

Cost Analysis and Estimating for Engineering and Management

Chapter 3 Material Analysis

Overview

- Look at Material in Manufacturing
- Determine the Material Cost
 - Finding the Amount of Material Needed
 - Obtaining a Cost for Material per Unit
- Consider Joint Material Costs

Role of Material

- Manufacturing Changes Material
 - The Change Adds Value
 - Results in a Product
 - Product May Become Material to the Next Enterprise
- Material Is the Substance Being Altered

Definitions

- Material
 - Purchased, Not Manufactured
 - Accounts for Up to 50% of Product Cost
- Product
 - Completed, Suitable for Delivery
- Customer
 - User of the Product
 - External or Internal to the Company

Definitions

- Direct Material
 - Becomes Part of the Product
 - Included in the Design
- Indirect Material
 - Used to Facilitate Manufacturing Process
- Components
 - Used as Purchased in Assembly

Manufacturing Processes

- Mixing, Combining, Refining
- Casting and Molding
- Cutting, Shaping, Forming
- Joining and Assembly
- Cleaning, Painting, Finishing, Coating
- Packaging

Material Costs

- Two Parts
 - Amount of Material (Number of Units)
 - Cost of Material (per Unit)
- Amount of Material
 - Calculated
 - Includes Allowances for Waste, etc.

Cost of Material

- Historical Cost
- Contracted Cost
- Formal Quotes
- Other with Varying Degrees of Accuracy
 - Informal Quotes/Estimates from Suppliers
 - Catalogs
 - Estimates, “Guess-timates”

Other Cost Variations

- Price Changes
- Market Conditions
- Volume Price Breaks
- Discounts

Amount of Material

- Bill of Material
 - Material Required for the Design
 - Specified by the Designer
- Specifications
 - Additional Information About the Material
 - Defines Detailed Requirements
- Need Correct Quantity of Material

Other Designations

- Subcontract Items
 - Made to Specific Designs
 - Not Sold to Others
 - Not Catalog Items
- Interdivisional Transfer
 - “Sold” to Another Division of the Company

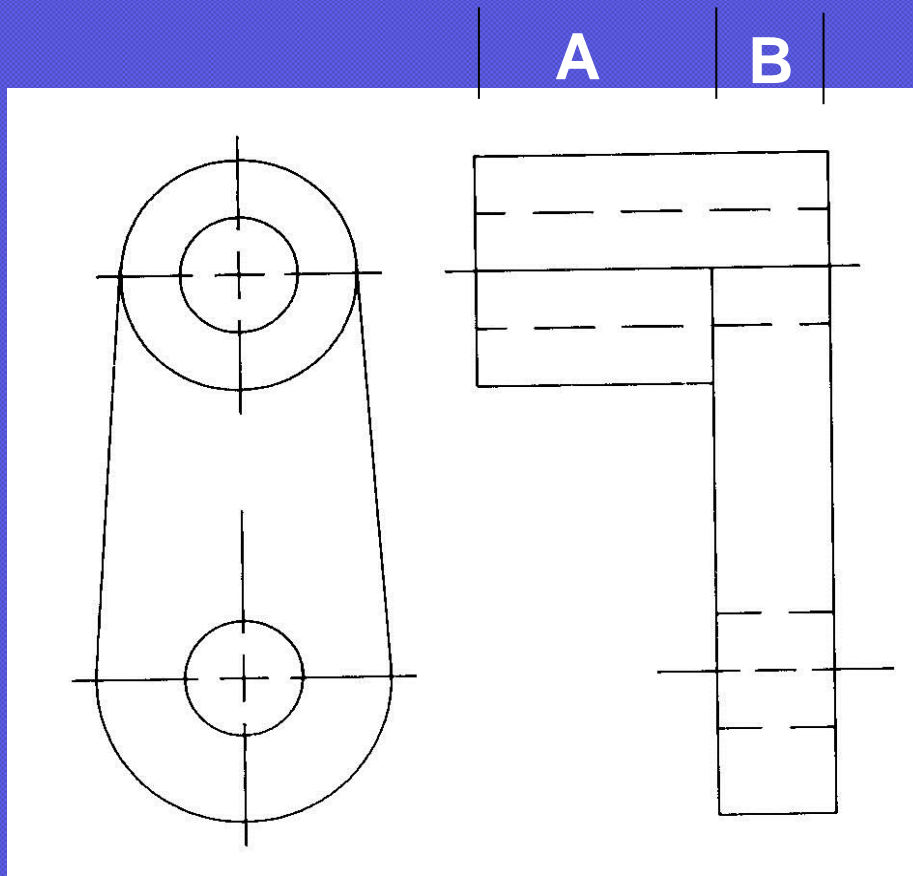
How Much Material?

- Amount of Material IN the Design
- Amount of Material NEEDED to Make the Design
- Difference = Loss
- Shape
 - Amount of Material In the Design

Shape

- Units Compatible with Purchased Material
- Design Should Optimize Material Usage
- Calculate Volume of the Part
- Convert Volume to Appropriate Units

