Basics of Cost and Schedule Control

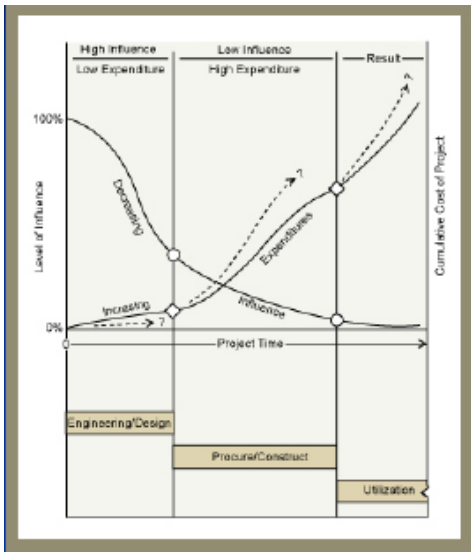
Topics

- 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

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

Growing Expenditures, Declining Control



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.

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.

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

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

Components of Effective Monitoring (Cont'd)

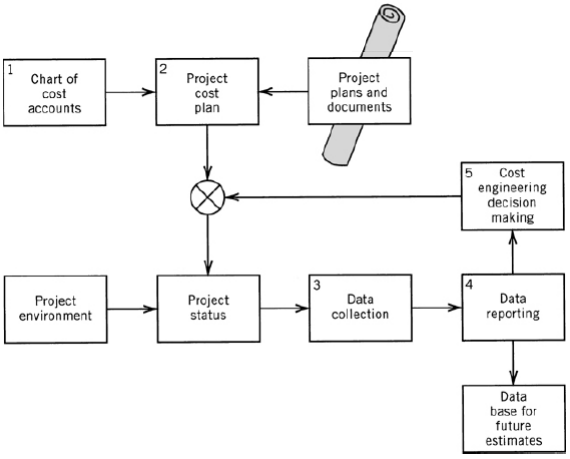
- Management Scheme organized for honestly and accurately identifying and reporting performance
- Involvement of responsible and knowledgeable people in the reporting scheme
- Project Reviews (walkthrough's & inspections)
- Project Audits

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

PROJECT COST CONTROL SYSTEMS

1. Charts of Accounts
2. Project Cost Plan
3. Data Collection
4. Data Reporting
5. Decision



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.*

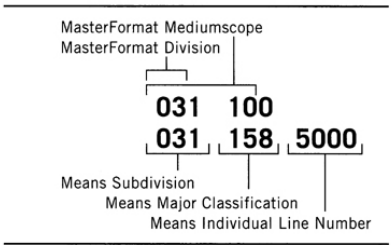
Cost Coding Systems

- 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.*

PROJECT COST CODE STRUCTURE

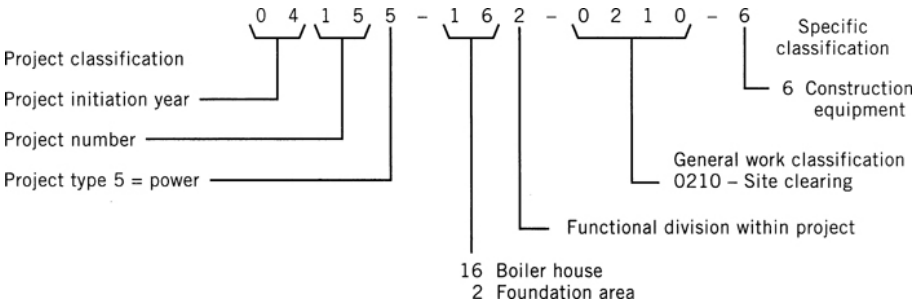
031 | Concrete Formwork

031	Struct C.I.P. Formwork	CREW	DAILY OUTPUT	LABOR-HOURS	UNIT	1996 BARE COSTS MAT.	LABOR	EQUIP.	TOTAL	TOTAL INCL. O&P
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

