

Basics of Cost and Schedule Control

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Topics

- Monitoring and Scheduling: Two Parts of a Feedback System.
- Definitions
- Schedule Updates from Monitoring
- Components of Effective Monitoring
- Cost Control As A Management Tool
- Project Cost Control Systems
- Earned Value Method
 - Parameters
 - Example
 - Scenarios

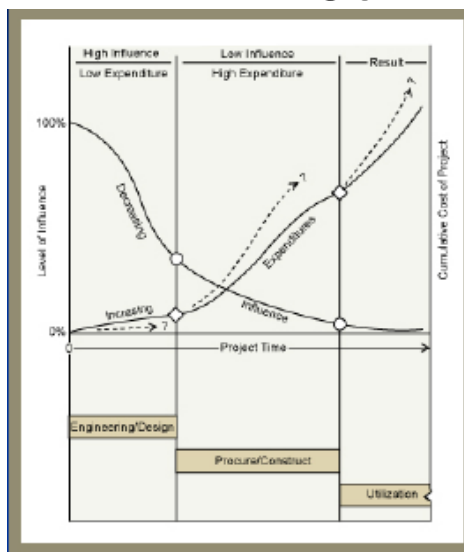
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Monitoring and Control: Two Parts of a Feedback System

- Goal is to *detect* and *correct* deviation from desired
 - Budget
 - Schedule
 - Quality
- Detection: Monitoring
- Correction: Control
 - Much harder than monitoring!!
 - Bring project performance back in line with plans
 - Typical: Bring plans in line with performance

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Growing Expenditures, Declining Control



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Definitions

- **Project Monitoring** is the set of procedures and management practices used to collect information about the performance achieved or forecasted in a project, based on a set of performance metrics.
- **Performance Analysis:** The process of determining performance variances based on monitored or forecasted performance.

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Definitions

- **Project Control:** is the establishment of a system to measure report, and forecast deviations in the project scope, budget, and schedule.
- The purpose of project control is to adjust the project to meet its goals by assessing the performance of the project, analyzing the causes of performance problems, designing changes to address problems that are determined to need attentions and implementing those changes through control actions.
- Project control is distinguished from project planning in two Important ways: 1) project control yields a set of designs, decisions, and actions, whereas project planning yields a design and 2) project control is a real time process during the implementation Not before the implementation begins.

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Schedule Updates from Monitoring

- New estimates for activity
 - Costs
 - Durations
 - Resource availability
- New critical path
 - May lead to changed monitoring priorities
- NB: A schedule that does not get updated to reflect in--field conditions is
 - Unlikely to be used
 - Dangerous if used

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Components of Effective Monitoring

- Representative Performance Metrics (established at planning phase)
- Cost & Schedule Milestones should be well--defined and defined and clearly approved/rejected.
- Reporting Schedule (perhaps of variable Δt 's)
 - Financial importance of activity
 - Activity criticality Rate of work
 - Rate of work
 - Difficulty of work

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Components of Effective Monitoring (Cont'd)

- Management Scheme organized for honestly and accurately identifying and reporting performance
- Involvement of responsible and knowledgeable people in the reporting scheme
- Project Reviews (walkthrough's & inspections)
- Project Audits

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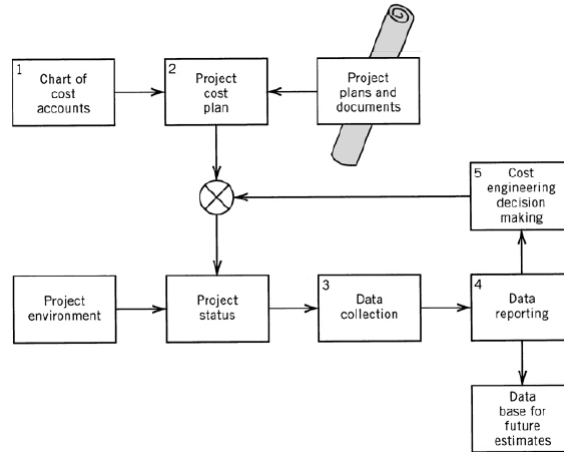
COST CONTROL AS A MANAGEMENT TOOL