Finding Shape Volume



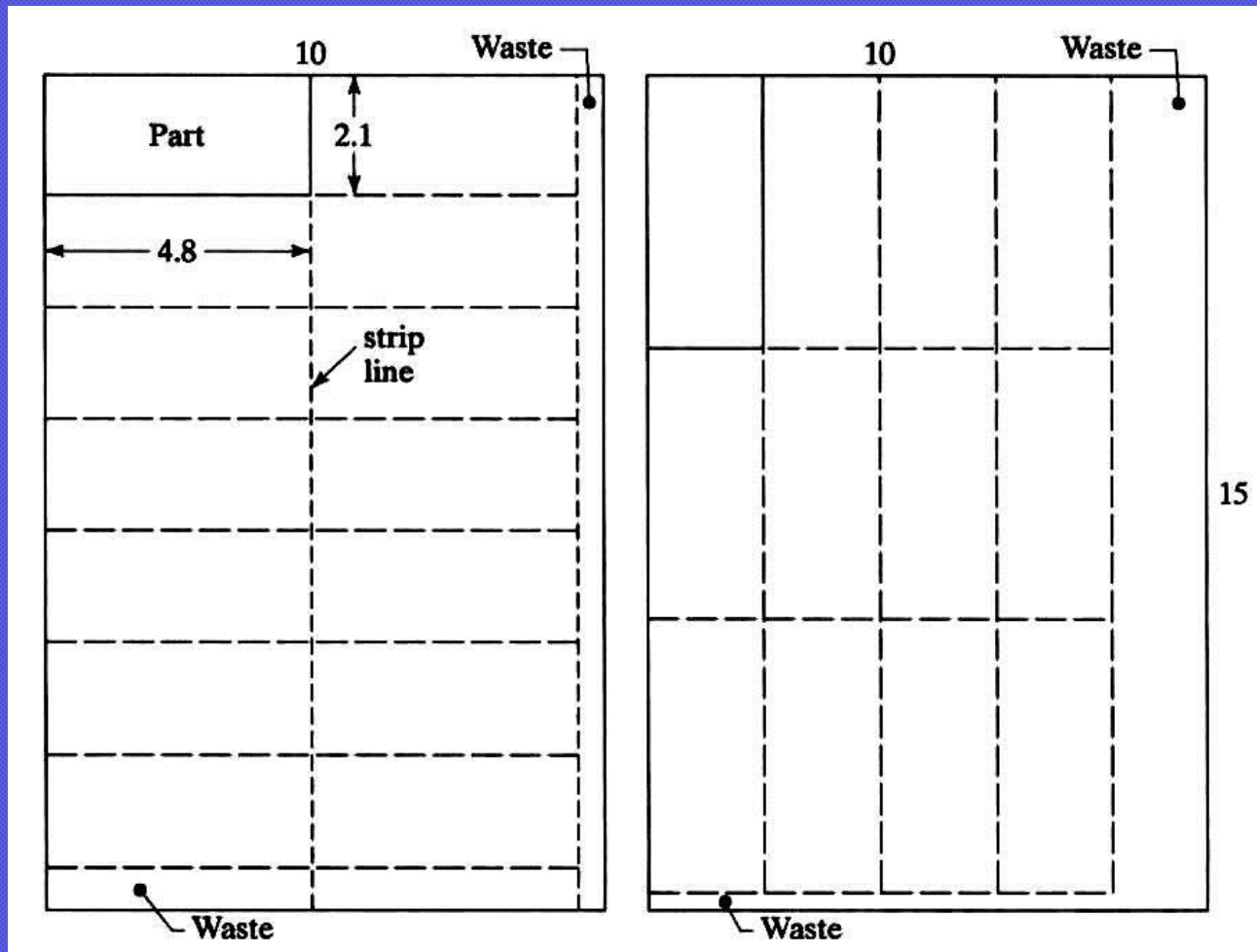
- Calculate volume of cylinder part “A”
- Subtract volume of hole in cylinder “A”
- Calculate volume of plate “B”
- Find volume of half cylinder at each end
- Find volume of trapezoidal portion between
- Subtract volume of two holes in plate

Material Required to Make

- Depends on:
 - Arrangement of Parts to Raw Material
 - Process Allowances
- Efficiency of Material Use Is Important

Effects of Part Layout

14
Parts



12
Parts

Additional Material

- Waste

- Determined by Design & Raw Material
- Difference Between Raw Material Dimensions and Part Shape

- Scrap

- Material Lost Due to Mistakes/Errors

- Shrinkage

- Material Lost Due to Physical Deterioration

Calculating Material

- Additive Processes (Molding, Casting)
 - S_f = Shape for Finished Part
 - S_s = Amount of Material to Start

$$S_s = (S_f + L_1) \times (1 + L_2 + L_3)$$

Eq 3.1

Calculating Material

- Subtractive Processes (Machining)
- No Simple Equation
- Use the Process

Machining Material Process

1. Obtain the finished part shape (S_f) and build quantity.
2. Determine the configuration of the raw material. This consists of the dimensions of the specified or supplied material.
3. Determine cutoff and clamping material requirements.
4. Lay out how the parts will be cut out of the supplied material.

Process Continued

5. Determine the number of parts that can be made from each unit of supplied material (n_1)
6. Divide the total number of parts required by n_1 to obtain the number of units of raw material needed.
7. Compute the total amount of material in units compatible with the pricing scheme (e.g. pound for \$/lb, etc.)

Efficiency

- Ratio of Useful Material to Purchased Material

$$E_s = \frac{S_f}{S_s} \times 100$$

Eq 3.2

Figuring Cost

- Sometimes Waste & Scrap (Called Salvage) Can Be Sold
- Salvage Value

$$V_s = (S_s - S_f) \times C_s$$

Eq 3.3

- Salvage Reduces Material Cost

$$C_{dm} = S_s C_{ms} - V_s$$

Eq 3.4

Material Cost Policies

- Material Specification
 - Lots of Choices for Material
 - Design Must Specify Explicitly
- Commodities
 - Highly Standardized Materials
 - Lots of Market Competition
 - Commonly Stocked, Catalog Items

