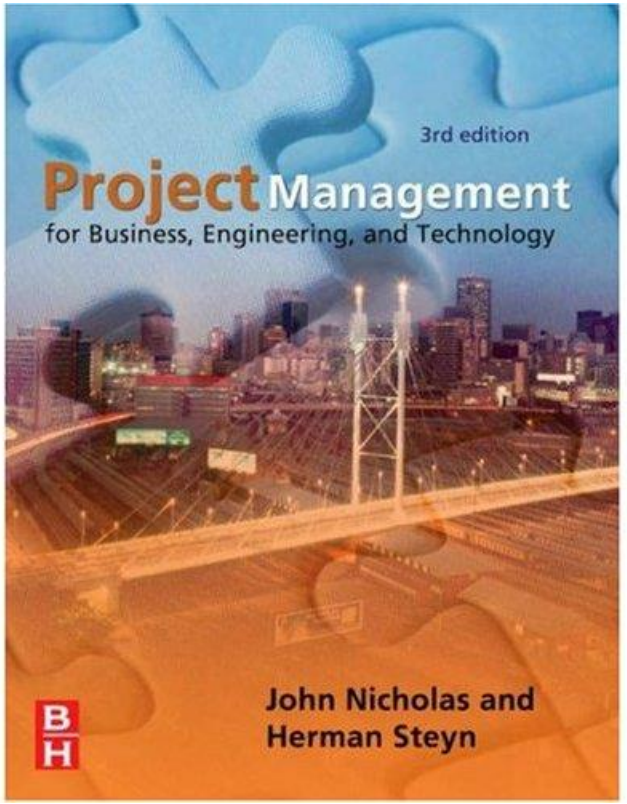
Chapter 8
Cost Estimating and Budgeting

Project Management for Business, Engineering, and Technology



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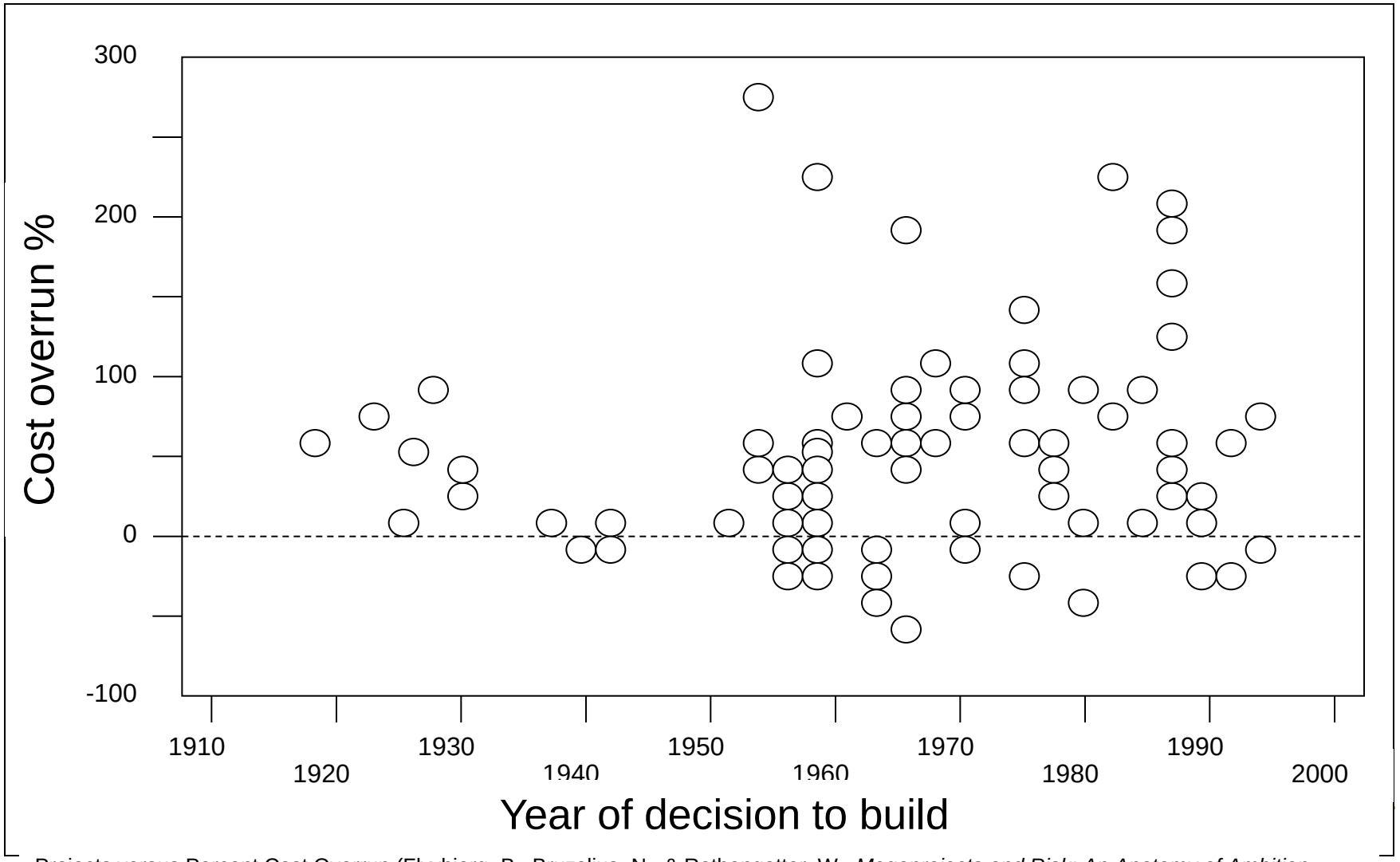
Cost Overruns on Projects