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

Integrated Construction Management

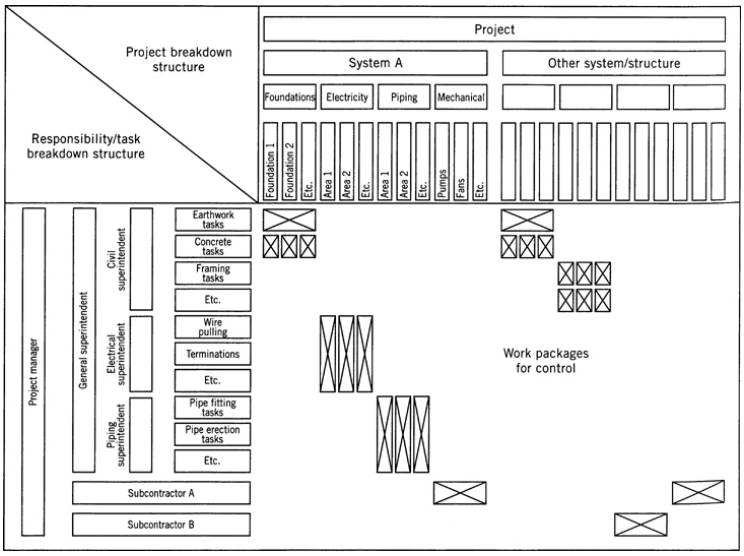
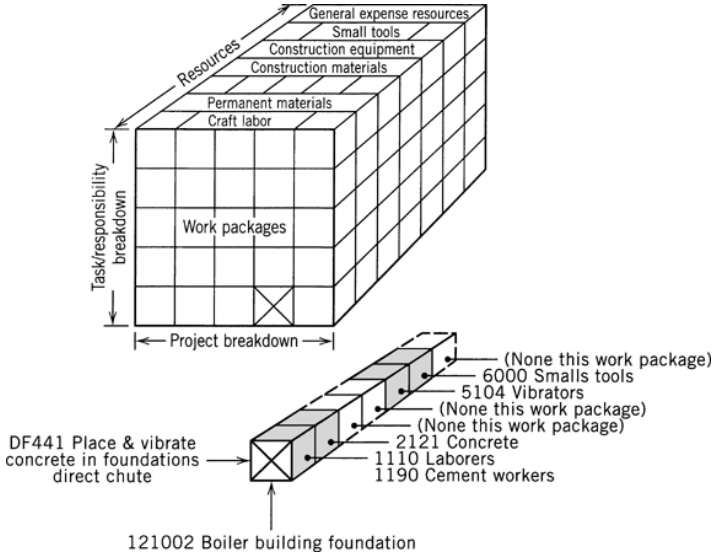


Figure 15.6 (p.259)
Product control matrix.

Figure 15.7 (p. 259)
Three-dimensional visualization of work-package-oriented cost accounts.



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.

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

Earned Value method (Cont'd)