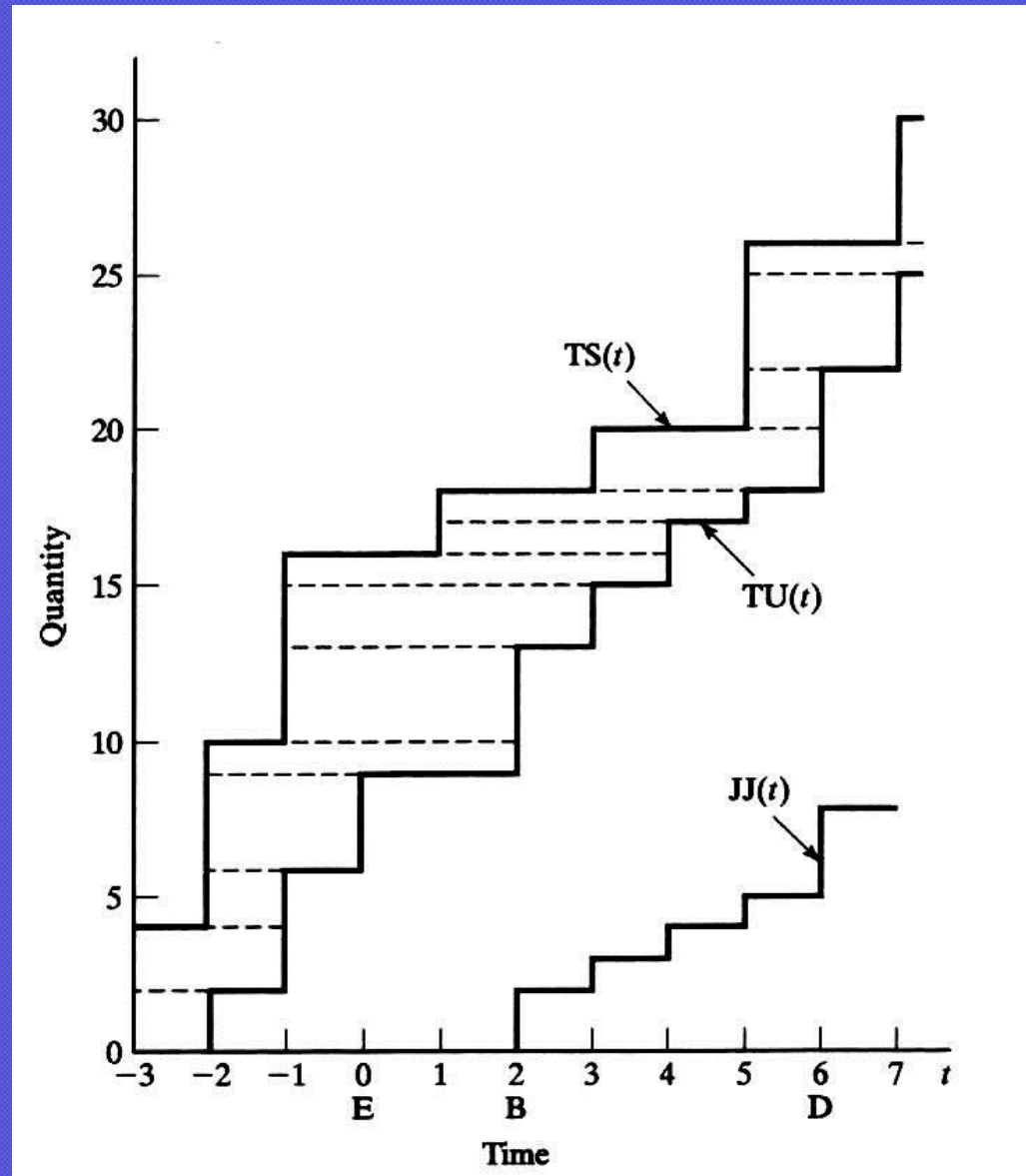
Contractual Costs

- Quotations
 - Terms and Conditions
 - Delivery Date
 - Fixed Price
- Quote or Price-In-Effect
 - Allows Seller to Adjust for Increased Costs

Material from Inventory

- Company Maintains Inventory of Materials
 - Used By Many Jobs
 - Orders Combined
 - Material from Different Orders
 - Different Order Times
 - Different Quantities (Quantity Discounts)
- Material Used Has Varying Cost