- The early detection of actual or potential cost overruns in field construction activities is vital to management.
- It provides the opportunity to initiate remedial action and increases the chance of eliminating such overruns or minimizing their impact.
- Cost overruns increase project costs and diminish profits

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PROJECT COST CONTROL SYSTEMS

1. [Charts of Accounts](#)
2. [Project Cost Plan](#)
3. [Data Collection](#)
4. [Data Reporting](#)
5. [Decision](#)



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COST ACCOUNTS

- The first step in establishing, a cost control system for a construction job is the definition of **project-level cost centers**.
- Their primary function is to divide the total project into significant control units, each consisting of a given type of work that can be measured in the field.
- See [Fig 15.2 Textbook page 254](#).

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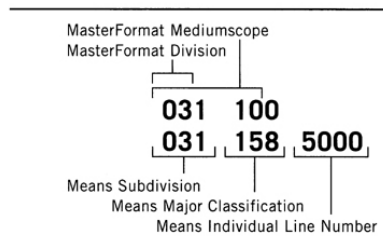
Cost Coding Systems

- A variety of cost coding systems exist in practice, and standard charts of accounts are published by organizations such as the *American Road Builders Association*, *Associated General Contractors*, and the *Construction Specifications Institute*.
- [Table 15.1 Textbook page 255 \(UCI\)](#)
- [Fig 15.3 Textbook page 256.](#)

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PROJECT COST CODE STRUCTURE

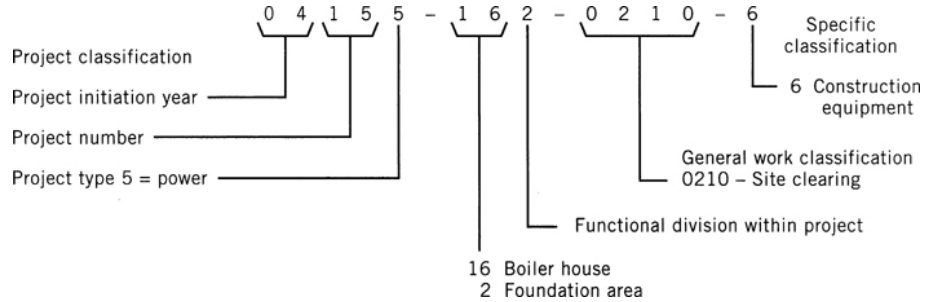
| 031 Concrete Formwork | | | | | | | | | | | |
|-------------------------|---|------|--------------|-------------|------|-----------------|-------|--------|-------|-----------------|------|
| 031 | Struct C.I.P. Formwork | CREW | DAILY OUTPUT | LABOR-HOURS | UNIT | 1996 BARE COSTS | | | | TOTAL INCL. O&P | |
| | | | | | | MAT. | LABOR | EQUIP. | TOTAL | | |
| 158 | FORMS IN PLACE, FOOTINGS Continuous wall, 1 use | | | | C-1 | | | | | | |
| 5000 | Spread footings, 1 use | | | 305 | .105 | SFCA | 1.51 | 2.50 | .09 | 4.10 | 5.75 |



Example from R.S. Means

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Large & Complex Projects



- 1. Labor
- 2. Permanent materials
- 3. Temporary materials
- 4. Installed equipment
- 5. Expendables
- 6. Construction equipment
- 7. Supply
- 8. Subcontract
- 9. Indirect

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Integrated Construction Management

