

Cost Analysis and Estimating for Engineering and Management

Chapter 4 Accounting Analysis

Overview

- Accounting
 - Records, Transactions, Reports
- Depreciation
 - What It Is, Uses, Calculations
- Budgeting
- Overhead
 - Calculations and Application
- Variance

Accounting

- Analyzes Money Transactions
- Multiple Disciplines
- Cost Accounting
 - Cost of Using Productive Assets
- Tax Accounting
 - Tax Consequences on Business

Accounting & Engineering

- Engineering
 - Looks Ahead
 - Cost Estimates BEFORE Things Happen
- Accounting
 - Money Transactions That Have Happened
 - Historical Records
 - Incompatible Data Formats

Transactions

- Money (or Something of Value) Comes In or Goes Out of the Company
- Recorded Twice (In 2 Accounts)
- *Double-Entry* Bookkeeping
- Accounts - Records of Like Transactions

“T” Accounts

- 2 Columns
- Left Hand Column - Called “Debit”
- Right Hand Column - Called “Credit”
- Each Transaction Has a Debit In One Account and a Credit In Another
- Note: Debit or Credit Have NO Value Meaning - Credit Is Not Always Good

“T” Account Illustration

T-account	
Debit (entry on left-hand side)	Credit (entry on right-hand side)

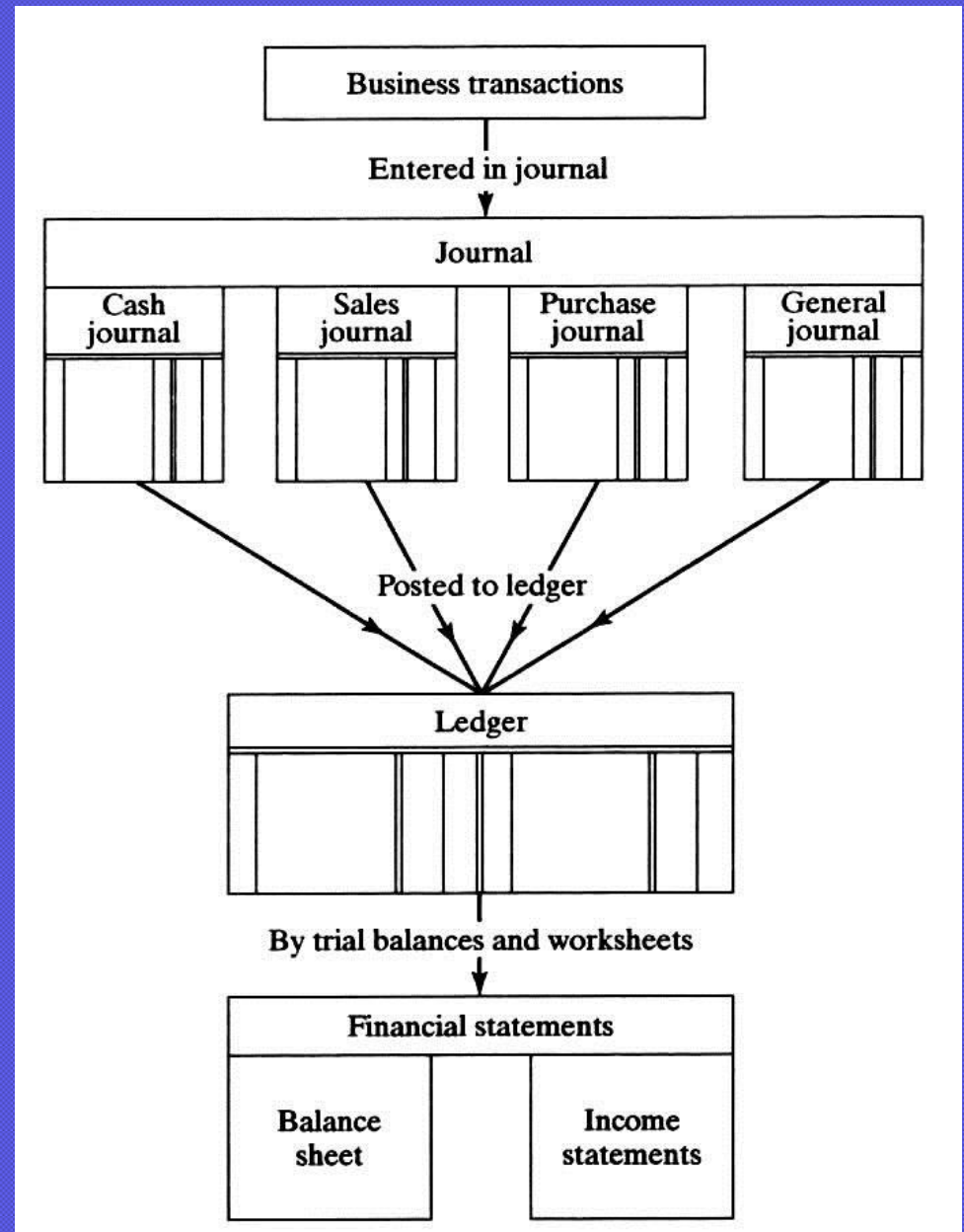
“T” Account In Practice

Account title								
Date	Description	F	\$		Date	Description	F	\$

Records

- Journals
 - Chronological Record of Transaction
- Transaction “Posted” to Ledgers
- Ledger
 - Group of Accounts

Transaction Record Flow



Accounting Conventions

- Money Measurement
 - All Transactions Recorded in Money
- Accounting Equivalence
 - Double Entry
 - $\text{Assets} = \text{Liabilities} + \text{Net Worth}$
- Conservatism
 - Record the Lesser Value

More Accounting Conventions

- Consistency
 - Always Record Transactions the Same Way
- Business Perspective
 - “Going Concern”
 - Transactions for the Sake of the Business
- Use Cost Not Value

Cash vs. Accrual

- Cash

- Transaction When Money Exchanged
- Individuals and Very Small Businesses

- Accrual

- Transaction When Earned
- Receipts at Shipment
- Payables When Material Received

Revenue vs. Expense

- Revenue

- Money Received
- Increases to Net Worth

- Expense

- Costs Incurred
- Decreases to Net Worth

Account Categories

- Asset
- Liability
- Net Worth
- Revenue
- Expense

Assets

- Things with Dollar Value
- Company Owns
- Current
 - For Short Period
- Fixed
 - Longer Than 1 Year