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

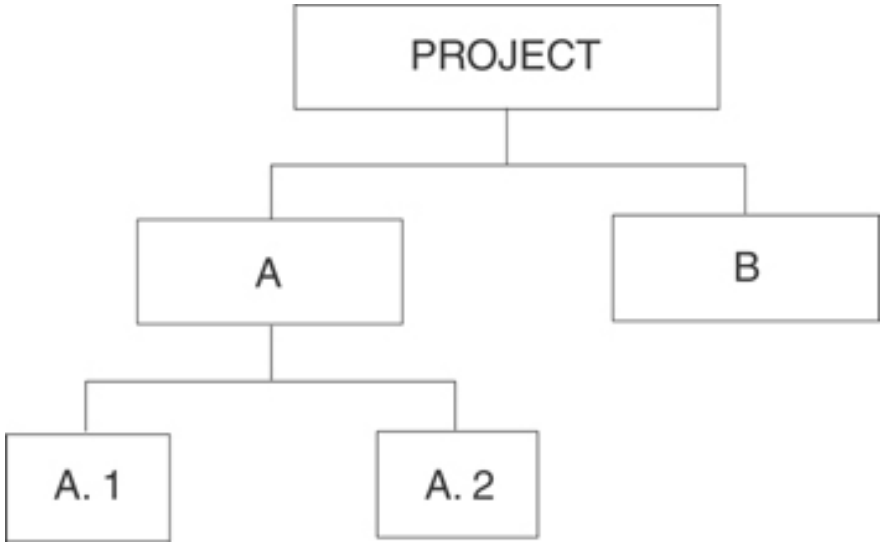
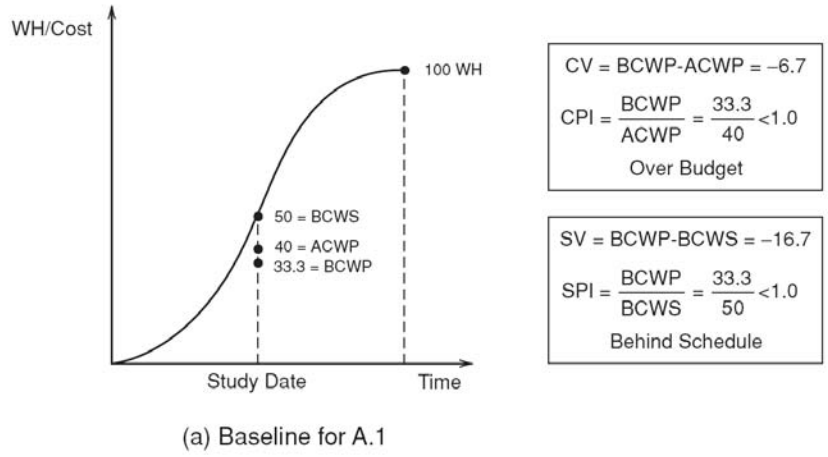


Figure 15.11-A Simple Project Hierarchy.

Table 15.2 Study Date Data for Simple Project

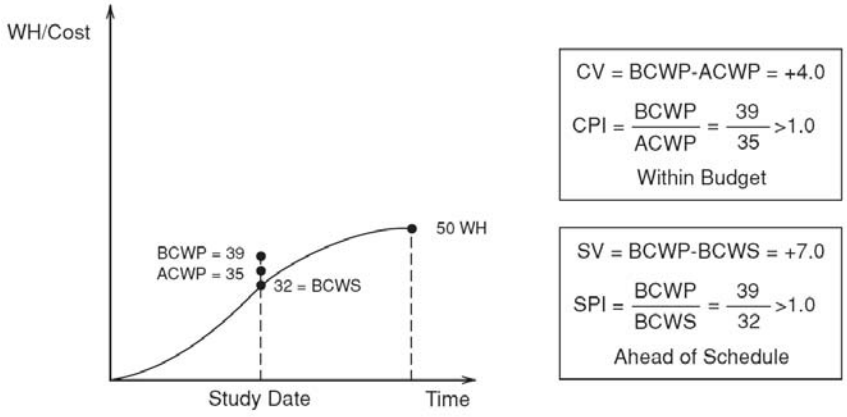
	BCAC	ACWP	BQAC	AQWP	PC (%)	BCWP	ECAC
A							
A.1	100	40	105	35	33.3	33.3	120
A.2	50	35	77	60	78.0	39.0	45
B	65	50	125	100	80.0	52.0	62.5
TOTAL	215	125	—	—	57.8	124.3	227.5

Project PC (PPC) = Total BCWP ÷ Total BCAC = 124.3 ÷ 215 = 57.8%
$ECAC_i$ = Estimated Cost at Completion for Work Package i = $ACWP_i \div PC_i$