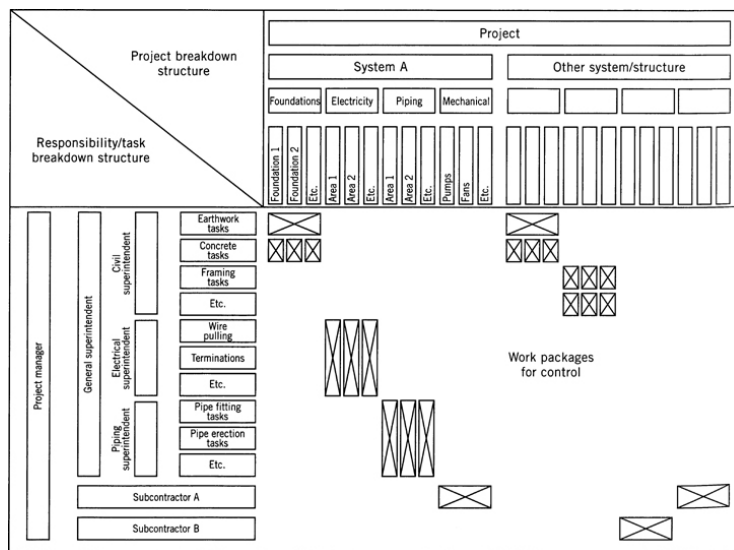
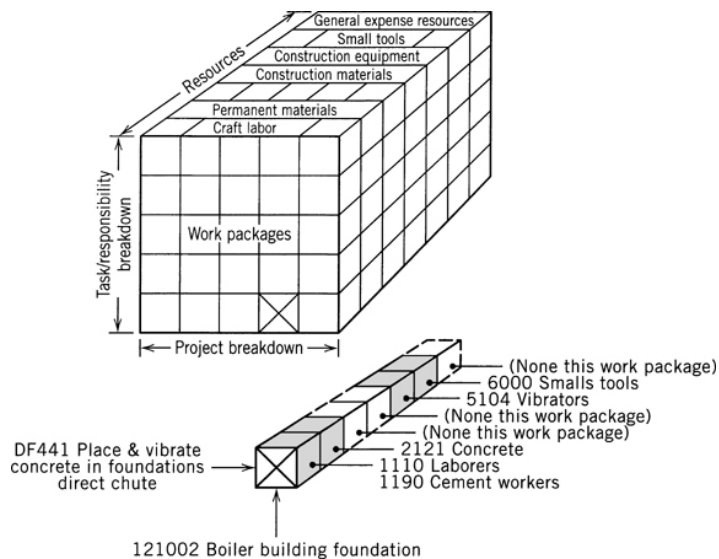


Figure 15.6
(p.259)
Product control matrix.

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Figure 15.7
(p. 259)

Three-dimensional visualization of work-package-oriented cost accounts.



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EARNED VALUE METHOD

- One widely accepted way of calculating progress on complex projects using a work or account based breakdown system.
- This system of determining project progress addresses both schedule status (e.g., on schedule, behind schedule, etc.) and cost status (e.g., over budget, etc.).
- This method of tracking cost and schedule was originally implemented by the Department of Defense in the late 1970s to help better control complex projects. The system was called the Cost and Schedule Control Systems Criteria or C/SCSC.

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Earned Value method parameters

1. **BCWS:** Budgeted Cost of Work Scheduled = Value of the baseline at a given time
2. **ACWP:** Actual Cost of Work Performed - Measured in the field
3. **BCWP:** Budgeted Cost of Work Performed = [% Complete] x BCAC
4. **BCAC:** Budgeted Cost At Completion = Contracted Total Cost for the Work Package
5. **AQWP:** Actual Quantity of Work Performed - Measured in the field
6. **BQAC:** Budgeted Quantity at Completion - Value of the Quantity Baseline as Projected at a given Point.