Liabilities

- Debts the Company Owes
- Short Term
 - Accounts Payable
 - Short Term Loans
- Long Term
 - Over 1 Year
 - Mortgages, Long Term Loans

Net Worth

- Ownership Interest
- Capital Stock
 - Portion Paid In By Owners
- Retained Earnings
 - Accumulation of Profits and Losses

Revenues & Expenses

- Revenue
 - Sales Income Before Deduction of Costs
- Expenses
 - Costs of Doing Business
- Gross Income
 - Revenue – Expense

Profit

- Gross Income – Taxes
- Recorded on Profit and Loss Statement
- Contributes to Net Worth

Financial and Operating Equation

$$\begin{array}{c} \text{Assets} \\ +|- \end{array} = \begin{array}{c} \text{liabilities} \\ -|+ \end{array} + \begin{array}{c} \text{networth} \\ -|+ \end{array} + \begin{array}{c} \text{revenue} \\ -|+ \end{array} - \begin{array}{c} \text{expenses} \\ +|- \end{array}$$

Eq 4.2

Debit Indicates:	Credit Indicates:
Asset increase	Asset decrease
Liability decrease	Liability increase
Net worth decrease	Net worth increase
Revenue decrease	Revenue increase
Expense increase	Expense decrease

Example of Transactions

Transaction	Accounts Affected	Type of Account	On Account	Debit (\$)	Credit (\$)
1. Company founded \$50,000 capital stock	Cash	Asset	Increase	50,000	
	Stock	N-W	Increase		50,000
2. Buy materials on account, \$10,000	Inventory	Asset	Increase	10,000	
	Acct pay	Liability	Increase		10,000
3. Pay monthly rent on shop, \$1500	Rent	Expense	Increase	1,500	
	Cash	Asset	Decrease		1,500
Total				61,500	61,500

Example of T-Accounts

Cash (A)			Accumulated depreciation (A)			Insurance (E)		
(1)	\$50,000	\$1,500	(3)			(14)	\$500	
(8)	2,000	4,000	(4)					
(10)	500	2,850	(6)					
		5,000	(7)					
		3,000	(9)					
		800	(12)					
		500	(14)					
		1,250	(16)					
Inventory (A)			Accounts payable (L)			Depreciation expense (E)		
(2)	\$10,000		(4)	\$4,000	\$10,000	(15)	\$600	
					12,000			
					(13)			
Accounts receivable (A)			Sales (I)			Rent (E)		
(5)	\$15,000	\$2,000	(11)	\$4,000	\$15,000	(3)	\$1,500	\$ 500 (10)
		4,000			(5)			
Computer (A)			Salaries (E)			Capital stock (NW)		
(13)	\$12,000		(6)	\$2,850		(7)	\$5,000	\$50,000 (1)
Equipment (A)			Advertising (E)			Taxes		
(9)	\$3,000		(12)	\$ 800		(16)	\$1,250	

Balancing

- Number of Entries
 - Debits **MUST EQUAL** Credits
 - For All Accounts (Not in Each Account)
- Footing
 - Find Difference Between Credit and Debit Totals In Each Account
 - Record In Positive Column

Finish Balancing

- Balance In Each Account
 - Debit
 - Credit
 - “Closed” (Debit = Credit)
- Balance the Books
 - Sum of All Debit Accounts MUST
EQUAL Sum of All Credit Accounts

Statements

- Balance Sheet
 - “Snap Shot” at a Point in Time
 - Summary of Assets, Liabilities and NW
- Profit and Loss Statement
 - Income and Expense Summary
 - Over a Specified Period of Time

Balance Sheet

XYZ Manufacturing Company Balance Sheet May 31, 20xx

<u>Assets =</u>		<u>Liabilities</u>	
Cash	\$15,000	Bank loan	\$15,000
Inventory	10,000	Mortgage	15,000
Land	15,000		
Fixed Assets	40,000	<u>+ Net worth</u>	
		Stock	45,000
		Earnings	<u>5,000</u>
	<u>\$80,000</u>		\$80,000

Profit and Loss Statement

- Or Income and Expense Statement
- Profit: Excess of Revenue Over Cost
 - Including Depreciation and Taxes
- Loss: Excess of Cost Over Revenue
 - Including Depreciation
 - Taxes Are Not Owed In Loss Situation
- Profit/Loss Included In Net Worth

General Manufacturing Co.

Profit-and-Loss Statement

June 30, 20xx

Income		
Product income		\$11,000
Expenses		
Salaries	\$2,850	
Rent	1,000	
Advertising	800	
Insurance	500	
Depreciation	<u>600</u>	
Total		<u>5,750</u>
Gross profits		\$5,250
Taxes @ 23.8%		<u>1,250</u>
Profit (to retained earnings)		\$4,000

Capital Assets

- Money Spent
 - Larger Amounts
 - Long Period of Use
- Decreasing Value Over Time
 - Physical Wear for Operation
 - Obsolescence
 - Regulations

Depreciation

- Accounting Charge
 - Provides for Recovery of Capital Costs
 - Over Time
- NOT a Cash Expenditure (Transaction)
 - Money Spent for Initial Acquisition
- Deduction to Income Statement
 - Largely for Tax Purposes

Property (Assets)

- Life
 - Longer Than One Year
 - Economic Life \neq Physical Life
- Tangible
- Intangible
- Real
 - Land Is Not Depreciated

Annual Depreciation

- In General

$$D_j = P(j) \times P$$

Eq 4.3

- Straight Line
–Simplest

$$P(j) = \frac{1}{N(k)}$$

Eq 4.4

$$D_j = \frac{1}{N(k)} (P - F_s)$$

Eq 4.5

Definitions

- Salvage Value

- Value Left at End of Depreciation Life
- What Asset Could Be Sold for

- Book Value

Investment – Salvage – Depreciation

Straight Line Example

Yr	Cost – Salv.	P(j), %	Book Value	D _j
0	\$90,000		\$100,000	
1		20	100,000	\$18,000
2		20	82,000	18,000
3		20	64,000	18,000
4		20	46,000	18,000
5		20	28,000	<u>18,000</u>
				Total: \$90,000

Accelerated Cost Recovery

- Costs Recovered More Quickly
- Allowed by Tax Laws
 - Certain Methods
 - MACRS
- Better Approximates Actual Life Cycle
- Helps Company Profits and Operations