Inventory Example

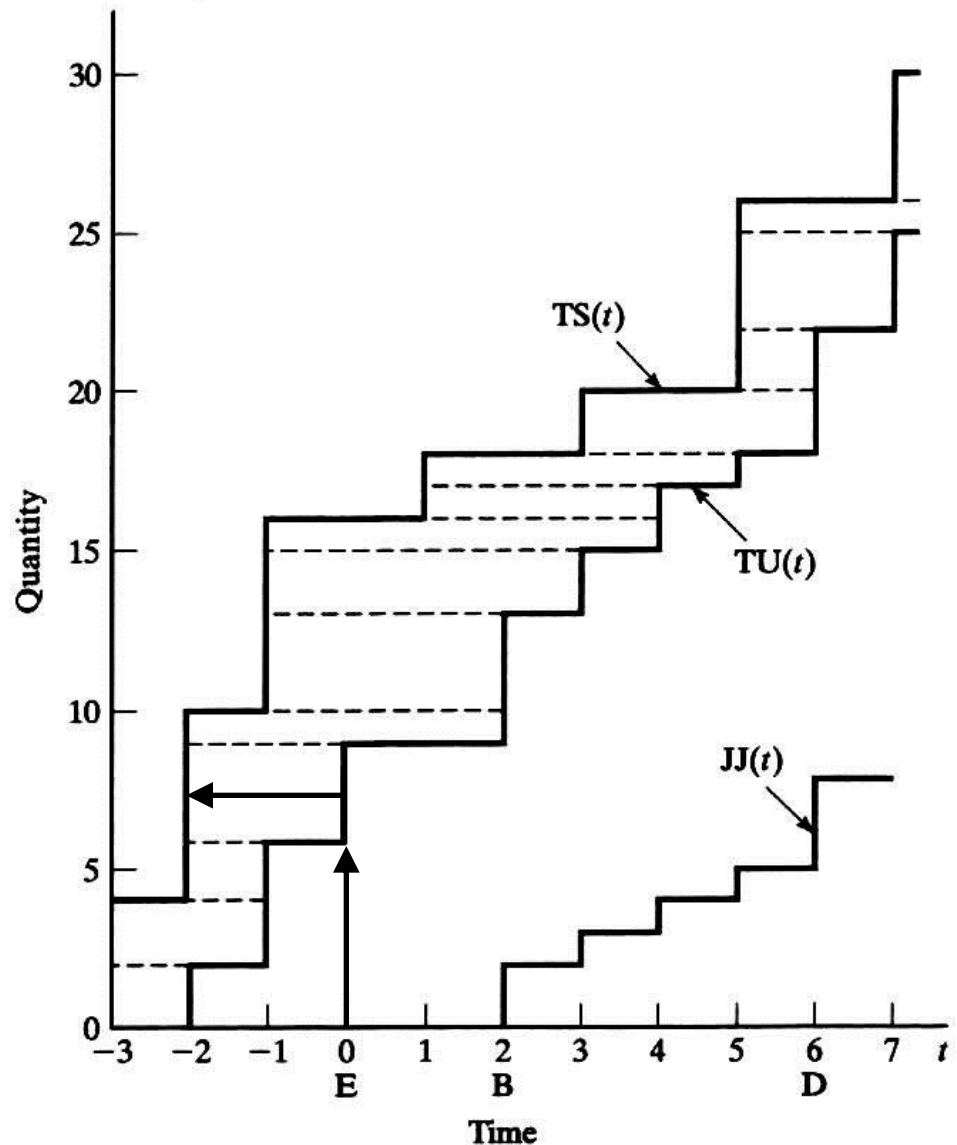


Cost By Time and Quantity

	Quantity	
Period	1-2	3-4
	Historical costs	
-2	11.10	8.95
-1	11.25	9.00
0	12.00	9.65
	Forecast costs	
1	12.95	10.01
2	12.97	10.44