[See Fig 15-10 textbook page 261](#)

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Earned Value method (Cont'd)

- **Example:** See textbook page 262-264
- **See Figure 15.13** textbook page 265

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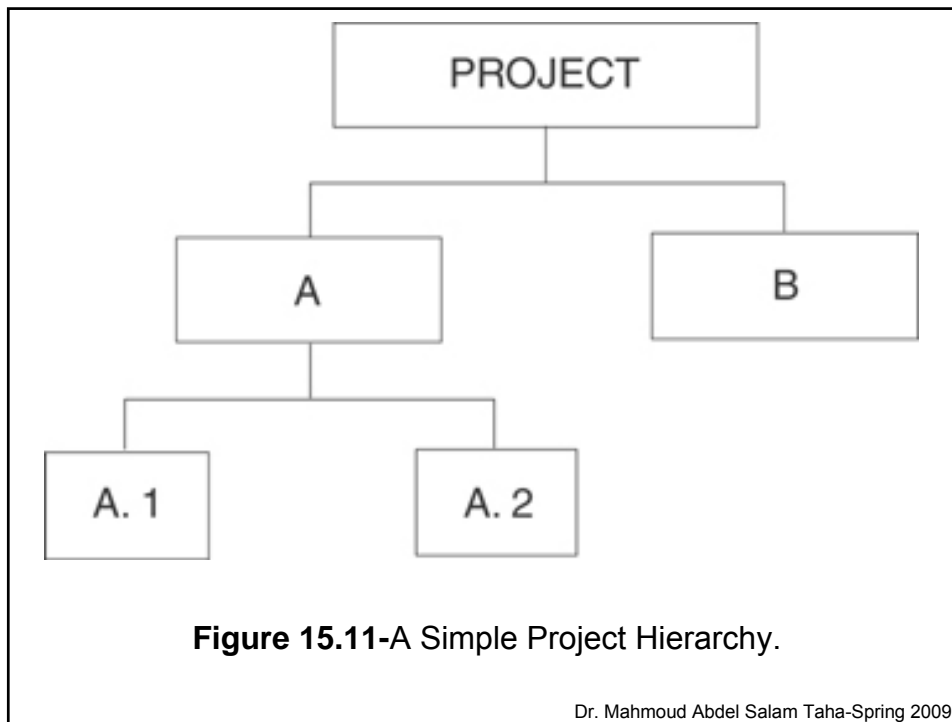


Table 15.2 Study Date Data for Simple Project

| | BCAC | ACWP | BQAC | AQWP | PC (%) | BCWP | ECAC |
|-------|------|------|------|------|--------|-------|-------|
| A | | | | | | | |
| A.1 | 100 | 40 | 105 | 35 | 33.3 | 33.3 | 120 |
| A.2 | 50 | 35 | 77 | 60 | 78.0 | 39.0 | 45 |
| B | 65 | 50 | 125 | 100 | 80.0 | 52.0 | 62.5 |
| TOTAL | 215 | 125 | — | — | 57.8 | 124.3 | 227.5 |

Project PC (PPC) = Total BCWP ÷ Total BCAC = 124.3 ÷ 215 = 57.8%

ECAC_i = Estimated Cost at Completion for Work Package i = ACWP_i ÷ PC_i

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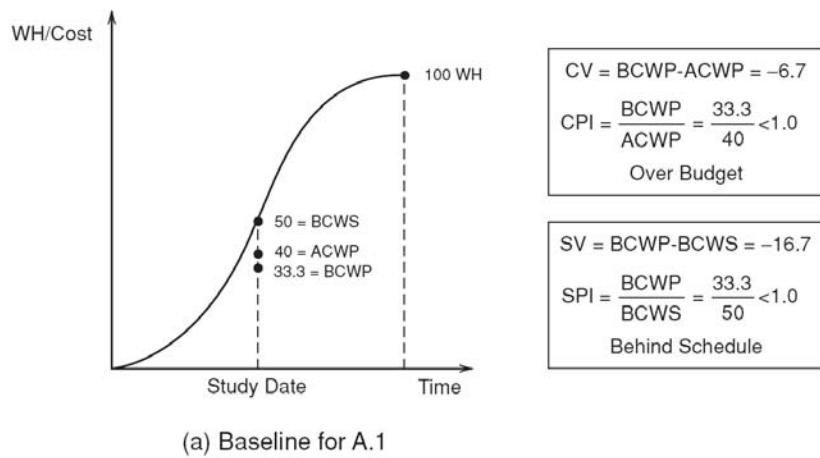


Figure 15.12a (p. 264)

State of Control Account for Single Project (continued on next two slides).