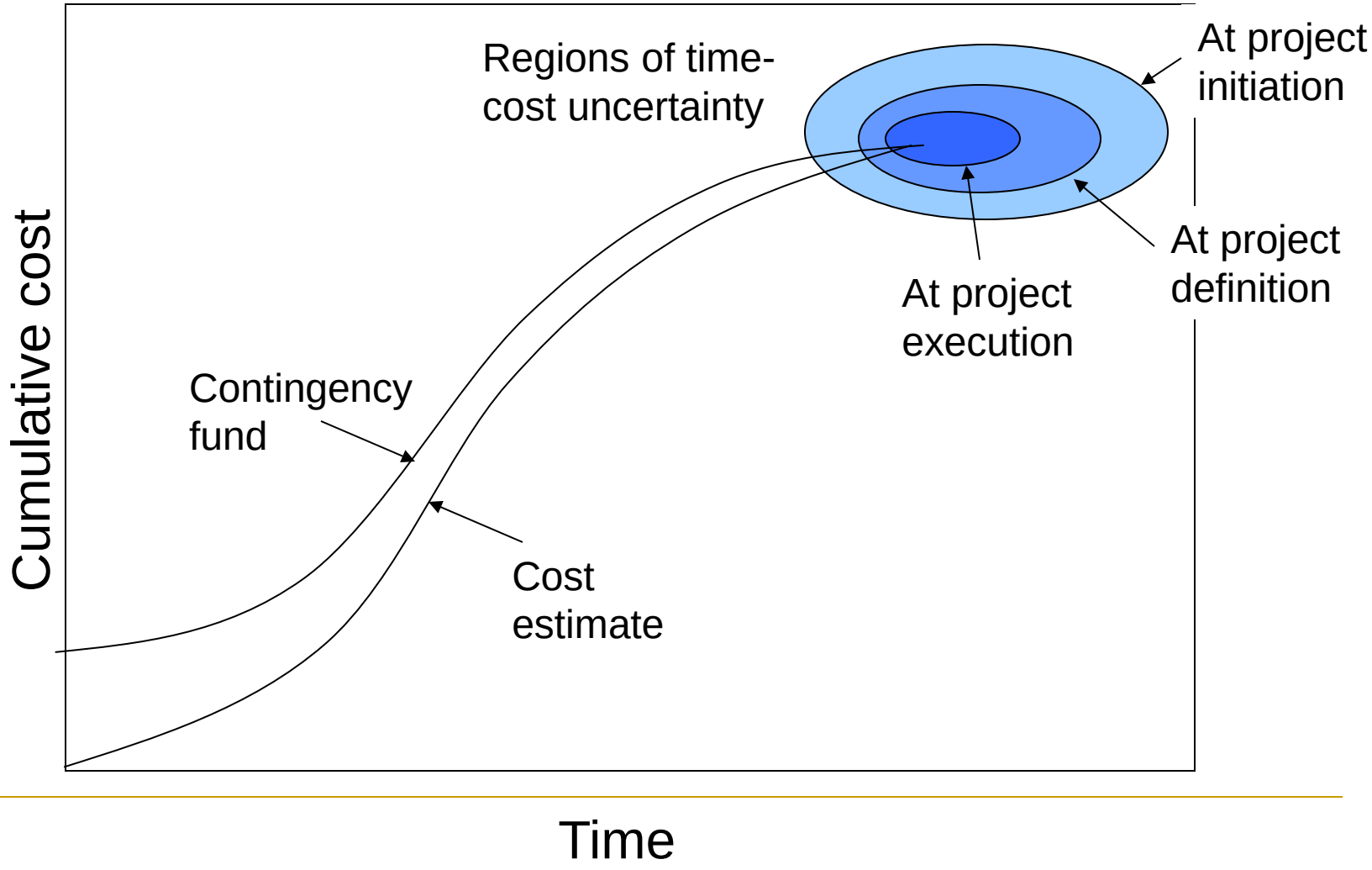


Projects versus Percent Cost Overrun (Flyvbjerg, B., Bruzelius, N., & Rothengatter, W., *Megaprojects and Risk: An Anatomy of Ambition.* Cambridge:Cambridge University Press, 2003, p. 17. With permission.)

Sources of Cost Escalation and Overruns

- Uncertainty and Lack of Accurate Information
- Changes in Requirements or Design
- Economic and Social Factors
- Inefficiency, Poor Communication, and Lack of Control
- Ego Involvement of the Estimator
- Project Contract
- Bias and Ambition

Cost Estimating and the Systems Development Life Cycle



System Life Cycle Costs

***Life cycle costs* (LCC)**

- *All* costs of a system throughout its full cradle-to-grave life cycle, i.e.:
- all costs incurred during the *project* life cycle phases of Definition and Execution
- PLUS all costs associated with the Operations phase of the system and the eventual disposal of the system

System Life Cycle Costs

Purpose of life cycle cost analysis

- To anticipate the realities of *operating, maintaining, and (ultimately) disposing of* the end-item system
- To *establish target costs* for operating, maintaining, and disposing of the end-item system.
- To *design* the system so it will meet those target costs.

Estimating Process

Estimate versus Target or Goal

- **Estimate**: a *realistic assessment* based upon known facts about the work, required resources, constraints, and the environment, derived from estimating methods
- **Target or goal**: a desired outcome, commitment, or promise.
- Don’t confuse estimates with goals. The estimating process is directed at producing good estimates, not restating targets or goals.

Estimating Process

Accuracy versus Precision

- **Accuracy:** the closeness of the estimated value to the actual value
- **Precision:** the number of decimal places in the estimate.
- Accuracy of estimates is more important than precision

Estimating Process

Estimating Methods

1. Expert opinion
2. Analogy + compensation for differences
3. Parametric: Formula or Cost Function, e.g.,

$$\text{Cost, engine A} = (\text{Cost, engine B})\left(\frac{\text{Thrust, engine A}}{\text{Thrust, engine B}}\right)^{0.7}$$

$$\text{Cost, cabling} = 150\,(\text{total area} + 10\%) + 300\sqrt{(\text{number of rooms})} + 125\,(\text{number of floors})$$

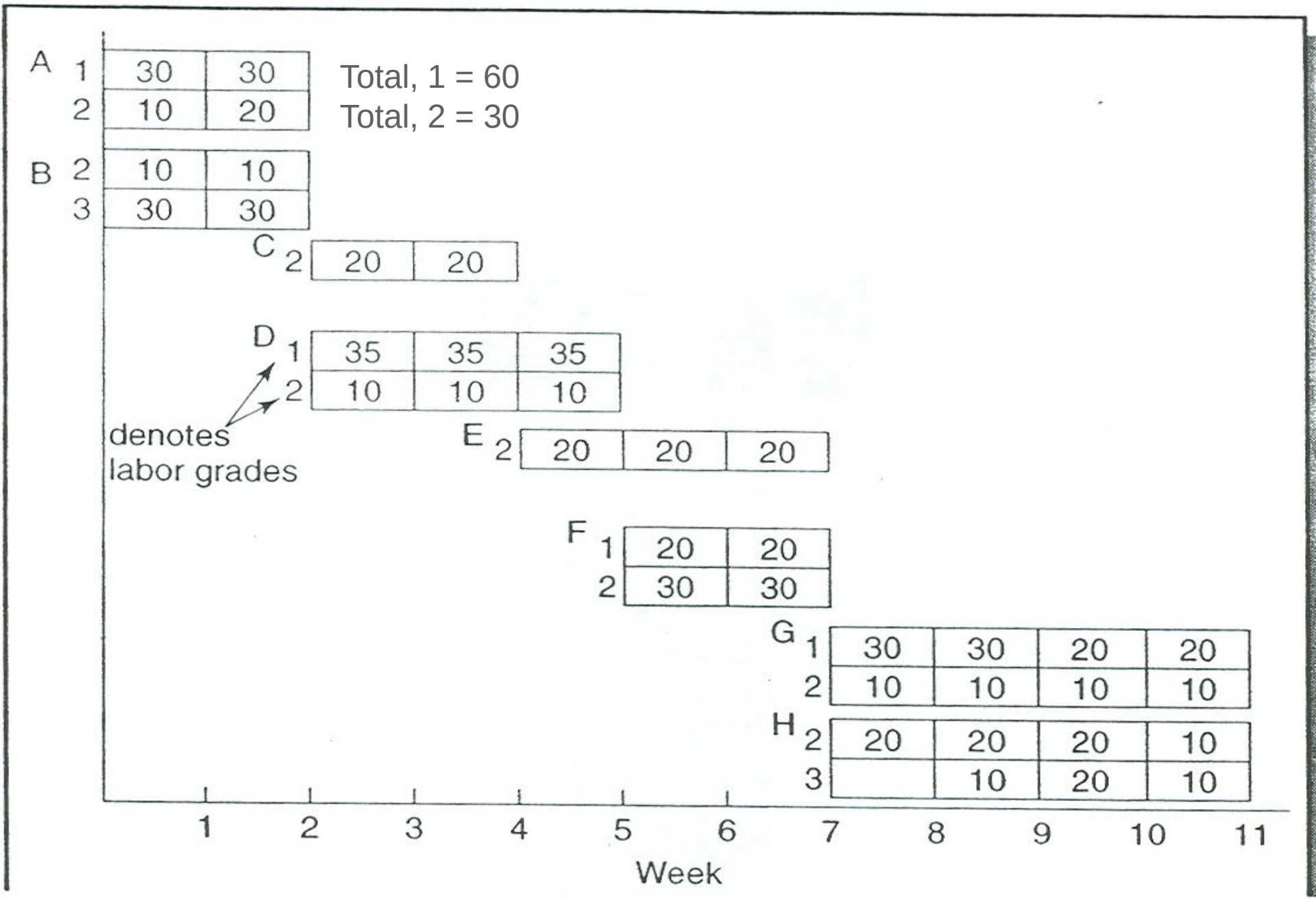
Estimating Methods (cont'd)

4. Cost engineering

   Detailed cost breakdown of labor, materials, etc. at the work package or task level.

   Example below

Schedule showing hours allocated to work packages by labor grade.



Labor Hours and Nonlabor Costs.