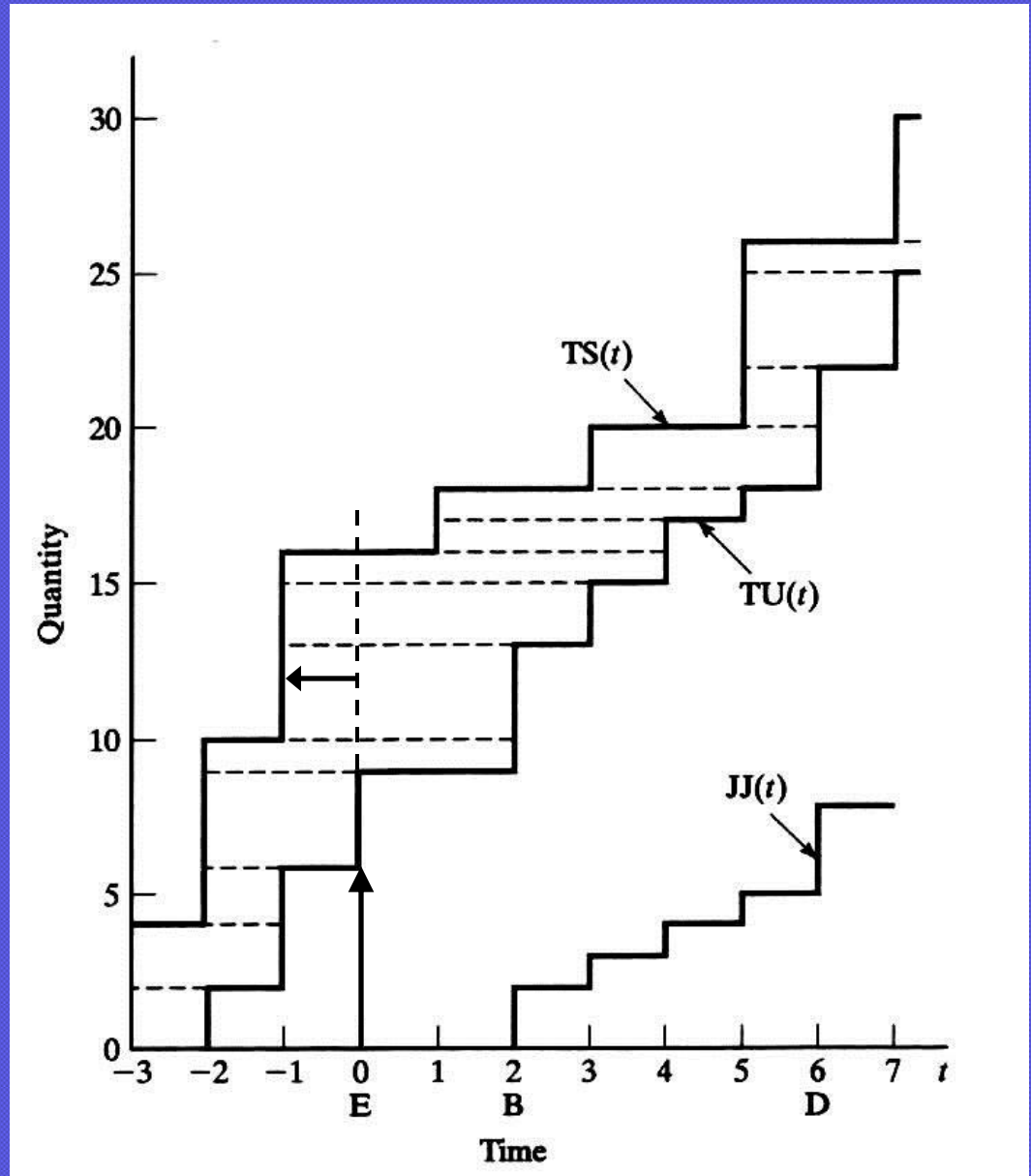
Original Cost Policy

\$7.80



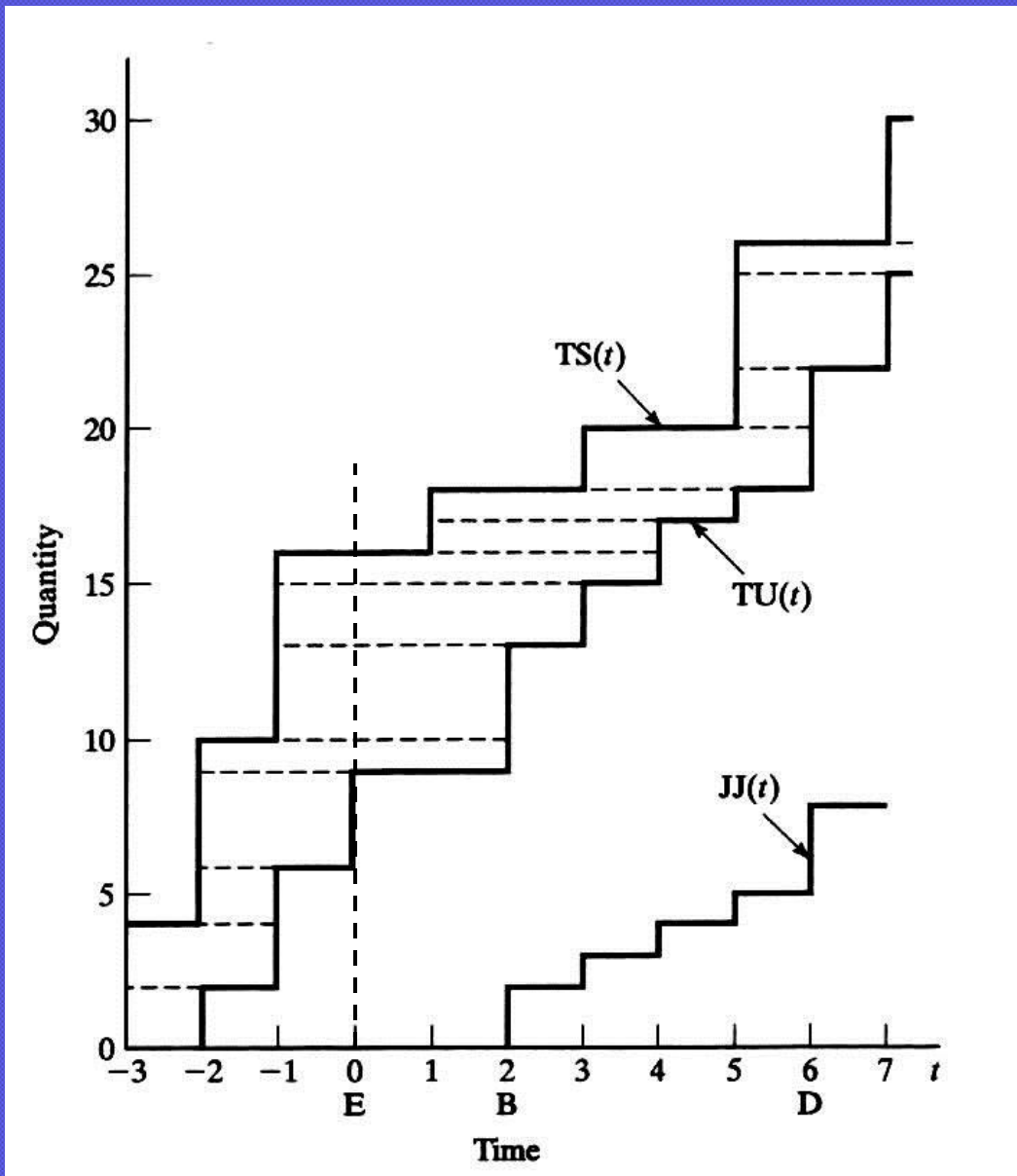
Last Cost Policy

\$7.90



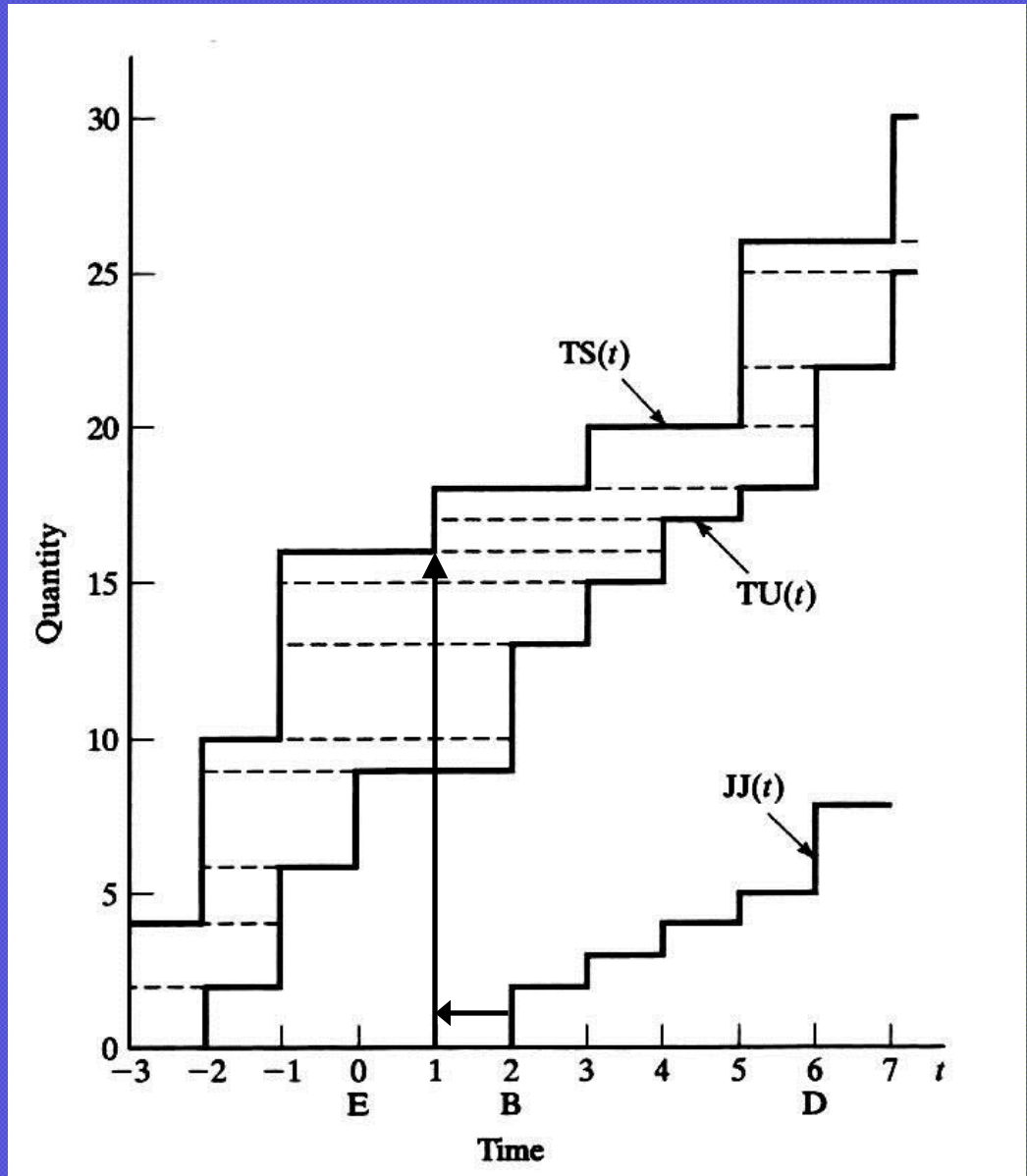
Current Cost Policy

