
  = $100,000/0.79 = $126,582

- FCAC = CAC + (TBC – CEV)
  = $68,000 + ($100,000 – $54,000)
  = $68,000 + $46,000
  = $114,000

- TCPI = (TBC – CEV)/(TBC – CAC)

= ($100,000 – $54,000)/( $100,000 – $68,000)
  = $46,000/$32,000
  = 1.44

## Control Costs

- Analyze cost performance on a regular basis
  - Determine which work packages require corrective action
  - Decide what specific corrective action
  - Revise the project plan
- Evaluate negative cost variance
- Take corrective actions
  - Near term activities
  - Activities with large cost estimate
- Reduce costs of activities
- Evaluate the trade-off of cost and scope



## Manage Cash Flow

- Ensure that cash comes in faster than it goes out
- Negotiate payment terms
  - Provide a down payment
  - Make equal monthly payments
  - Provide frequent payments
- Avoid only one payment at end of project
- Control outflow of cash

# Cost Estimating for Information Systems Development

- Common errors in estimating costs
  - Underestimating the work time necessary to complete an activity
  - Requiring rework to meet the user requirements
  - Underestimating growth in the project scope
  - Not anticipating new hardware purchases
  - Making corrections to flaws in excess of the reserve planning
  - Changing the design strategy
  - Increasing resources to fast-track phases of the SDLC



# IS Example: Estimated Activity Costs

**FIGURE 7.13** Estimated Activity Costs for Web-based Reporting System Project

| ACTIVITY | PRIMARY RESPONSIBILITY | WORK DAYS | LABOR COSTS | MATERIALS COSTS | TRAVEL COSTS | TOTAL COSTS |
|---|---|---|---|---|---|---|
| 1. Gather Data | Beth | 3 | $4,440 | | | $4,440 |
| 2. Study Feasibility | Jack | 4 | 7,360 | | | 7,360 |
| 3. Prepare Problem Definition Report | Rose | 1 | 1,000 | | | 1,000 |
| 4. Interview Users | Jim | 5 | 9,200 | | $6,000 | 15,200 |
| 5. Study Existing System | Steve | 8 | 3,200 | | | 3,200 |
| 6. Define User Requirements | Jeff | 5 | 1,600 | | | 1,600 |
| 7. Prepare System Analysis Report | Jim | 1 | 480 | | | 480 |
| 8. Input & Output | Tyler | 8 | 17,280 | | | 17,280 |
| 9. Processing & Database | Joe | 10 | 13,600 | | | 13,600 |
| 10. Evaluation | Cathy | 2 | 3,760 | | | 3,760 |
| 11. Prepare System Design Report | Sharon | 2 | 1,760 | | | 1,760 |
| 12. Software Development | Hannah | 15 | 7,120 | $500 | | 7,620 |
| 13. Hardware Development | Joe | 10 | 9,600 | | | 9,600 |
| 14. Network Development | Gerri | 6 | 2,400 | | | 2,400 |
| 15. Prepare System Development Report | Jack | 2 | 960 | | | 960 |
| 16. Software Testing | Maggie | 6 | 6,720 | | | 6,720 |
| 17. Hardware Testing | Gene | 4 | 5,120 | | | 5,120 |
| 18. Network Testing | Greg | 4 | 5,440 | | | 5,440 |
| 19. Prepare Testing Report | Rose | 1 | 1,760 | | | 1,760 |
| 20. Training | Jim | 4 | 5,760 | 1,300 | | 7,060 |
| 21. System Conversion | Beth | 2 | 1,200 | | | 1,200 |
| 22. Prepare Implementation Report | Jack | 1 | 1,560 | | | 1,560 |
| **Total** | | **104** | **$111,320** | **$1,800** | **$6,000** | **$119,120** |

## Project Management Information Systems

- Store all costs associated with each resource
- Calculate the budget for each work package
- Determine cost for the entire project
- Define different rate structures for each resource
- Analyze cost performance