Work Package	Hours by Labor Grade			Nonlabor Costs			
	1	2	3	Material	Equipment	Subcontracts	Other
A	60	30		$ 500			
B		20	60		$1,000		
C		40			500		$ 500
D	105	30			500		
E		60				$4,500	
F	40	60		8,000	1,000	5,000	500
G	100	40		1,500			500
H		70	40		1,000		1,500
Total	305	350	100	$10,000	$4,000	$9,500	$3,000

Labor Grade — **Hours x Labor Rate x (100% + Overhead Rate) = Labor Cost**

1 — 305 ($20)(100% + 90%) = $11,590
2 — 350 ($25)(100% + 100%) = $17,500
3 — 100 ($40)(100% + 120%) = $8,800
$37,890

Total = $26,500

Preliminary Estimate = Labor Cost + Nonlabor Costs
= $37,890 + $26,500
= $64,390

Final Estimate = Preliminary + G/A Rate
= $64,390 (100% + 10%)
= $70,829

Budget = Final Estimate + Contingency (Reserve)
= $70,829 + $7,100
= $77,929

Estimating Process

- Any of these methods can be used in any area of project
- Parametric and cost engineering methods are the best

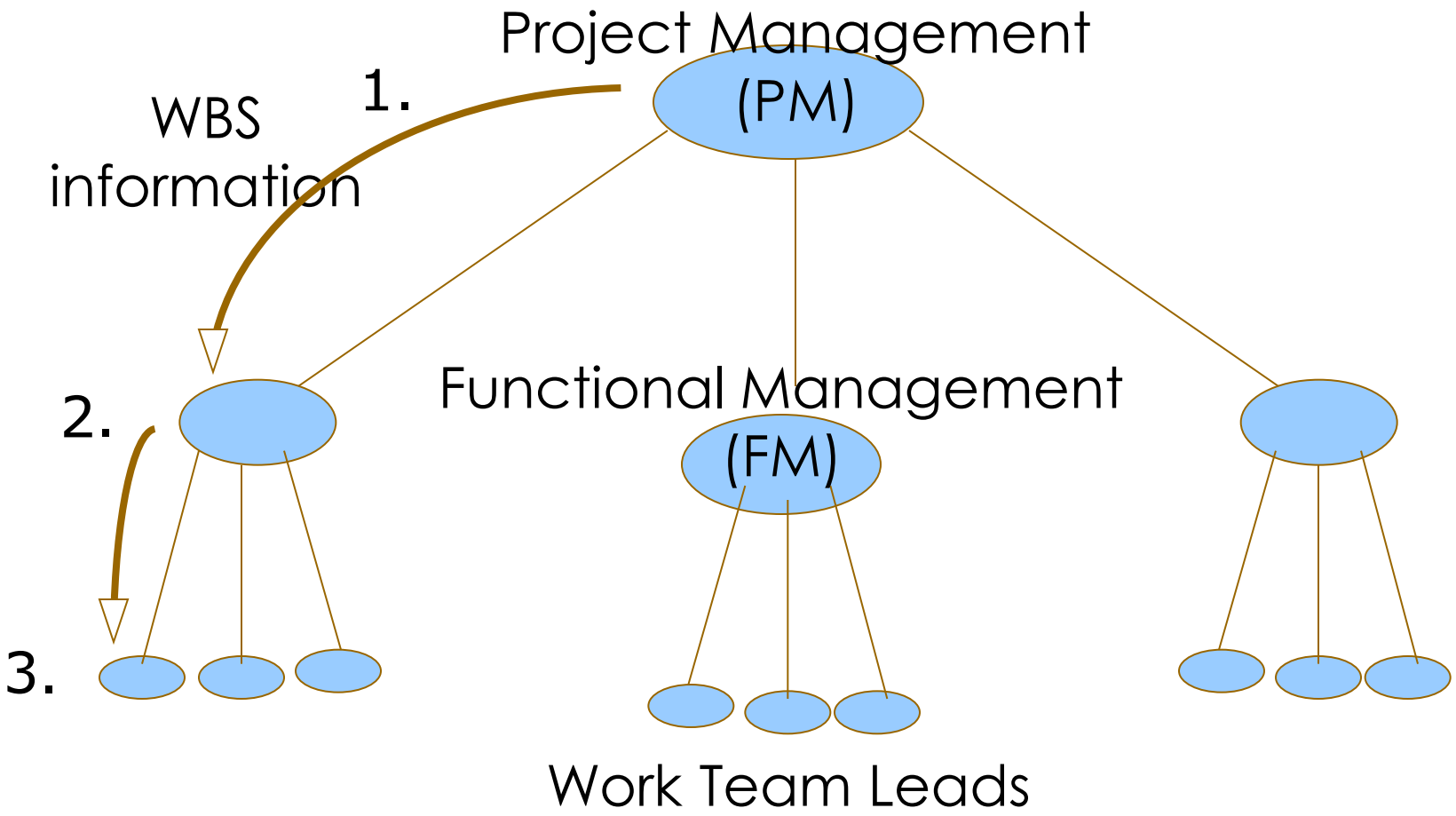
Estimating Process

- Rule of Thumb:

  The smaller the work packages or portion of the end-item estimated, the better the estimate