No Current
Receipts
Assume
Qty = 8
\$7.85



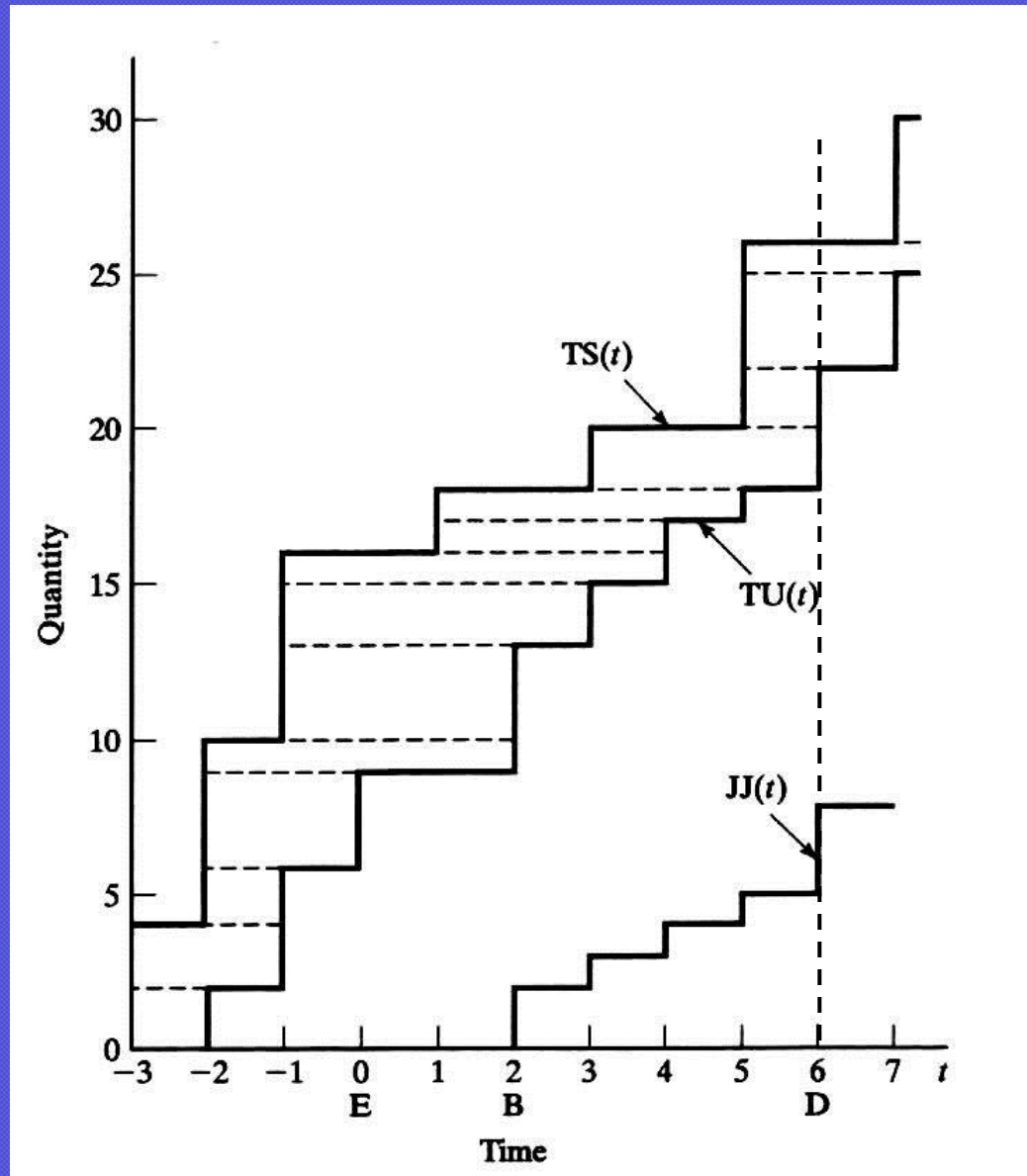
Lead-Time Replacement Cost

\$12.95



Delivery Cost Policy

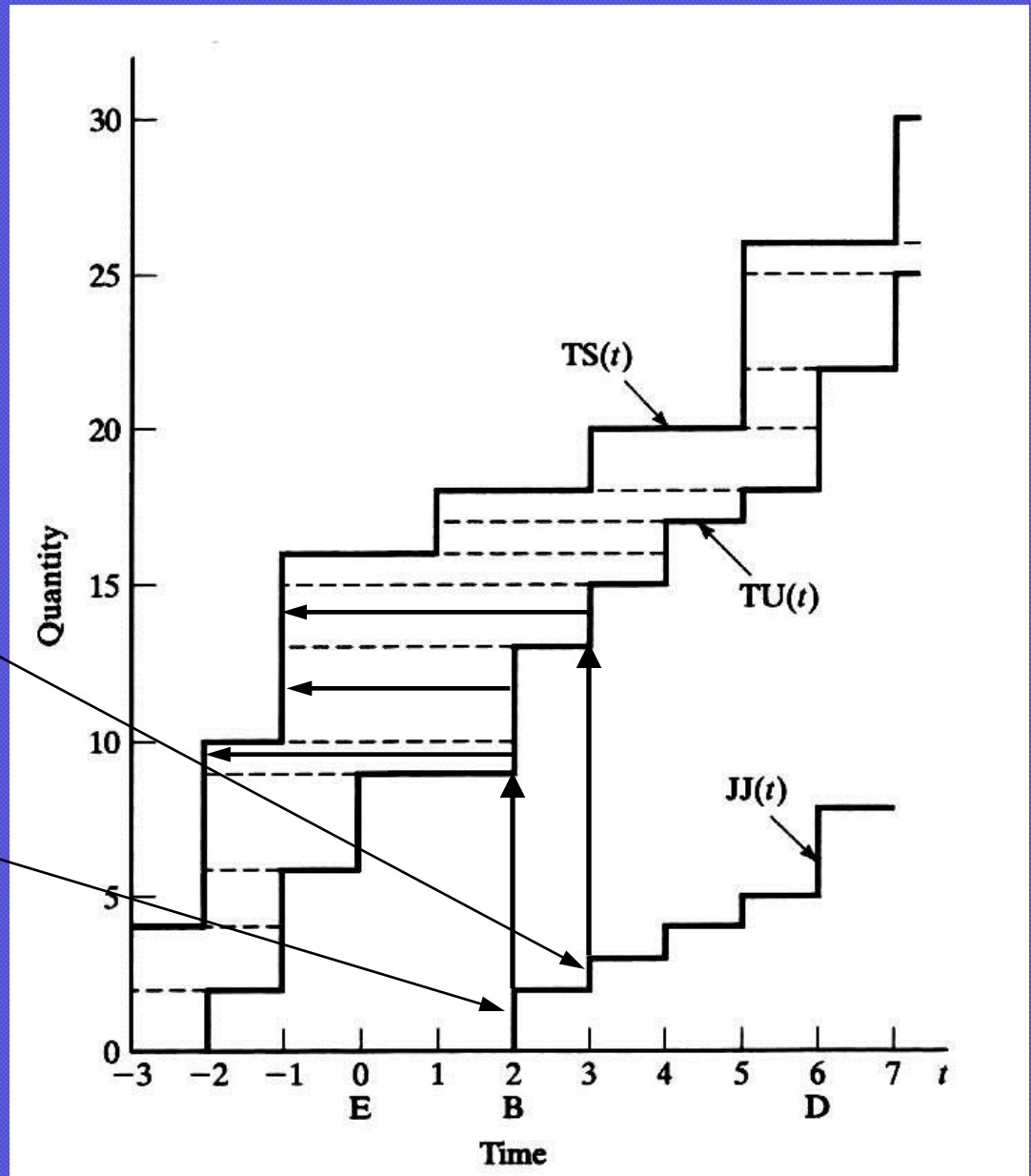
No Receipts