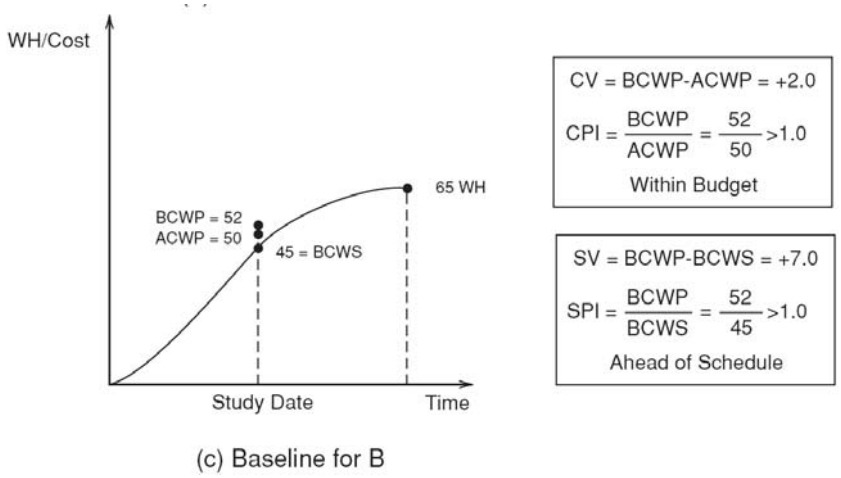
(a) Baseline for A.1

Figure 15.12a (p. 264)
State of Control Account for Single Project (continued on next two slides).



(b) Baseline for A.2

Figure 15.12b (cont.)



(c) Baseline for B

Figure 15.12c (cont.)

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

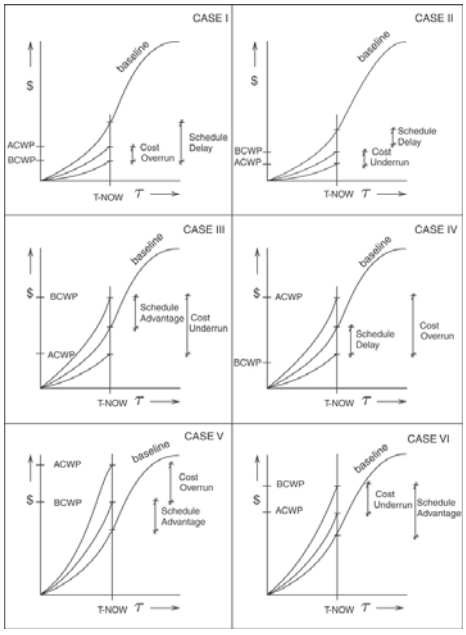


Table 15.3 Values of CPI, CV, and SPI, SV for the Six Scenarios (Singh, 1991)

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

Table 15.3 (p. 266)
Values of CPL, CV, and SPI, SV for the Six Scenarios (Singh, 1991).

Questions!

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?

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?

3. Cost Data Collection

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

4. Project Cost Reporting

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

5. Cost Engineering

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

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		

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 100–699			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
	.05	Grade beams		.01	security
	.07	Slab on grade		.02	Timekeeper
	.08	Beams		.03	Watchmen
	.10	Slab on forms	705		Guards
	.11	Columns		.01	Utilities and services
	.12	Walls		.02	Water
	.16	Stairs		.03	Gas
	.20	Expansion joint		.04	Electricity
	.40	Screeds	710		Telephone
	.50	Float finish	711		Storage facilities
	.51	Trowel finish	712		Temporary fences
	.60	Rubbing	715		Temporary bulkheads
	.90	Curing	717		Storage area rental
245		Precast concrete	720		Job sign
260		Concrete forms	721		Drinking water
	.01	Footings	722		Sanitary facilities
	.05	Grade beams	725		First-aid facilities
	.07	Slab on grade	726		Temporary lighting
	.08	Beams	730		Temporary [illegible]
	.20	Face brick			Protection of adjoining property
	.60	Glazed tile	795		Drawings
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