Accelerated Recovery Rates

Year	3-Year	5-Year	10-Year
1	33	20	10
2	45	32	18
3	22	24	16
4		16	14
5		8	12
6			10
7			8
8			6
9			4
10			2

Accelerated Recovery Example

Year	Cost	P(j)	Book Value	D _j
0	\$100,000		\$100,000	
1		20	100,000	\$20,000
2		32	80,000	32,000
3		24	48,000	24,000
4		16	24,000	16,000
5		8	8,000	<u>8,000</u>
				Total: \$100,000

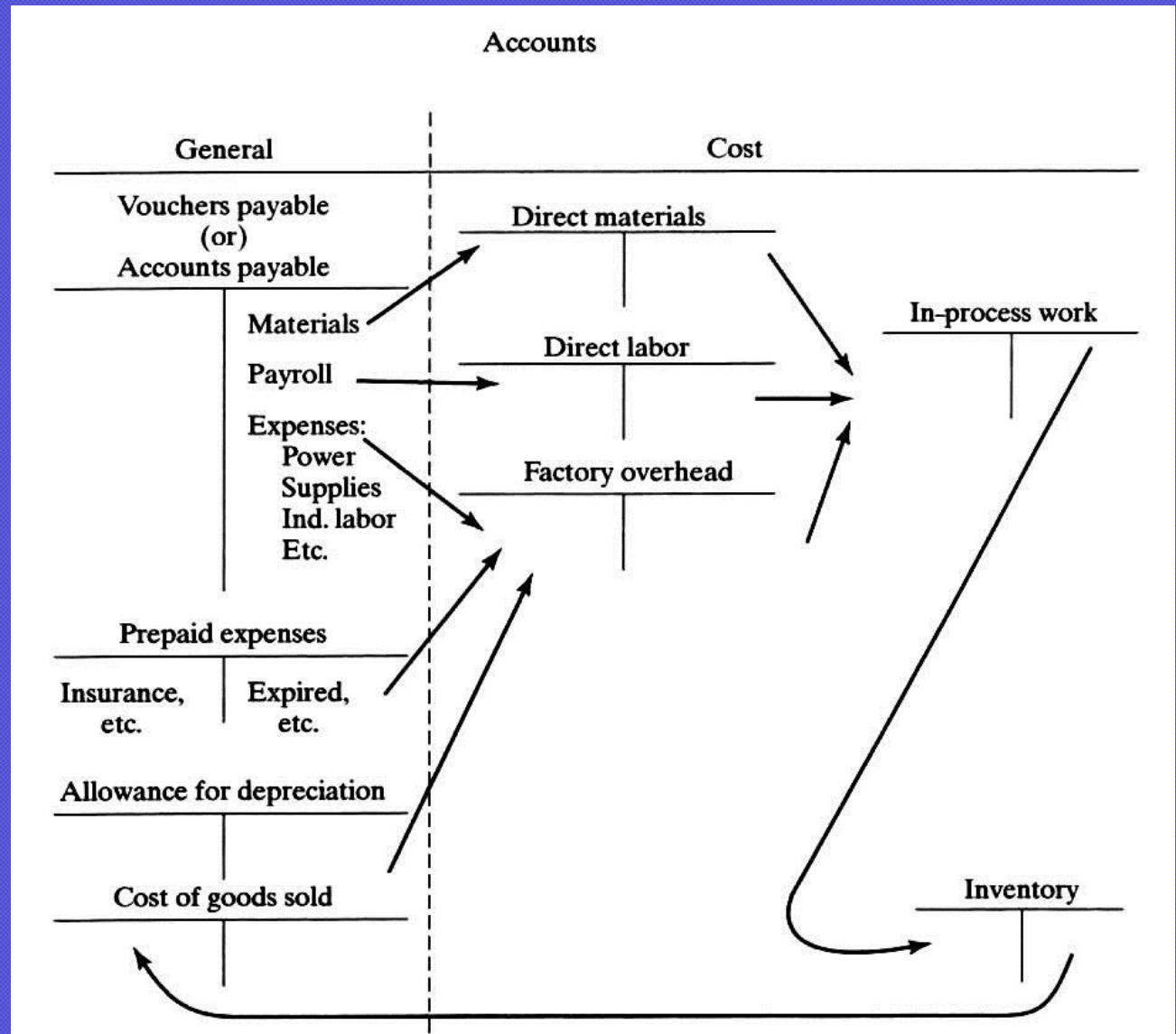
Budgeting

- Written Plan
- For a Future Period
- Based On:
 - Cost Estimating
 - Accounting Records
 - Conjectures of Future Activity

Budget Types

- Appropriation
 - Proposed Expenditures
 - Usually for Big Items (Building, Equip.)
- Fixed Budget
 - For Departments
- Variable Budgets
 - Tied to Activity Levels
 - Highlights Variations from Planned

Cost vs. General Accounts



Overhead

- Collect Costs
 - Not Tied More Directly to Production
 - Obtained from Budgets
- Distribute
 - Rational Apportioning to Products
- Allow Accurate Estimates & Quotes
 - Along With Direct Costs

About Costs

- Direct Labor Costs
 - Uses Gross Hourly Cost Rate
- Utilization
 - Attribute of Machines
 - Percent of Possible Time In Use ($\leq 100\%$)
- Efficiency
 - Attribute of Labor
 - Level and Amount of Effort

Budget (Physical Assets)

Center	No.	ft ²	Hours	Hp Hours	Dep	Tooling
Light	20	3,200	49,300	443,000	\$52,500	\$200,000
Heavy	2	3,400	6,800	748,000	95,000	80,000
Assy	15	1,100	17,000	24,000		10,000
Testing	8	<u>1,700</u>	<u>13,600</u>	<u>68,000</u>	<u>22,500</u>	<u>65,000</u>
		9,400	86,700	1,283,000	\$170,000	\$355,000

Budget (Labor Assets)

Center	Wrkrs	Wage (\$/hr)	Fringes (\$/hr)	Gross (\$/hr)	Direct Hours	Budget Cost (\$)
Light	29	21.40	6.42	27.82	58,000	1,613,560
Heavy	4	25.75	7.73	33.48	8,000	267,800
Assy	10	18.65	5.60	24.25	20,000	484,900
Test	<u>8</u>	20.05	6.02	26.07	<u>16,000</u>	<u>417,040</u>
Total	51				102,000	2,783,300