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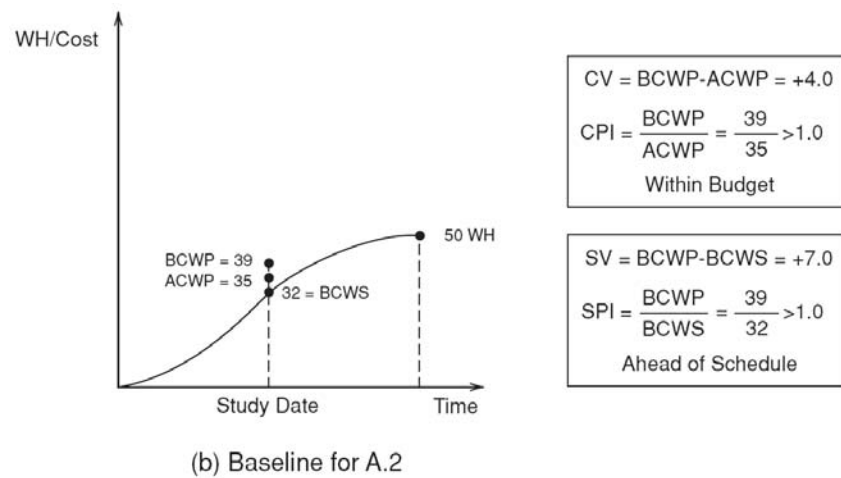
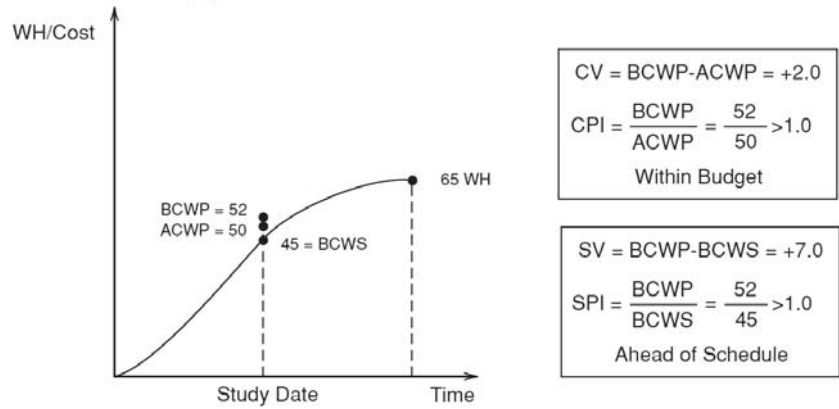


Figure 15.12b (cont.)

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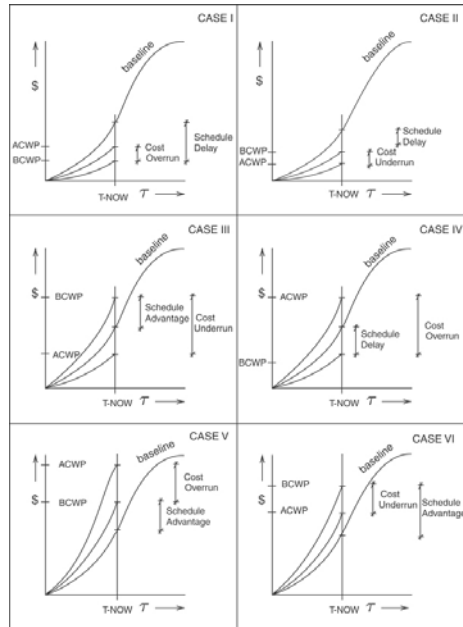


(c) Baseline for B

Figure 15.12c (cont.)