Estimation Process

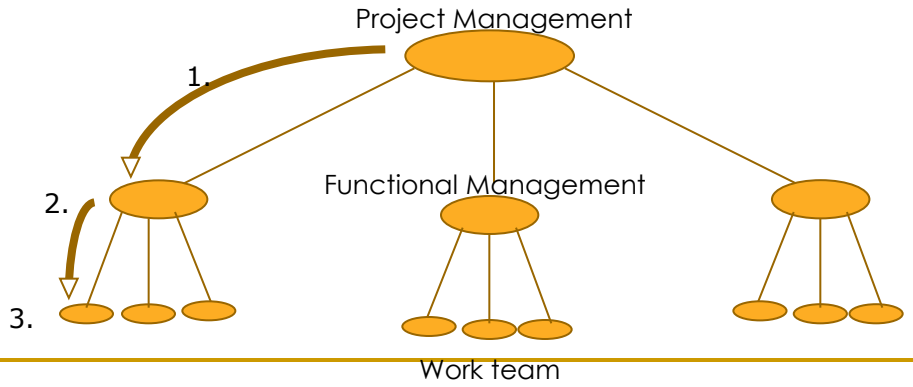
Procedure for larger projects



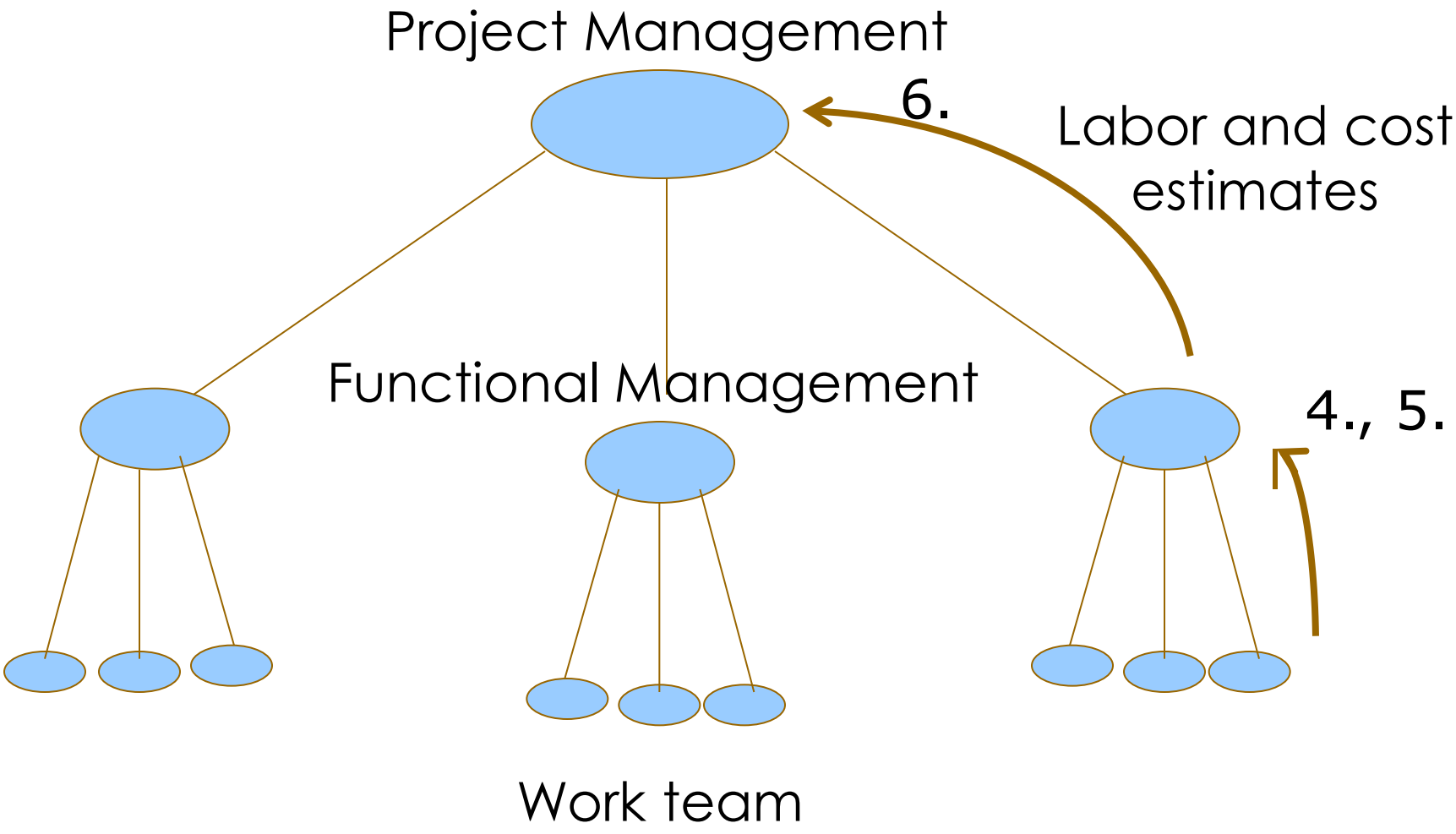
Estimation Process

Procedure for larger projects, steps 1-3

1. PM: Uses WBS to identify work packages
2. FM: Subdivide work packages into identifiable tasks; determine labor, material, facilities, and resources requirements for each
3. Supervisors/team leads: Estimate number of labor hours and quantities of materials needed

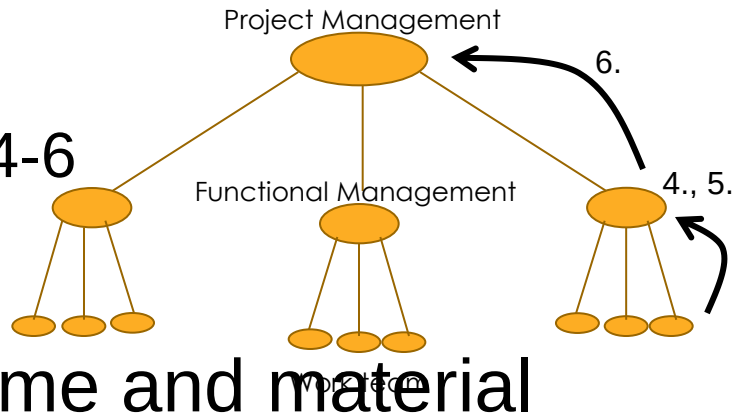


Estimation Process



Estimation Process

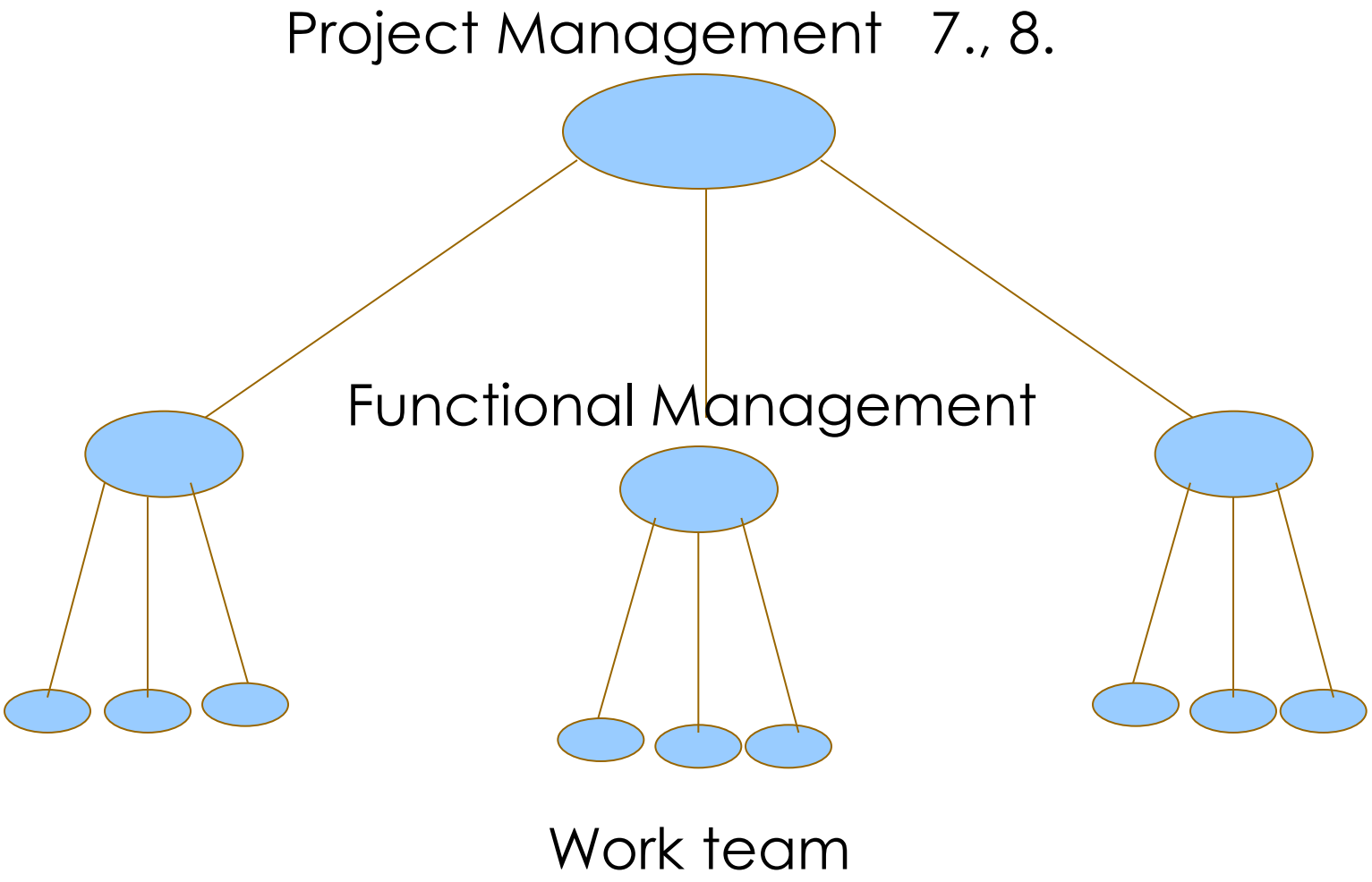
Procedure for larger projects, steps 4-6



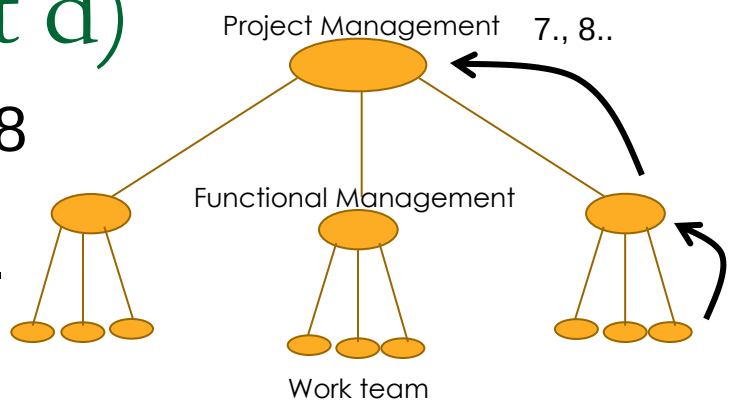
4. FM: check and aggregate time and material estimates
5. FM: convert time estimates into costs
6. PM: checks over and approves all estimates aggregates costs; added in overhead costs:

Project cost = ∑direct costs + ∑ overhead costs

Estimation Process



Estimating Process (cont'd)



Procedure for larger projects, steps 7-8

7. PM: Adds in contingency amounts.

   Two possible contingencies

   1. Base estimate = Σ (WP estimates + WP contingency)
      (to handle "known-unknowns")

   2. Final estimate = Base estimate + overheads + project contingency
      (to handle "unknown unknowns"; PM controls this)

8. PM: Compares bottom-up estimates to top-down targets or goals. Attempt to reconcile differences.

Estimating Process

Estimates can be made at any level

- project
- work package
- task

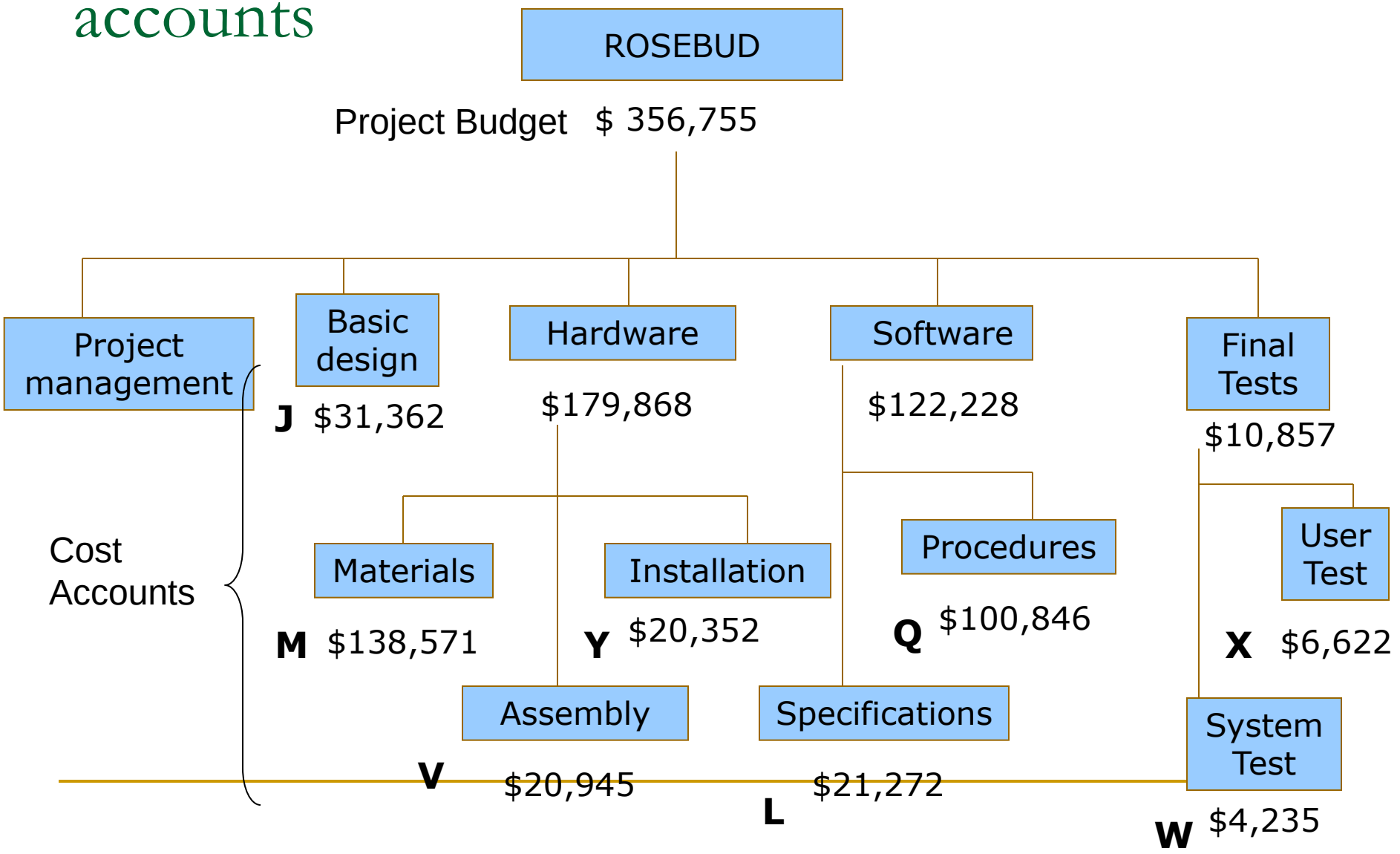
Project Budget

- Specific for each project
  - Not a fiscal budget.
- Subdivided into Control Accounts, one for each work package
- Each cost account is a portion of the project total budget
- Rosebud Example

Elements of Typical Budget

I. Direct Costs **Direct Labor (DL)** Charges for labor working directly on project	50,000.00
Direct Overhead on Labor (% of DL) E.g., 40% Labor support: benefits, etc.	20,000.00
Direct Nonlabor and **Materials (M)** Subcontractors, consultants, travel, telephone, materials, purchased parts, etc.	10,000.00
Direct Overhead on Nonlabor and Materials (% of M) Shipping, insurance, security, etc. E.g., 33.33%	3,333.33
Direct Total	83,333.33
II. General & Administrative (% of Direct Total) E.g., 20% **(Indirect overhead)** Corporate overhead: proposals, publicity, president, etc.	16,667.00
Budget Amount	100,000.00

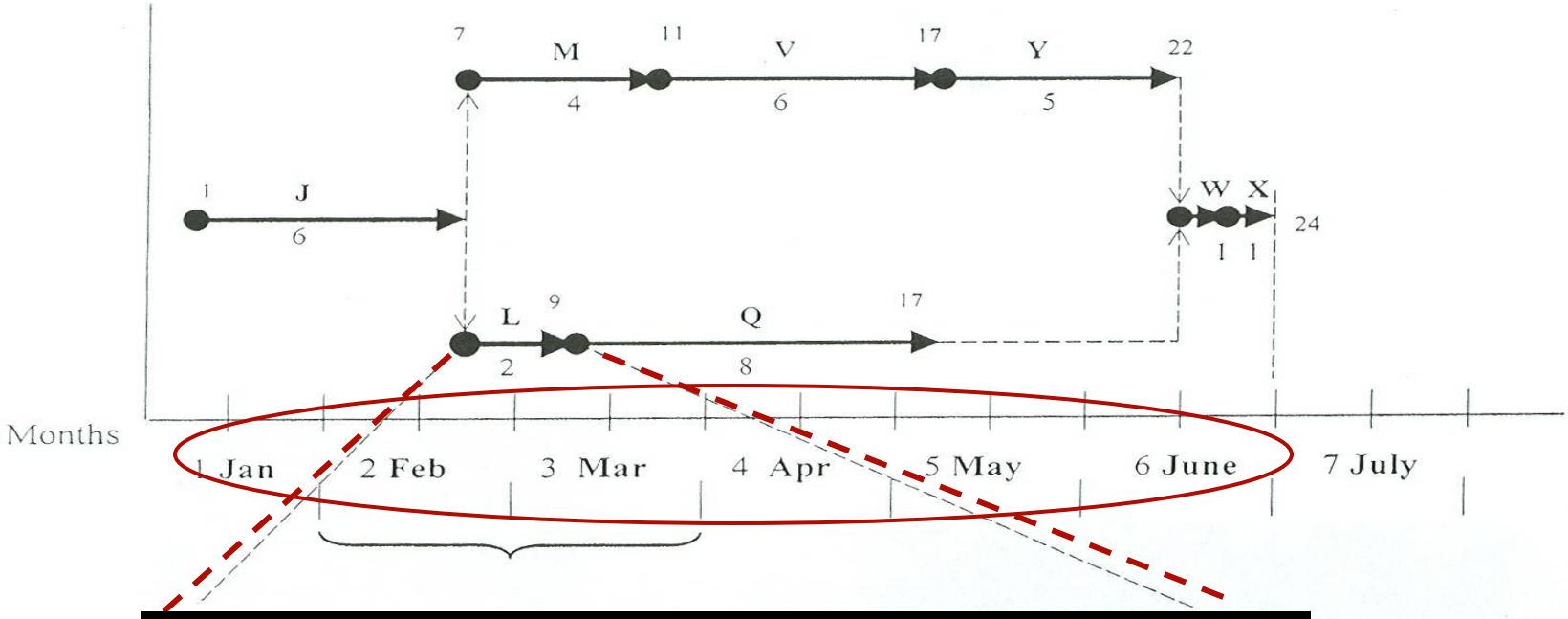
Project budget subdivided into control accounts