Collecting Overhead Costs

- Costs Tied to Production
 - But Not to Specific Products
- General Costs
 - Engineering
 - Management
 - Sales

Annual Overhead

Overhead Budget	
Factory	
Space	\$256,000
Utilities	\$239,625
Indirect labor	\$229,000
Tooling services	\$469,600
Engineering	
	\$247,000
Management	
	\$505,000
Total budget	\$1,946,225

Allocating Overhead Costs

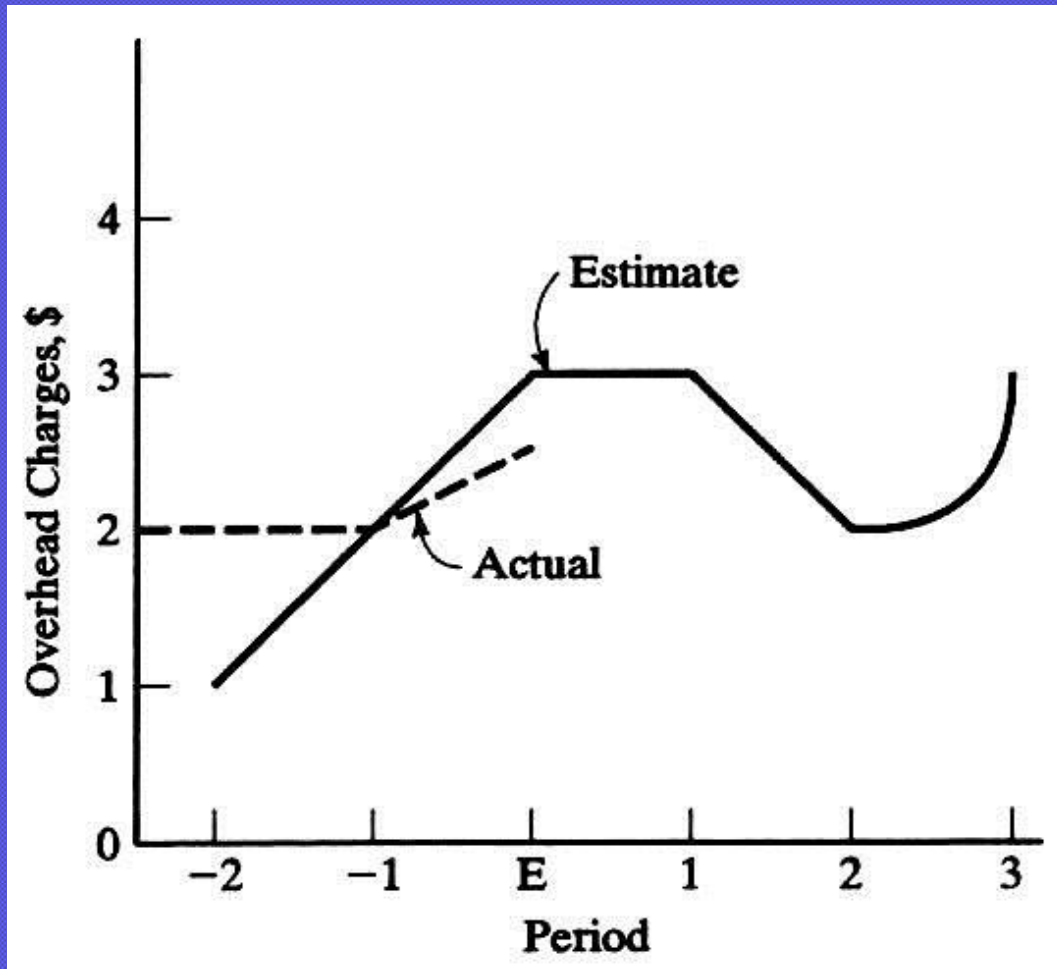
- Single Overhead Rate (Traditional)
 - Divide Total Overhead Over Some Measure of Production
 - e.g. Per Direct Labor Hour (Burden)
 - Misleading, Does Not Apportion Overhead as It Is Used

Allocation Basis

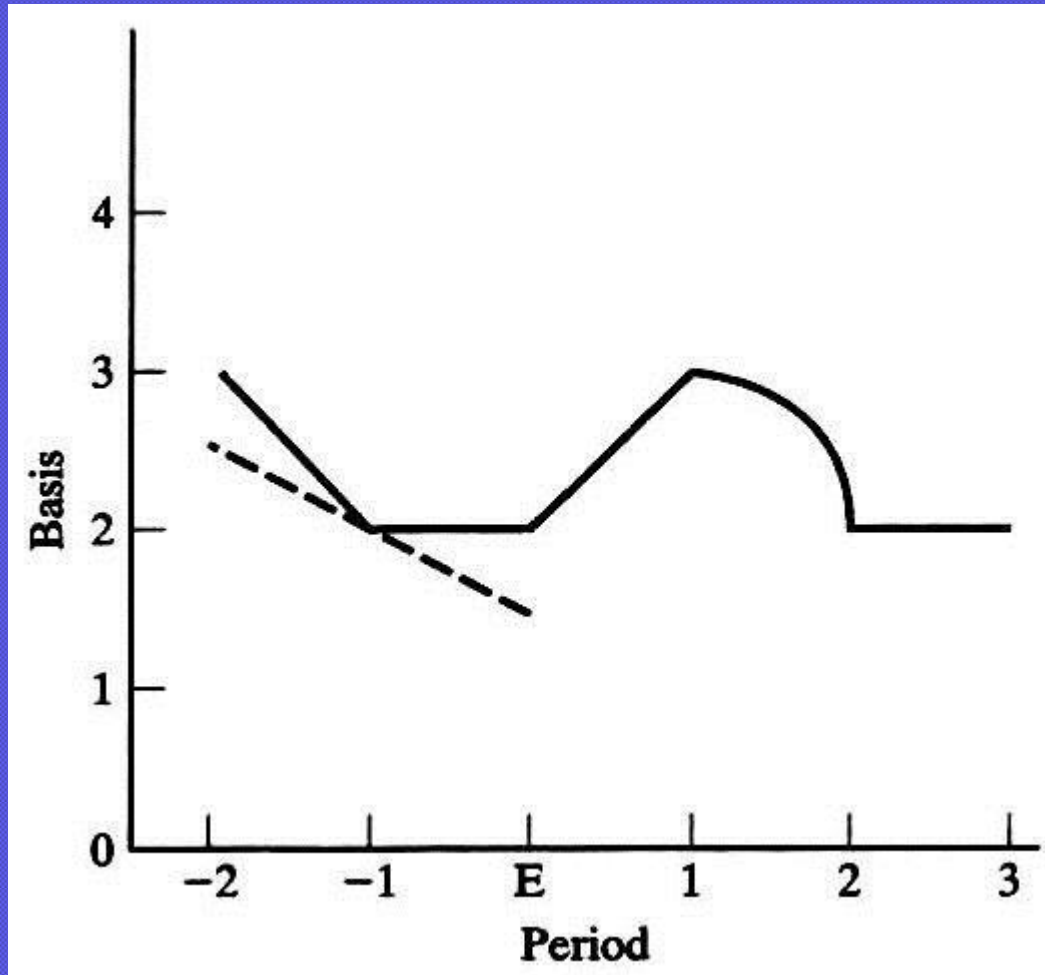
- Collect Overhead Charges
- Determine the Concurrent Basis
 - Labor \$, Hours, Prime Cost
- Calculate the Overhead Rate
- Apply the Rate