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Figure 15.13 (p. 265)
Scenarios for Permutations
Between ACWP, BCWP, and
BCWS (Singh, 1991).



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Table 15.3 Values of CPI, CV, and SPI, SV for the Six Scenarios (Singh, 1991)

| | | | |
|-----------------------|---------------------|-----------------------|---------------------|
| $CPI < 1$ $CV < 0$ | → overrunning cost | $CPI > 1$ $CV > 0$ | → within budget |
| $SPI < 1$ $SV < 0$ | → behind schedule | $SPI < 1$ $SV < 0$ | → behind schedule |
| CASE I | | CASE II | |
| $CPI > 1$ $CV > 0$ | → within budget | $CPI < 1$ $CV < 0$ | → overrunning cost |
| $SPI > 1$ $SV > 0$ | → ahead of schedule | $SPI < 1$ $SV < 0$ | → behind schedule |
| CASE III | | CASE IV | |
| $CPI < 1$ $CV < 0$ | → overrunning cost | $CPI > 1$ $CV > 0$ | → within budget |
| $SPI > 1$ $SV > 0$ | → ahead of schedule | $SPI > 1$ $SV > 0$ | → ahead of schedule |
| CASE V | | CASE VI | |

Table 15.3 (p. 266)

Values of CPL, CV, and SPI, SV for the Six Scenarios (Singh, 1991).

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Questions!

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1. Chart of Cost Accounts

- What will be the basis adopted for developing estimated project expenditures, and how will this basis be related to the firm's general accounts and accounting functions?
- What will be the level of detail adopted in defining the project cost accounts and how will they interface with other financial accounts?



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2. Project Cost Plan

- *How will* the cost accounts be utilized to allow comparisons between the project estimate and cost plan with actual costs as recorded in the field?
- How will the project budget estimate be related to the construction plan and schedule in the formation of a project cost control framework?



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3. Cost Data Collection

- *How will* cost data be collected and integrated into the cost reporting system?



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4. Project Cost Reporting

- What project cost reports are relevant and required by project management in its cost management of the project?



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5. Cost Engineering

- What cost engineering procedures should project management implement in its efforts to minimize costs?



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Table 15.1 Classification of Accounts: Major Divisions in Uniform Construction Index

| Cost Centers | | | |
|--------------|----------------------------|----|----------------------|
| 0 | Conditions of the contract | 9 | Finishes |
| 1 | General requirements | 10 | Specialties |
| 2 | Site work | 11 | Equipment |
| 3 | Concrete | 12 | Furnishings |
| 4 | Masonry | 13 | Special construction |
| 5 | Metals | 14 | Conveying system |
| 6 | Carpentry | 15 | Mechanical |
| 7 | Moisture prevention | 16 | Electrical |
| 8 | Doors, windows, and glass | | |



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Figure 15.2 (p. 254)
List of typical product expense (cost) accounts.