Assume
Qty = 8
\$10.01



MOOP Cost Policy

\$7.90

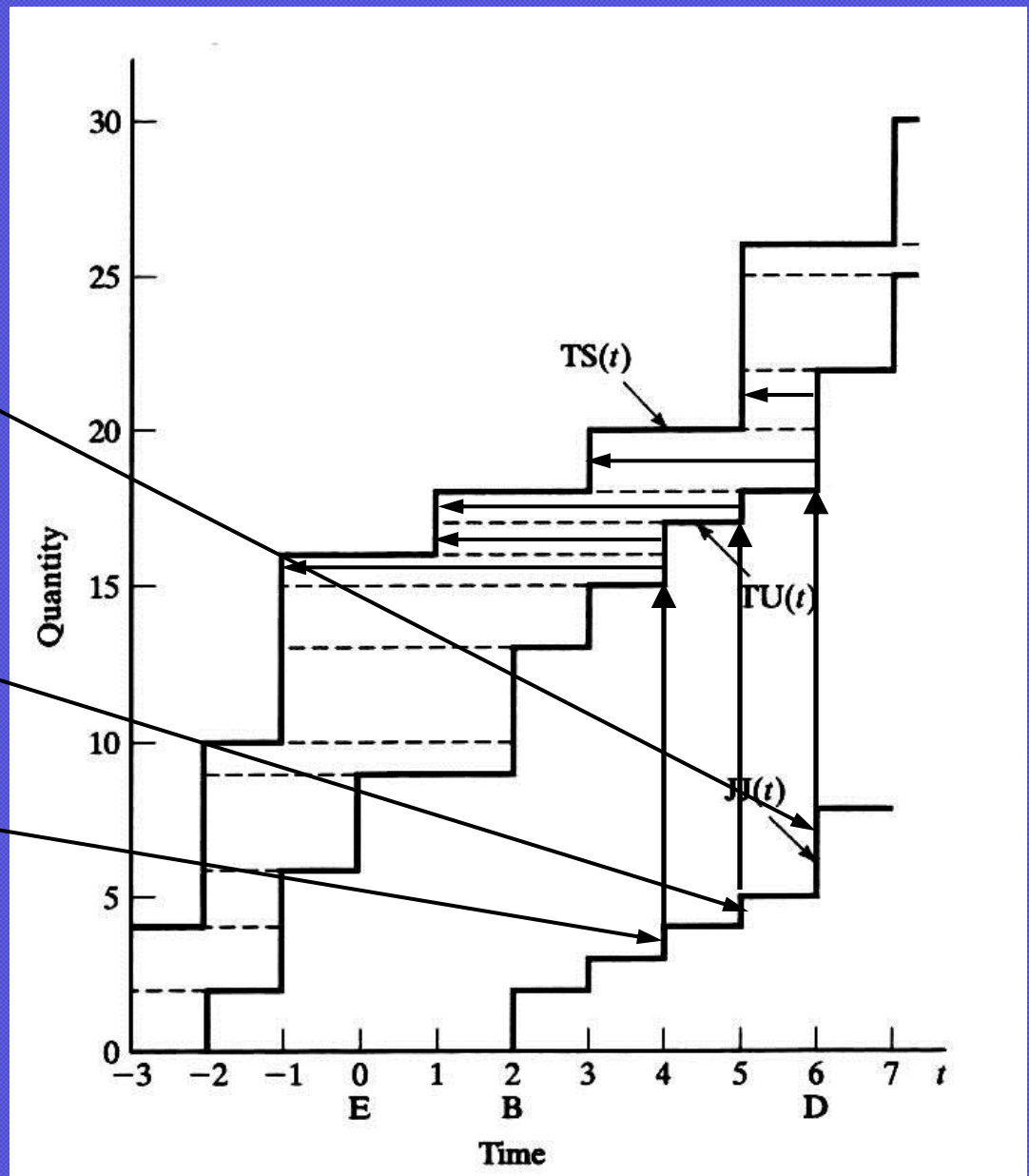
$$\begin{aligned}
 &3 \times \$7.90 \\
 &+ \$7.80 \\
 &\$31.50 / 4 \\
 &= \$7.88
 \end{aligned}$$