$$\text{overheadrate} = \frac{\text{overheadcharges}}{\text{basis}}$$

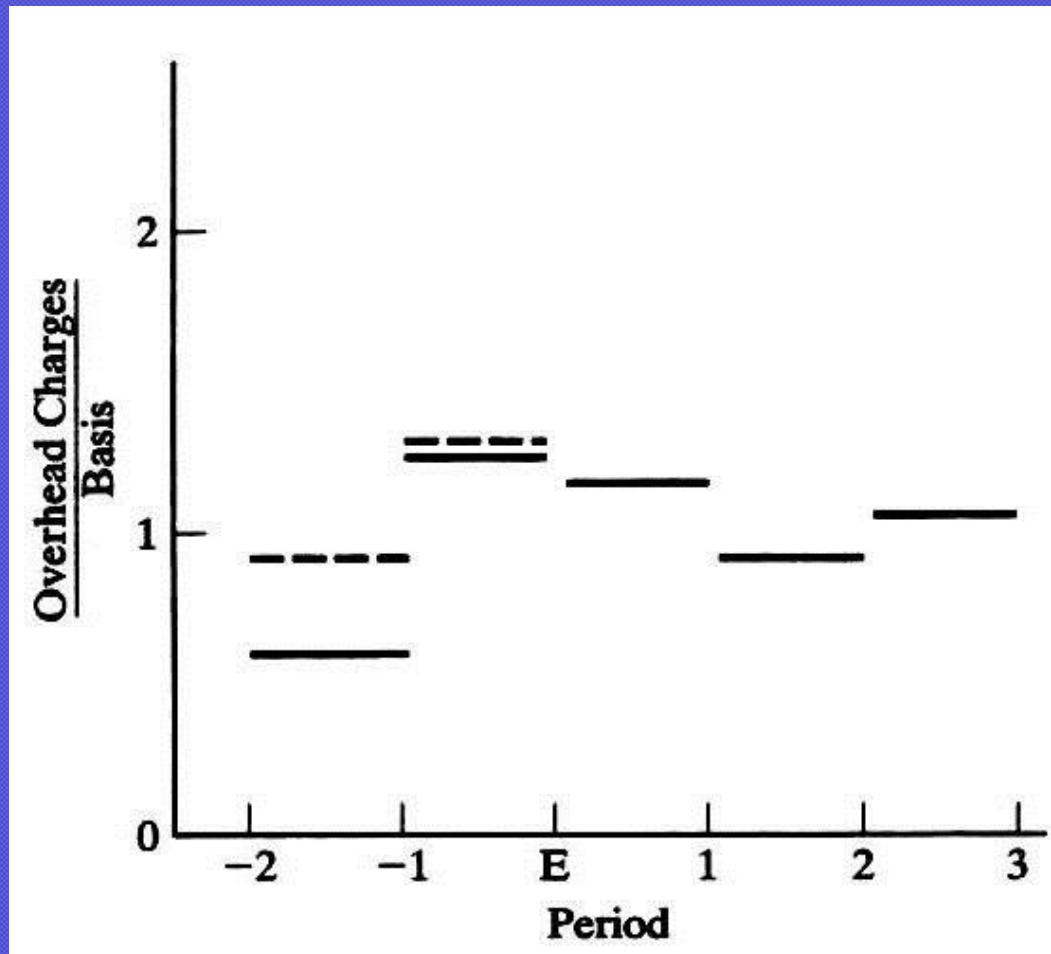
Overhead Charges



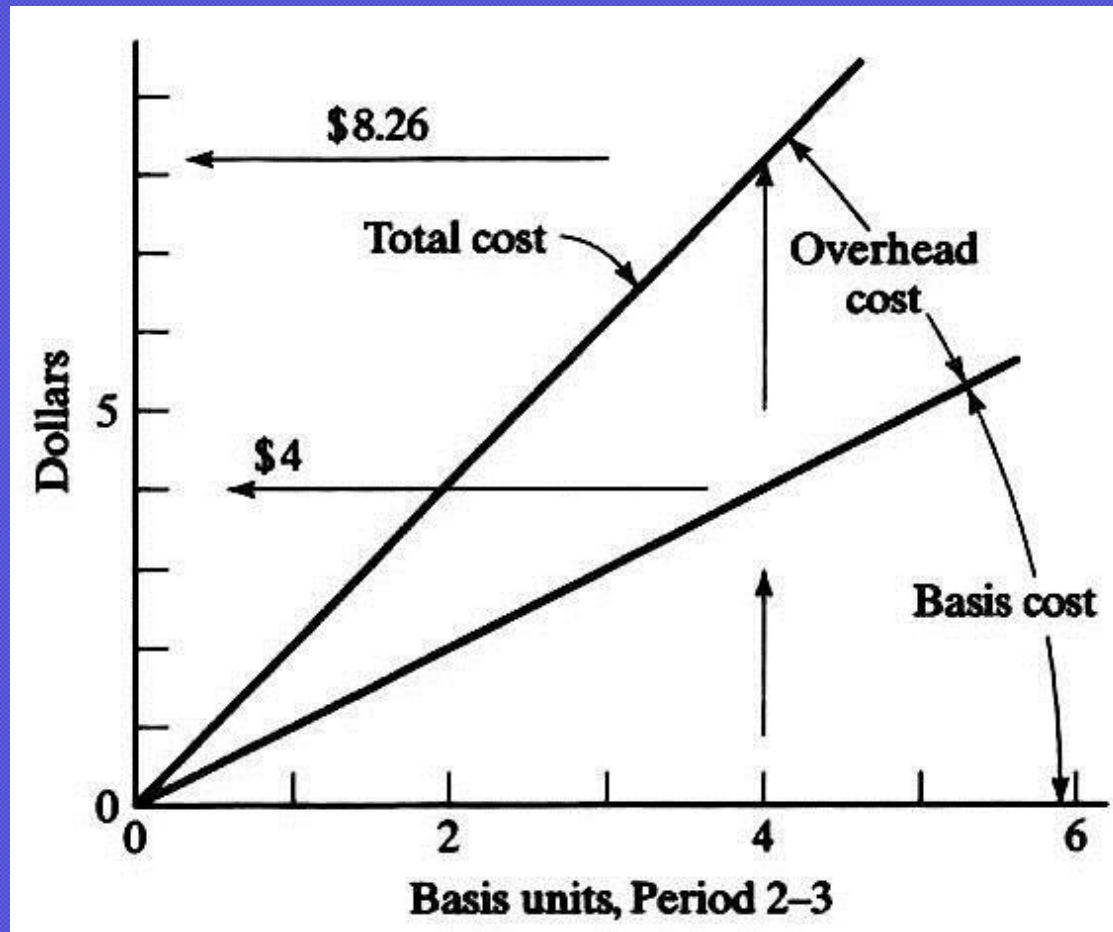
Basis



Overhead Rate



Applying the Rate



Single Rate Example

Center	Est. Hours	Wage (\$/hr)	Direct Labor (\$)	O/H (\$/hr)	O/H Costs (\$)	Total (\$)
Light	7.31	27.82	203.36	24.23	177.12	380.49
Heavy	471.23	33.48	15,776.78	24.23	11,417.90	27,194.68
Assy	21.26	24.25	515.56	24.23	515.13	1,030.68
Test	7.93	26.07	206.74	24.23	192.14	<u>398.88</u>
Subtot						29,004.73
Mat'l (\$/unit)	\$173.80					
Total Mat'l						<u>36,498.00</u>
Total Cost						65,502.73

Productive Hour Cost

- Collect O/H Charges by Category
- Apportion O/H Charges by Use
- Examples
 - Maintenance to Equipment
 - Management to Labor

Assignment to Centers

Center	Dep	Tooling	Space	Utilities
Light	\$52,500	\$200,000	\$87,149	\$82,739
Heavy	95,000	80,000	92,596	139,703
Assy		10,000	29,957	4,482
Test	<u>22,500</u>	<u>65,000</u>	<u>46,298</u>	<u>12,700</u>
	\$170,000	\$355,000	\$256,000	\$239,625
Allo- cation	MACRS	Directly assigned	Shop area	HP Hr

Assignment to Centers (con't)

Center	Indir Lab	Tools	Engr	Mgmt	Total O/H
Light	\$130,216	\$162,146	\$140,451	\$292,763	\$1,147,963
Heavy	17,961	273,781	19,373	48,589	767,003
Assy	44,902	8,784	48,431	87,980	234,538
Test	<u>35,922</u>	<u>24,889</u>	<u>38,745</u>	<u>75,667</u>	<u>321,721</u>
	\$229,000	\$469,600	\$247,000	\$505,000	\$2,471,225
Allo- cation	DLHr	HP Hr	DLHr	DL\$	

Productive Hour Cost Rate

- $\text{PHC} = \text{Machine Rate} + \text{Direct Rate}$

Center	Total O/H	Budget hr	Machine \$/hr	Wages \$/hr	PHC \$/hr
Light	\$1,147,963	49,300	23.29	27.82	51.11