0 Conditions of the Contract
0000-0099. unassigned

1 General Requirements
0.100. Alternates of Project Scope
0.101-0109. unassigned
0110. Schedules and Reports
0111-0119. unassigned
0120. Samples and Shop Drawings
0121-0129. unassigned
0130. Temporary Facilities
0131-0139. unassigned
0140. Cleaning Up
0141-0149. unassigned
0150. Project closeout
0151-0159. unassigned
0160. Allowances
0161-0169. unassigned

2 Site Work
0200. Alternates
0210-0209. unassigned
0120. Clearing of Site
0211. Declination
0212. Structures moving
0213. Clearing and grubbing
0214-0219. unassigned
0220. Earthwork
0221. Site grading
0222. Excavating and backfilling
0223. Dewatering
0224. Subdrainage
0225. Soil poisoning
0226. Soil compaction control
0227. Soil stabilization
0228-0229. unassigned
0230. Piling
0231-0234. unassigned
0235. Caissons
0236-0239. unassigned
0240. Shoring and bracing
0241. Sheeting
0242. Underpinning
0243-0249. unassigned
0250. Site drainage
0251-0254. unassigned
0255. Site utilities
0256-0259. unassigned
0260. Roads and Walks
0261. Paving
0262. Curbs and gutters
0263. Walks
0264. Road and parking Appurtenances
0265-0269. unassigned
0270. Site Improvements
0271. Fences
0272. Playing fields
0273. Fountains
0274. Irrigation systems
0275. Yard improvements
0276-0279. unassigned
0280. Lawns and Planting
0281. Soil Preparation
0282. Lawns
0283. Ground covers and other plants
0284. Trees and shrubs
0285-0289. unassigned
0290. Railroad Work
0291-0294. unassigned
0295. Marine Work
0296. Boat Facilities
0297. Protective Marine Structures
0298. Dredging
0299. unassigned

3 Concrete
0300. Alternates
0301-0309. unassigned
0310. Concrete Formwork
0311-0319. unassigned
0320. Concrete Reinforcement
0321-0329. unassigned
0330. Cast-in-Place Concrete
0331. Heavyweight aggregate concrete
0332. Lightweight aggregate concrete
0333. Post-tensioned concrete
0334. Nailable concrete
0335. Specially finished concrete
0336. Specially placed concrete
0337-0339. unassigned
0340. Precast Concrete
0341. Precast concrete panel
0342. Precast structural concrete
0343. Precast prestressed concrete
0344-0349. unassigned
0350. Cementitious Decks
0351. Poured gypsum deck
0352. Insulating concrete roof decks
0353. Cementitious unit decking
0354-0399. unassigned

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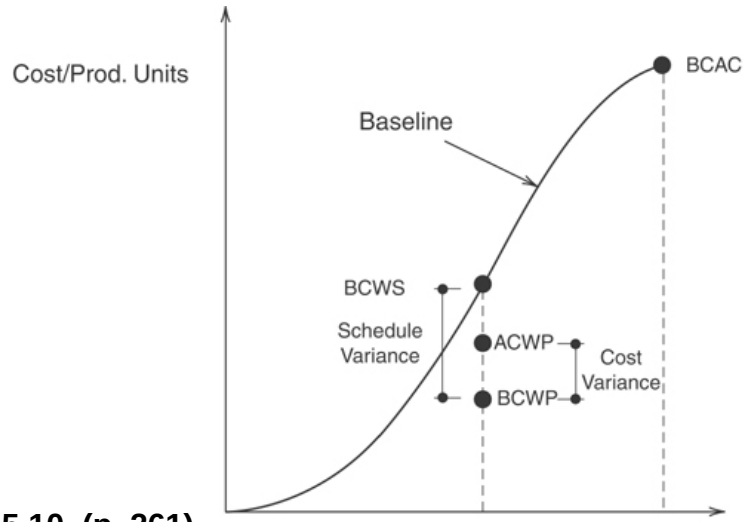

Figure 15.10 (p. 261)
Control Values for Earned Value Analysis.