| MASTER LIST OF PROJECT COST ACCOUNTS Subaccounts of General Ledger Account 80.000 PROJECT EXPENSE | | | |
|---|---------------------------|--------------------------------------|----------------------------------|
| Project Work Accounts 100-999 | | Project Overhead Accounts 700-999 | |
| 100 | Clearing and grubbing | 700 | Project administration |
| 101 | Demolition | .01 | Project manager |
| 102 | Underpinning | .02 | Office engineer |
| 103 | Earth excavation | 701 | Construction supervision |
| 104 | Rock excavation | .01 | Superintendent |
| 105 | Backfill | .02 | Carpenter foreman |
| 115 | Wood structural piles | .03 | Concrete foreman |
| 116 | Steel structural piles | 702 | Project office |
| 117 | Concrete structural piles | .01 | Move in and move out |
| 121 | Steel sheet piling | .02 | Furniture |
| 240 | Concrete, poured | .03 | Supplies |
| .01 | Footings | 703 | Timekeeping and security |
| .05 | Grade beams | .01 | Timekeeper |
| .07 | Slab on grade | .02 | Watchmen |
| .08 | Beams | .03 | Guards |
| .10 | Slab on forms | 705 | Utilities and services |
| .11 | Columns | .01 | Water |
| .12 | Walls | .02 | Gas |
| .16 | Stairs | .03 | Electricity |
| .20 | Expansion joint | .04 | Telephone |
| .40 | Screeds | 710 | Storage facilities |
| .50 | Flat finish | 711 | Temporary fences |
| .51 | Trowel finish | 712 | Temporary bulkheads |
| .60 | Rubbing | 715 | Storage area rental |
| .90 | Curing | 717 | Job sign |
| 245 | Precast concrete | 720 | Drinking water |
| 260 | Concrete forms | 721 | Sanitary facilities |
| .01 | Footings | 722 | Sanitary facilities |
| .05 | Grade beams | 725 | First-aid facilities |
| .07 | Slab on grade | 726 | Temporary lighting |
| .08 | Beams | 730 | Temporary lighting |
| .20 | Face brick | | Protection of adjoining property |
| .60 | Glazed tile | 795 | Drawing |
| 400 | Carpentry | 796 | Engineering |
| 440 | Millwork | 800 | Worker transportation |
| 500 | Miscellaneous metals | 805 | Worker housing |
| .01 | Metal door frames | 810 | Worker feeding |
| .20 | Window sash | 880 | General clean-up |
| .50 | Toilet partitions | 950 | Equipment |
| 560 | Finish hardware | .01 | Move in |
| 620 | Paving | .02 | Set up |
| 680 | Allowances | .03 | Dismantling |
| 685 | Fencing | .04 | Move out |

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Figure 15.3 (p. 256)
Detailed codes for classification within the Uniform Construction Index

| | | | |
|---------------|------------------------------|------------|--------------------------------|
| 0000-0099. | 0 Conditions of the Contract | 0270. | Site Improvements |
| 0000-0099. | unassigned | 0271. | Fences |
| | | 0272. | Playing fields |
| | | 0273. | Fountains |
| 0.100. | 1 General Requirements | 0274. | Irrigation systems |
| 0.101-0109. | Alternates of Project | 0275. | Yard improvements |
| 0.101-0109. | unassigned | 0276-0279. | unassigned |
| 0111-0119. | Schedules and Reports | 0280. | Lawn and Planting |
| 0120. | Scope | 0281. | Soil Preparation |
| 0120. | Samples and Shop | 0282. | Lawns |
| 0121-0129. | Drawings | 0283. | Ground covers and other plants |
| 0130. | Temporary Facilities | 0284. | Trees and shrubs |
| 0134-0139. | unassigned | 0285-0289. | unassigned |
| 0140. | Cleaning Up | 0290. | Railroad Work |
| 0141-0149. | unassigned | 0291-0294. | unassigned |
| 0150. | Project closure | 0295. | Marine Work |
| 0151-0159. | unassigned | 0296. | Boat Facilities |
| 0160. | Allowances | 0297. | Protective Marine Structures |
| 0161-0169. | unassigned | 0298. | Dredging |
| | | 0299. | unassigned |
| 0200. | 2 Site Work | | |
| 0210-0299. | Alternates | | 3 Concrete |
| 0210. | Clearing of Site | 0300. | Alternates |
| 0211. | Dedication | 0301-0309. | unassigned |
| 0212. | Structures moving | 0310. | Concrete Formwork |
| 0213. | Clearing and grubbing | 0311-0319. | unassigned |
| 0214-0219. | unassigned | 0320. | Concrete Reinforcement |
| 0220. | Earthwork | 0321-0329. | unassigned |
| 0221. | Site grading | 0330. | Cast-in-Place Concrete |
| 0222. | Excavating and backfilling | 0331. | Heavyweight aggregate concrete |
| 0223. | Dewatering | 0332. | Lightweight aggregate concrete |
| 0224. | Subdrainage | 0333. | Post-tensioned concrete |
| 0225. | Soil poisoning | 0334. | Nonable concrete |
| 0226. | Soil compaction control | 0335. | Specialty finished concrete |
| 0227. | Soil stabilization | 0336. | Specialty placed concrete |
| 0228-0229. | unassigned | 0337-0339. | unassigned |
| 0230. | Piling | 0340. | Precast Concrete |
| 0231-0234. | unassigned | 0341. | Precast concrete panel |
| 0235. | Caissons | 0342. | Precast structural concrete |
| 0236-0239. | unassigned | 0343. | Precast prestressed concrete |
| 0240. | Shoring and bracing | 0344-0349. | unassigned |
| 0241. | Sheeting | 0350. | Cementitious Decks |
| 0242. | Underpinning | 0351. | Poured gypsum deck |
| 0243-0249. | unassigned | 0352. | Insulating concrete roof decks |
| 0250. | Site drainage | 0353. | Cementitious unit decking |
| 0251-0254. | unassigned | 0354-0399. | unassigned |
| 0255. | Site utilities | | |
| 0256-0259. | unassigned | | |
| 0260. | Roads and Walks | | |
| 0261. | Paving | | |
| 0262. | Curbs and gutters | | |
| 0263. | Walks | | |
| 0264. | Road and parking | | |
| Appurtenances | unassigned | | |
| 0265-0269. | unassigned | | |