Heavy	767,003	6,800	112.79	33.48	146.27
Assy	234,538	17,000	13.80	24.25	38.04
Test	<u>321,721</u>	<u>13,600</u>	23.66	26.07	49.72
	\$2,471,225	86,700			

Applying PHC Rates

Center	Est Hrs	PHC \$/hr	Cost, \$/lot
Light	7.31	51.11	373.61
Heavy	471.23	146.27	68,926.81
Assy	21.26	38.04	808.73
Test	<u>7.93</u>	49.72	<u>394.28</u>
Subtotal	507.73		70,503.43
Material			36,498.00
Total			107,001.44

Methods Comparison

- Traditional Single Rate
 - Example Product Cost
 - \$65,503
- Productive Hour Cost Rate
 - Example Product Cost
 - \$107,001
- Significant Potential Error

Activity Based Costing (ABC)

- Volume Related Cost Drivers
 - Number of Product Units Built Directly Effects Costs
- Non-Volume Related Cost Drivers
 - Costs Not Effected by Number of Units
 - Can Be Determined By Various Factors
 - e.g. Engineering, Upper Management

Cost Drivers

Volume	Non-volume
Direct labor hours	Input
Machine hours	Number of suppliers
Direct labor costs	Number of engr changes
Production volume	Number of sales orders
Kilowatt hours	Output
Utilities	Number of products
	Inventory levels
	Defect and scrap levels
	Process
	Number of schd changes
	Amount of rework
	Downtime
	Number of material moves

Calculation

- Sum Up Costs By Categories

$$C_{uabc} = \Sigma(h_{pi}C_{hi}) + \Sigma\left(\frac{h_{bi}C_{hi}}{N_b}\right) + \Sigma\left(\frac{M_iC_{oi}}{N_b}\right) + \Sigma C_{oi}$$

Eq 4.13

Variance

- Compare Budget to Actual Costs
- Variance Indicates Deviation from Plan
- Unfavorable Variance
 - Actual Costs Exceed Standard Costs
- Favorable Variance
 - Actual Costs Are Less Than Standard
 - Not Always Beneficial to the Company