## Critical Success Factors

- Estimated activity **costs** must be **based on** the estimated **activity resources**.
- The **person** who will be **responsible** for performing the activity should **estimate the costs** for that activity. This generates commitment from the person.
- Cost estimates should be **reasonable and realistic**.
- Once the project starts, it is important to **monitor actual costs and work performance** to ensure that everything is within budget.
- A system should be established to **collect**, on a regular and timely basis, data on **costs actually expended and committed**, and the earned value (percent complete) of the work performed, so they can be compared to the cumulative budgeted cost (CBC).
- If at any time during the project it is determined that the project is overrunning the budget, or the value of the work performed is not keeping up with the actual amount of costs expended, **corrective action must be taken immediately**.

## Critical Success Factors (continued)

- It is important to use the **time-phased cumulative budgeted cost** (CBC), rather than the total budgeted cost (TBC), as the **baseline** against which cumulative actual cost (CAC) is compared. It would be misleading to compare the actual costs expended to the total budgeted cost because cost performance will always look good as long as actual costs are below the TBC.
- To permit a realistic comparison of cumulative actual cost to cumulative budgeted cost, portions of the **committed costs** should be **assigned** to **actual costs** while the associated work is in progress.
- The **earned value** of the work actually performed is a key parameter that must be determined and reported throughout the project.
- For each reporting period, the **percent complete data** should be obtained from the person responsible for the work. It is important that the person make an honest assessment of the work performed relative to the entire work scope.
- One way to prevent inflated percent complete estimates is to keep the work packages or activities small in terms of scope and duration. It is important that the person estimating the percent complete assess not only how much work has been performed but also what **work remains to be done**.



## Critical Success Factors (continued)

- The key to effective cost control is to **analyze cost performance** on a **timely and regular basis**. Early identification of cost variances (CV) allows corrective actions to be taken immediately, before the situation gets worse.
- For analyzing cost performance, it is important that all the **data** collected be as **current as possible** and be based on the same reporting period.
- Trends in the **cost performance index** (CPI) should be monitored carefully. If the CPI goes **below 1.0** or gradually decreases, **corrective action** should be taken.
- As part of the regular cost performance analysis, the estimated or **forecasted cost at completion** (FCAC) should be **calculated**.
- The key to effective cost control is to **aggressively address work packages** or activities **with negative cost variances** and cost inefficiencies as soon as they are identified. A concentrated effort must be applied to these areas. The amount of negative cost variance should determine the priority for applying these concentrated efforts.

## Critical Success Factors (continued)

- When attempting to reduce negative cost variances, **focus on** activities that will be performed in the **near term** and on activities that have **large estimated costs**.
- Addressing cost problems early will **minimize the negative impact** on scope and schedule. Once costs get out of control, getting back within budget becomes more difficult and is likely to require reducing the project scope or quality, or extending the project schedule.
- The key to **managing cash flow** is to ensure that cash comes in faster than it goes out.
- It is desirable to **receive payments** (cash inflow) from the customer as **early as possible**, and to delay making payments (cash outflow) to suppliers or subcontractors as long as possible.



## Summary

- The total project cost is often estimated during the initiating phase of the project when the project charter or a proposal is prepared, but detailed plans are not usually prepared at that time.
- The project budgeting process involves two steps: the budget for each work package is determined and the budget for each work package is then distributed over the expected time.
- Aggregating the estimated costs of the specific activities for the appropriate work packages in the work breakdown structure will establish a total budgeted cost (TBC).
- The cumulative budgeted cost (CBC) is the time-phased baseline budget that will be used to analyze the cost performance of the project.
- At any time during the project, it is possible to forecast what the total costs will be at the completion of the project or work package based on analysis of actual cost expended and the earned value of work performed.
- The key to effective cost control is to analyze cost performance on a regular and timely basis.
- It is important to manage the cash flow on a project.