Project Budget

- The best project budgets are time-phased to allow cost tracking vs. time
- Example

Note: Start-Finish dates shown in weeks



Project ROSEBUD Date

Department Programming Work Package L- S/W Specifications

Charge	Rate	Months+ 1	2	3	4	5	6	Totals Hours	Cost
Direct labor									
Professional	$35/hr.		130					130	4,550
Associate	$30/hr		50	100				150	4,500
Assistant	$20/hr			100				100	2,000
Direct labor cost			6,050	5,000					11,050
Labor overhead	75%		4,538	3,750					8,288
Other direct cost*									0
Total direct cost			10,588	8,750					19,338
General/administrative	10%		1,059	875					1,934
Total costs			11,647	9,625					21,272

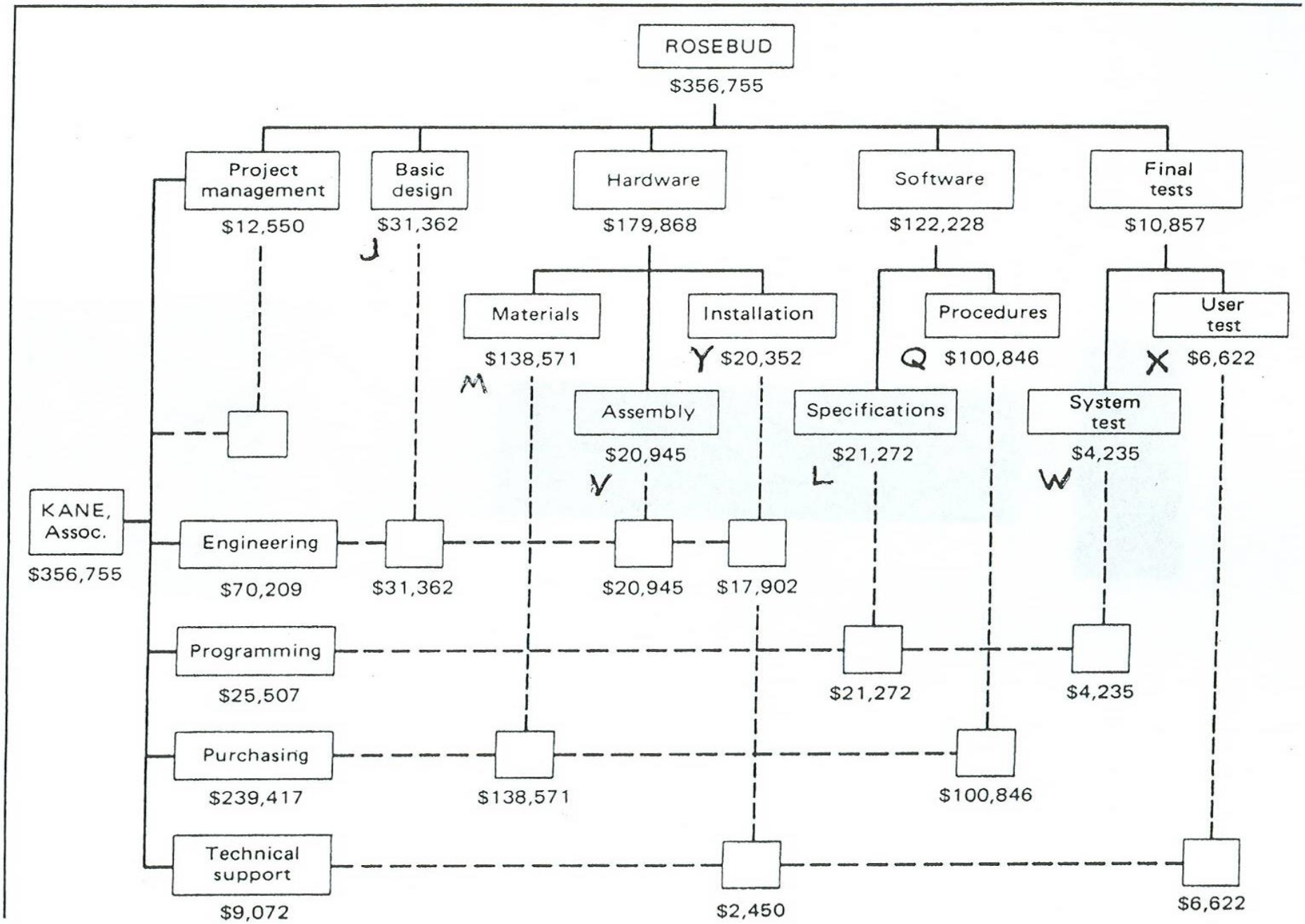
+ Should extend for as many months as required by the project.
* Should be itemized to include costs for materials, freight, subcontracts, travel, and all other nonlabor direct costs.

Budget for programming department for Work Package L.

Project Cost Accounting System

- Enables budget information be aggregated or disaggregated according to work packages or functional areas
- Example

Aggregation of cost account information by project and organization.



Project Cost Accounting System; Cost Monitoring

Weekly Expense and Cumulative Expense Profiles.

- Created from work package budgets and the project schedule
- Assume expenses occur uniformly throughout work package duration
- Example

Project Cost Accounting System; Cost Monitoring

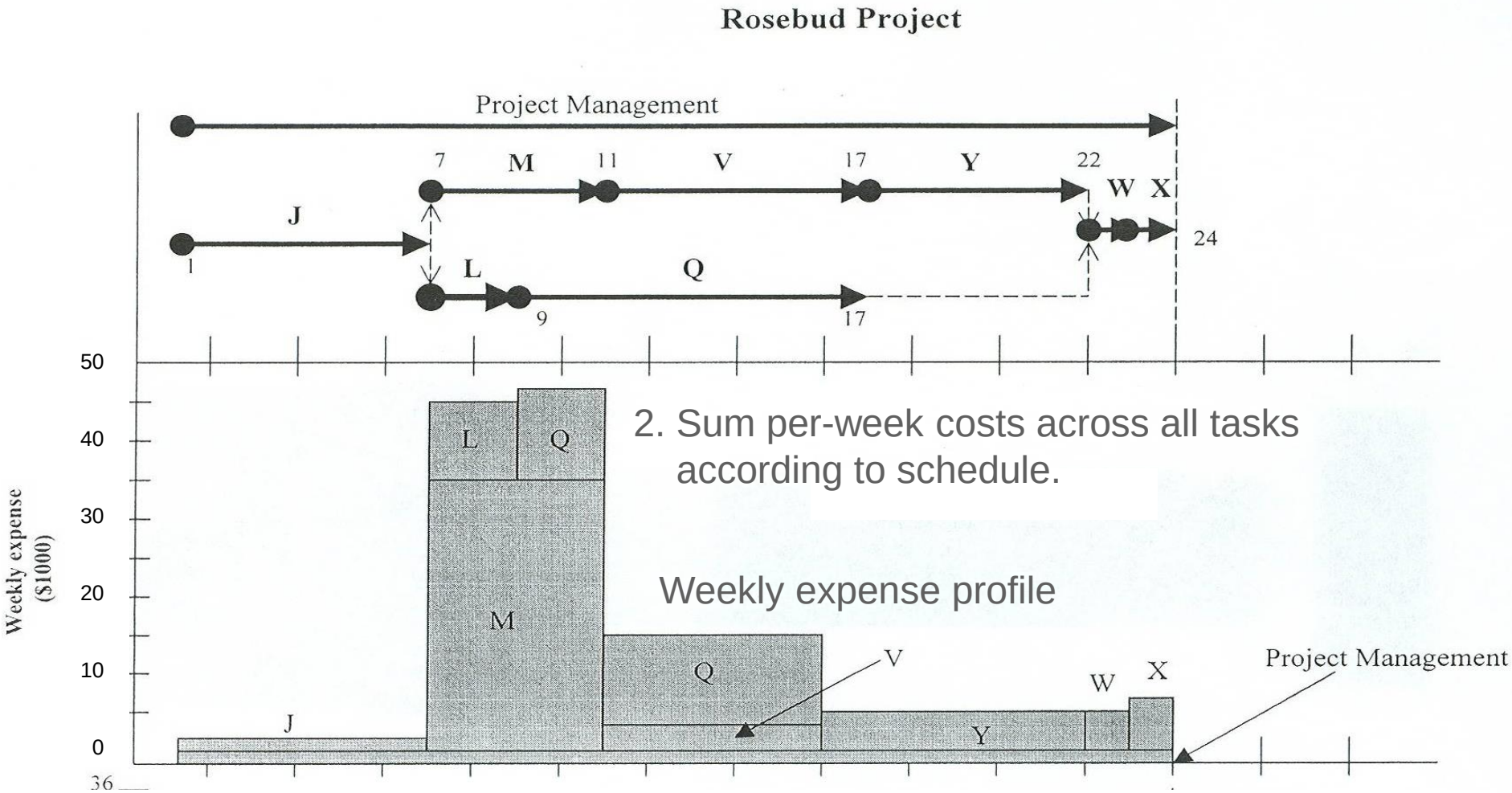
- Weekly expense profile
  - Analogous to resource loading profile
- Example