Evaluation of Variance

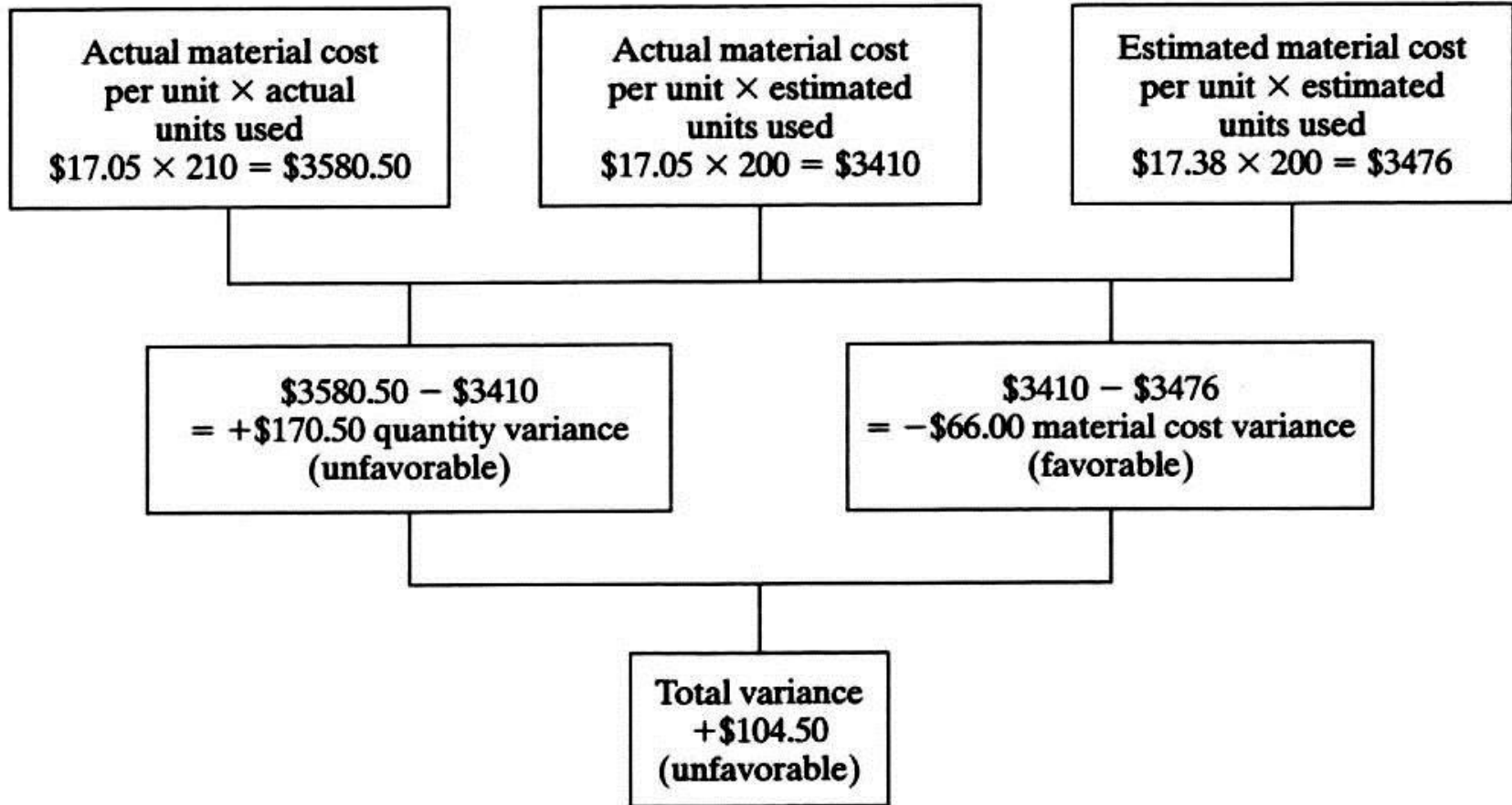
- Unfavorable Variance

- Example Increased Cost Due to Higher Production Than Planned
- Probably Results in More Profit for the Company