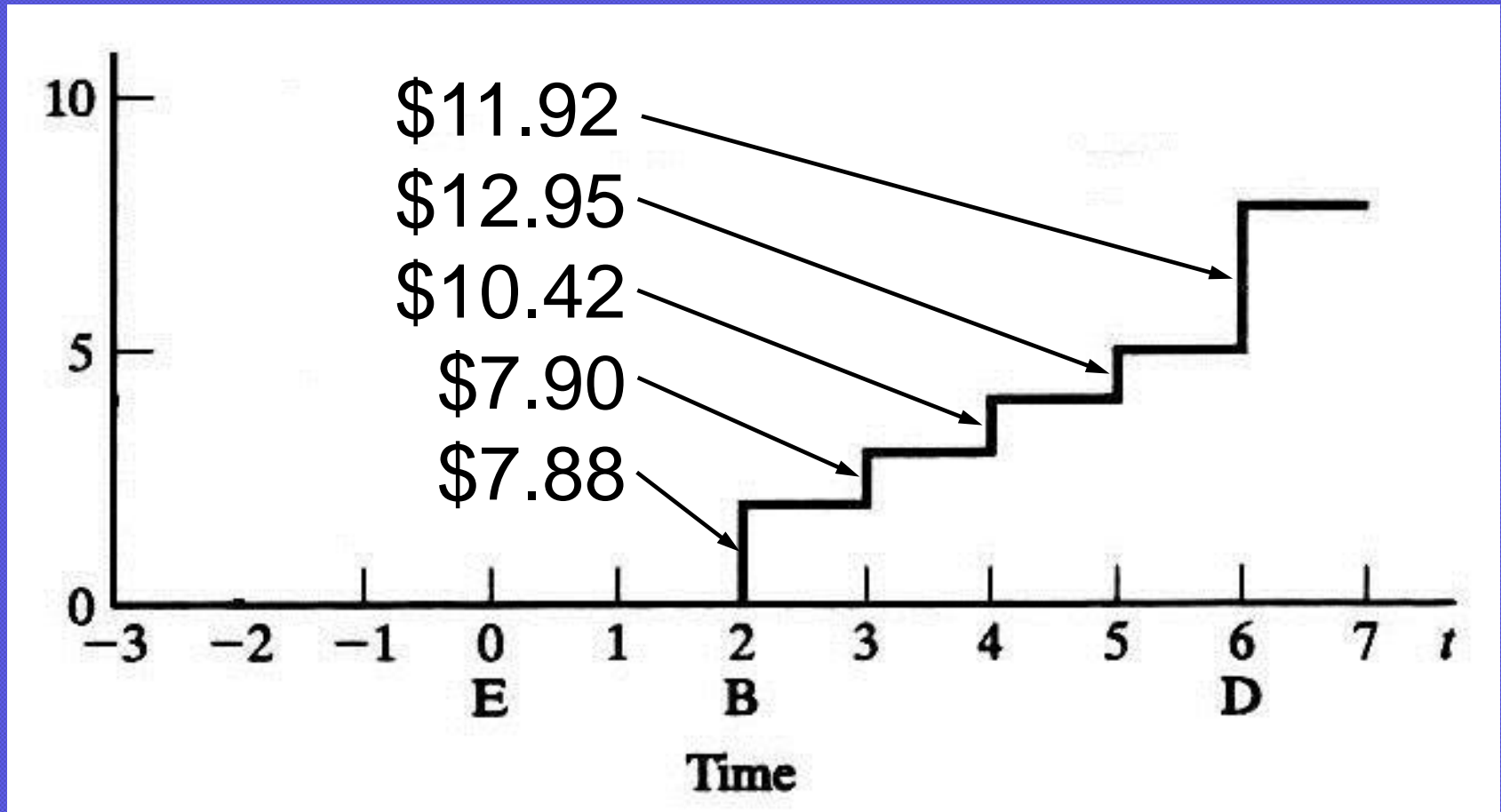
$$\begin{aligned}
 &2 \times \$13.52 \\
 &2 \times \$10.32 \\
 &\$47.68 / 4 \\
 &= \$11.92
 \end{aligned}$$

\$12.95

$$\begin{aligned}
 &\$12.95 \\
 &+ \$7.90 \\
 &\$20.85 / 2 \\
 &= \$10.42
 \end{aligned}$$



MOOP Cost Policy



$$(7.88 \times 2) + 7.90 + 10.42 + 12.95 + (11.92 \times 3) = \$82.79$$

$\$10.35 / \text{Unit}$

Comparison of Policies

Policy	Unit Cost
Original Cost (FIFO)	7.80
Last Cost (LIFO)	7.90
Current Cost	7.85
Lead Time Replacement (NIFO)	12.95
Cost at Delivery	10.01
Money Out of Pocket (MOOP)	10.35

Joint Material Costs

- Similar to Joint Labor Costs
 - Often Includes Some Joint Labor Cost
- Start with a Common Material
- At Some Point, Split into Different Products
- Need to Apportion Material Cost to the Various Products

Distinction

- Distribution Process
 - Material Divided but Not Changed
- Conversion Process
 - Material Is Changed During the Separation Process

Dejointing Cost

- Sometimes Multiple Basis for Dejointing
- Marketing Decisions May Influence
 - One Product Subsidizes Another
 - Premium and/or Discount Pricing
- Accurate Costing Needs to Know Actual Cost Distribution

Product Designations

- Primary Product
 - Reason the Process Exists
- Secondary Product
 - Would Not Exist If Not for the Primary Product

Summary

- Discussed Material Used in Manufacturing
- Learned How to Determine the Amount of Material Needed
- How to Find a Unit Cost for Material
- Used the Cost and Amount to Get Material Cost