Rosebud Project

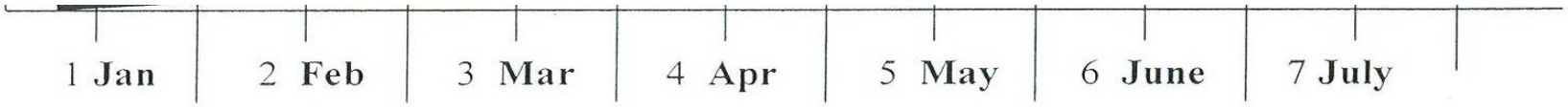
Compute uniform per-week cost (analogous to weekly resource requirement)

For each work package, total budget, time, and average per-week expense
(assume uniform expenditure through time period)

Work Package	Budget $	Time (wks)	Per-week $
Project mgt	$12,550	24	$523
J	$31,362	6	$5,227
M	$138,571	4	$34,643
V	$20,945	6	$3,491
Y	$20,352	5	$4,070
L	$21,272	2	$10,636
Q	$100,846	8	$12,606
W	$4,235	1	$4,235
X	$6,622	1	$6,622
	$356,755		



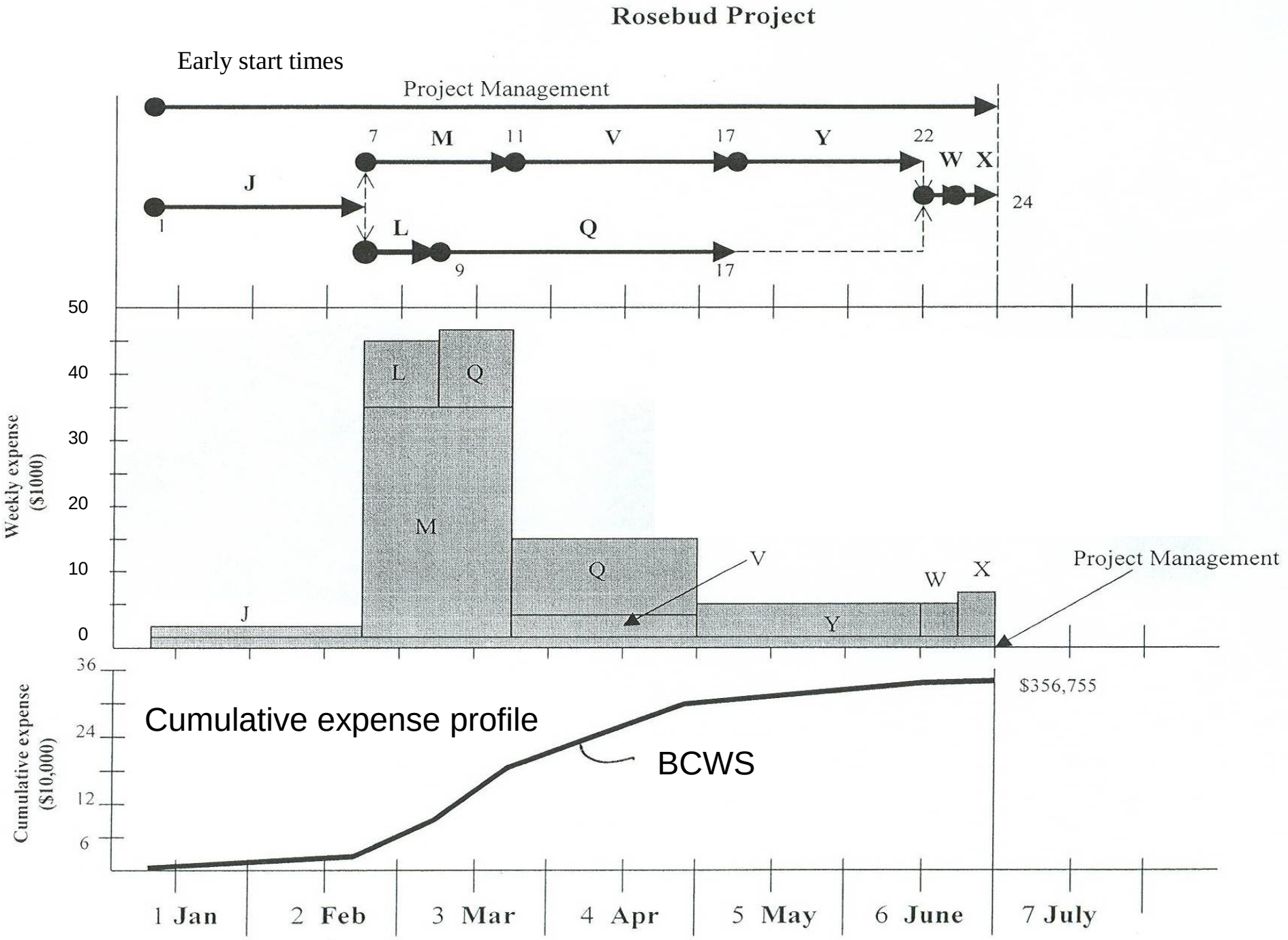
Plot showing expected per work expenses based on scheduled activities and per-week costs of each.