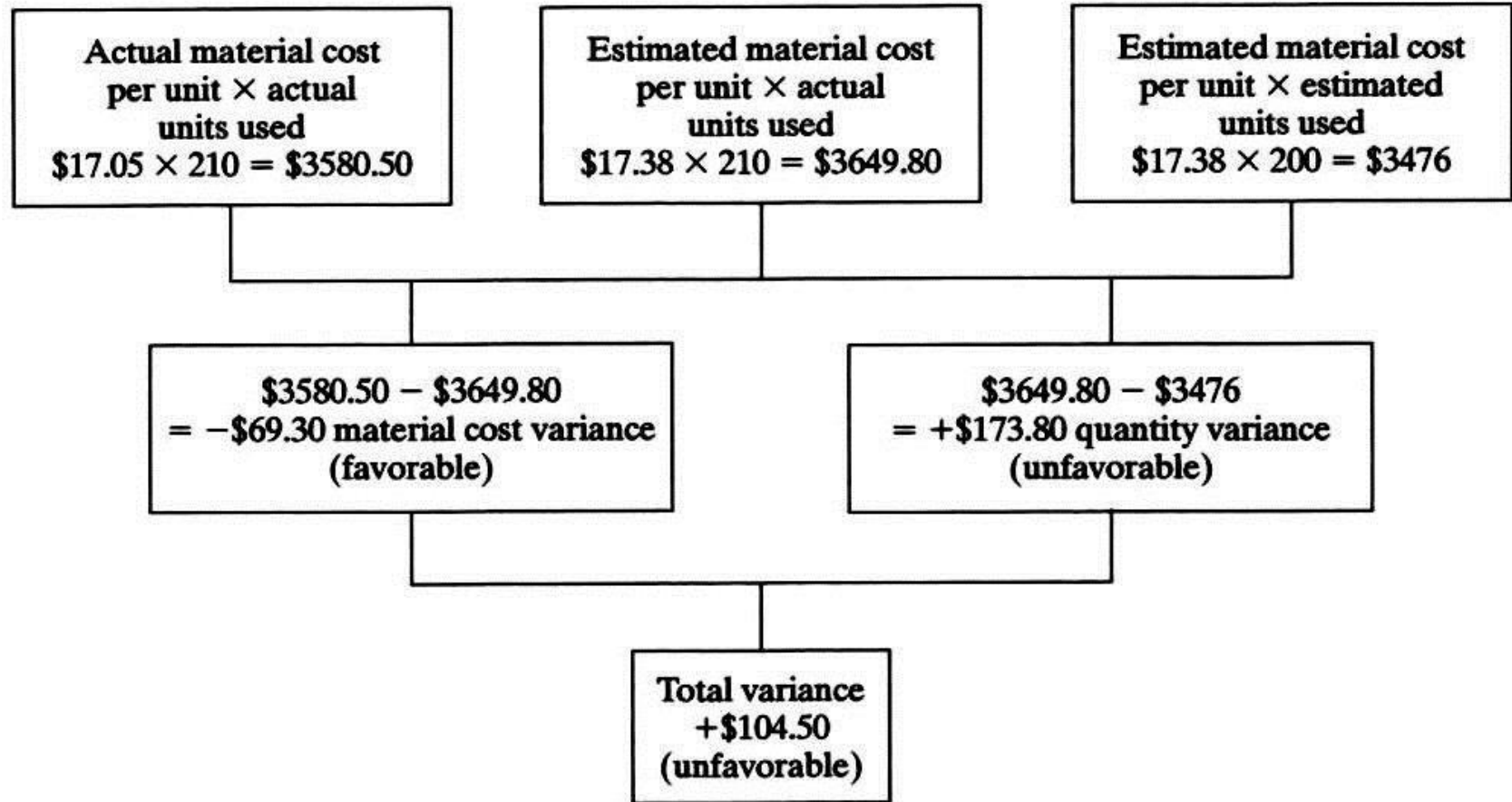
- Favorable Variance

- Could Be from Lower Number of Orders

Finding the Variance



Finding the Variance - Alt.



Material Variance

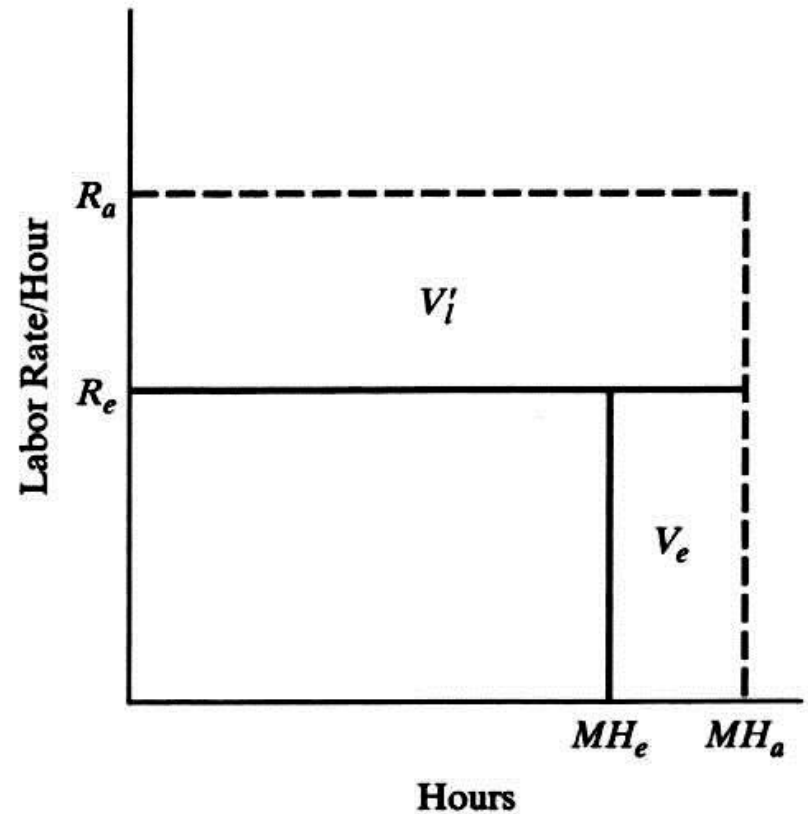
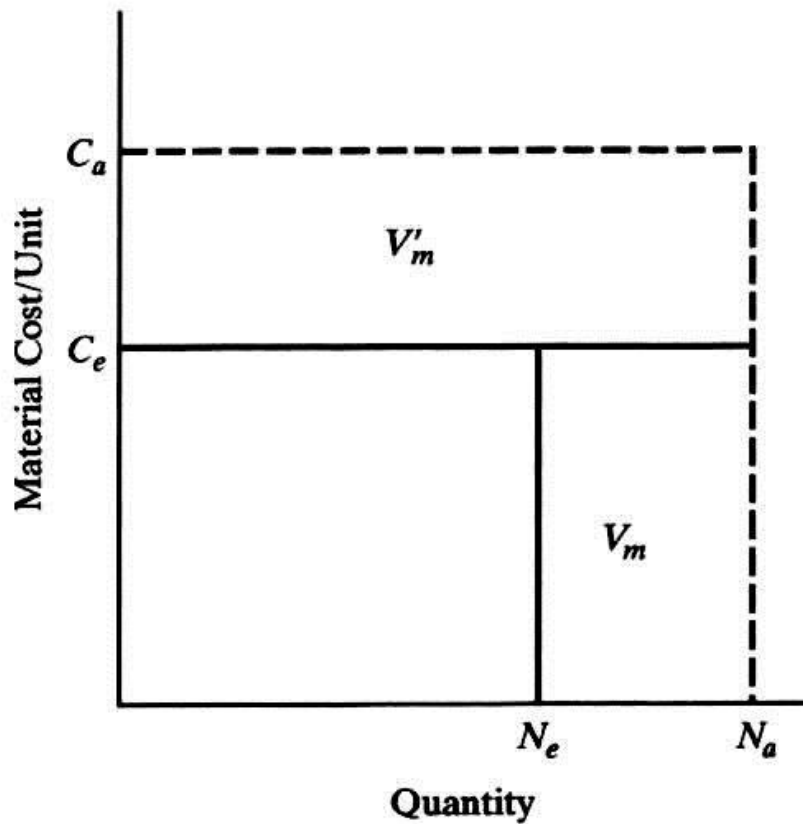
- Total Is the Same
- Depends on Order of Calculation

$$V_m = (N_a - N_e)C_e$$

$$V'_m = (C_a - C_e)N_a$$

Eq 4.14

Illustration



Use of Variances

- Monitor and Control
 - Find Causes of Variance
 - Correct Causes or Budget Process
- Example
 - Extra Production
 - Scrap or More Orders
 - Scrap is Production Problem
 - More Orders Is Sales Forecast Problem

Summary

- How Accounting Works and Fits
- Working With and Impact of Depreciation
- What a Budget Is, What It's Used For
- Determine and Apply Overhead Rates
- Use Variance for Monitor and Control