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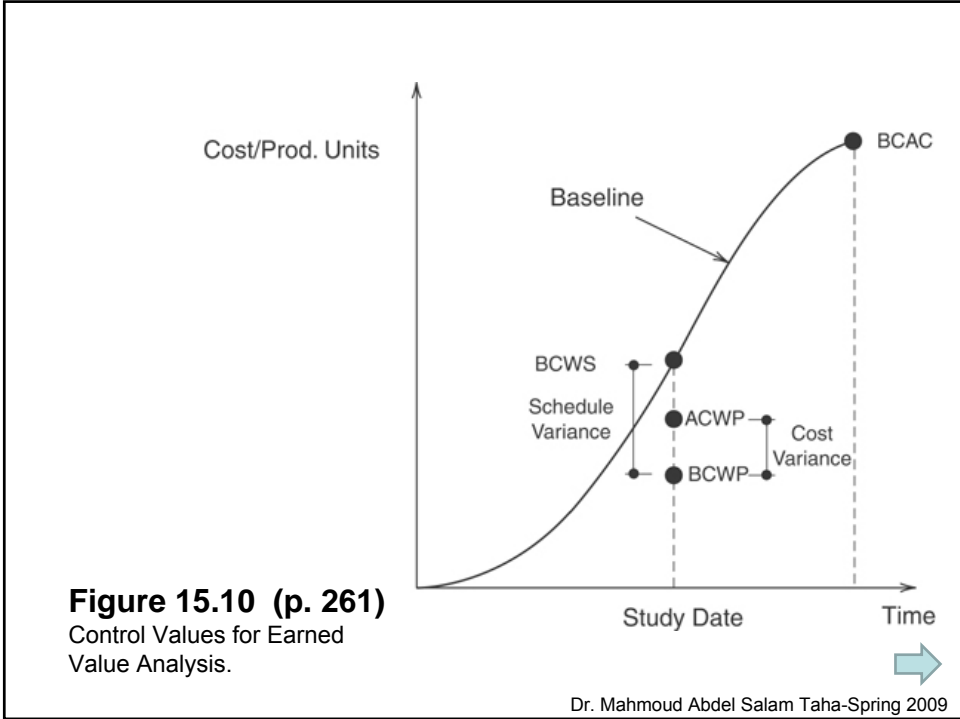


Figure 15.10 (p. 261)
Control Values for Earned Value Analysis.