Project Cost Accounting System; Cost Monitoring

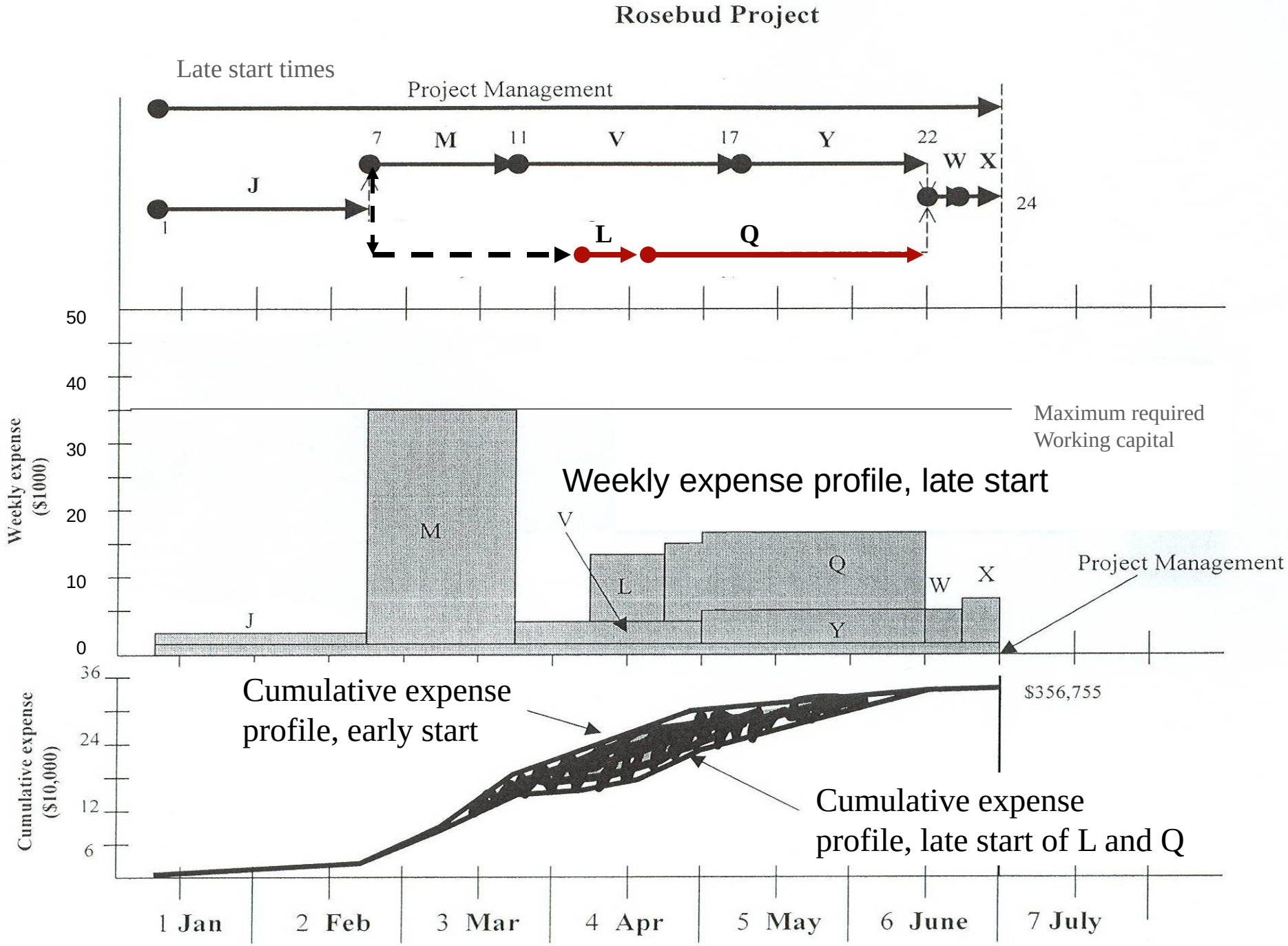
- Cumulative expense profile shows the Budgeted Cost of the Work Scheduled (BCWS), which is the expected expenditure growth throughout the project

- Example


Rosebud Project
Early start times
Project Management
7
M
11
V
17
Y
22
W
X
J
24
1
L
Q
9
17
50
40
30
20
10
0
Weekly expense ($1000)
L
Q
M
Q
V
W
X
Project Management
J
Y
36
24
12
6
Cumulative expense ($10,000)
$356,755
Cumulative expense profile
BCWS
1 Jan
2 Feb
3 Mar
4 Apr
5 May
6 June
7 July

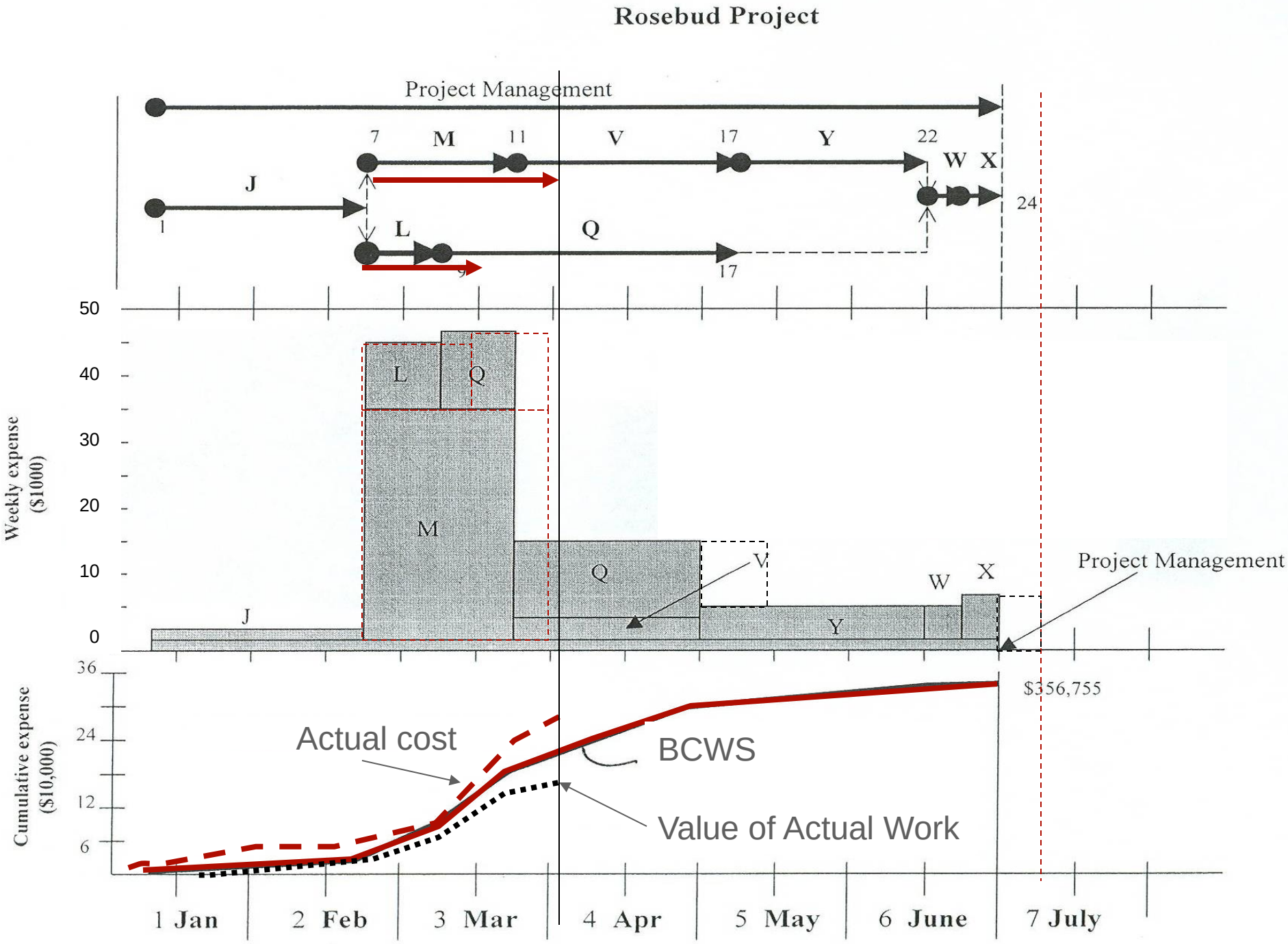
Project Cost Accounting System; Cost Monitoring

- Planning and Control
  - The weekly and cumulative expense profiles are used to adjust schedules to accommodate cash-flow and working capital constraints
  - Example


Rosebud Project
Late start times
Project Management
7
M
11
V
17
Y
22
W
X
J
1
24
L
Q
50
40
30
20
10
0
Weekly expense ($1000)
Maximum required Working capital
Weekly expense profile, late start
M
V
Q
L
W
X
Project Management
J
Y
36
24
12
6
Cumulative expense ($10,000)
Cumulative expense profile, early start
$356,755
Cumulative expense profile, late start of L and Q
1 Jan
2 Feb
3 Mar
4 Apr
5 May
6 June
7 July

Project Cost Accounting System; Cost Monitoring

- Planning and Control
  - During project execution actual expenses are tracked against BCWS
  - Example


Rosebud Project
Project Management
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Weekly expense ($1000)
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V
Y
W
X
Project Management
36
24
12
6
Cumulative expense ($10,000)
$356,755
Actual cost
BCWS
Value of Actual Work
1 Jan
2 Feb
3 Mar
4 Apr
5 May
6 June
7 July