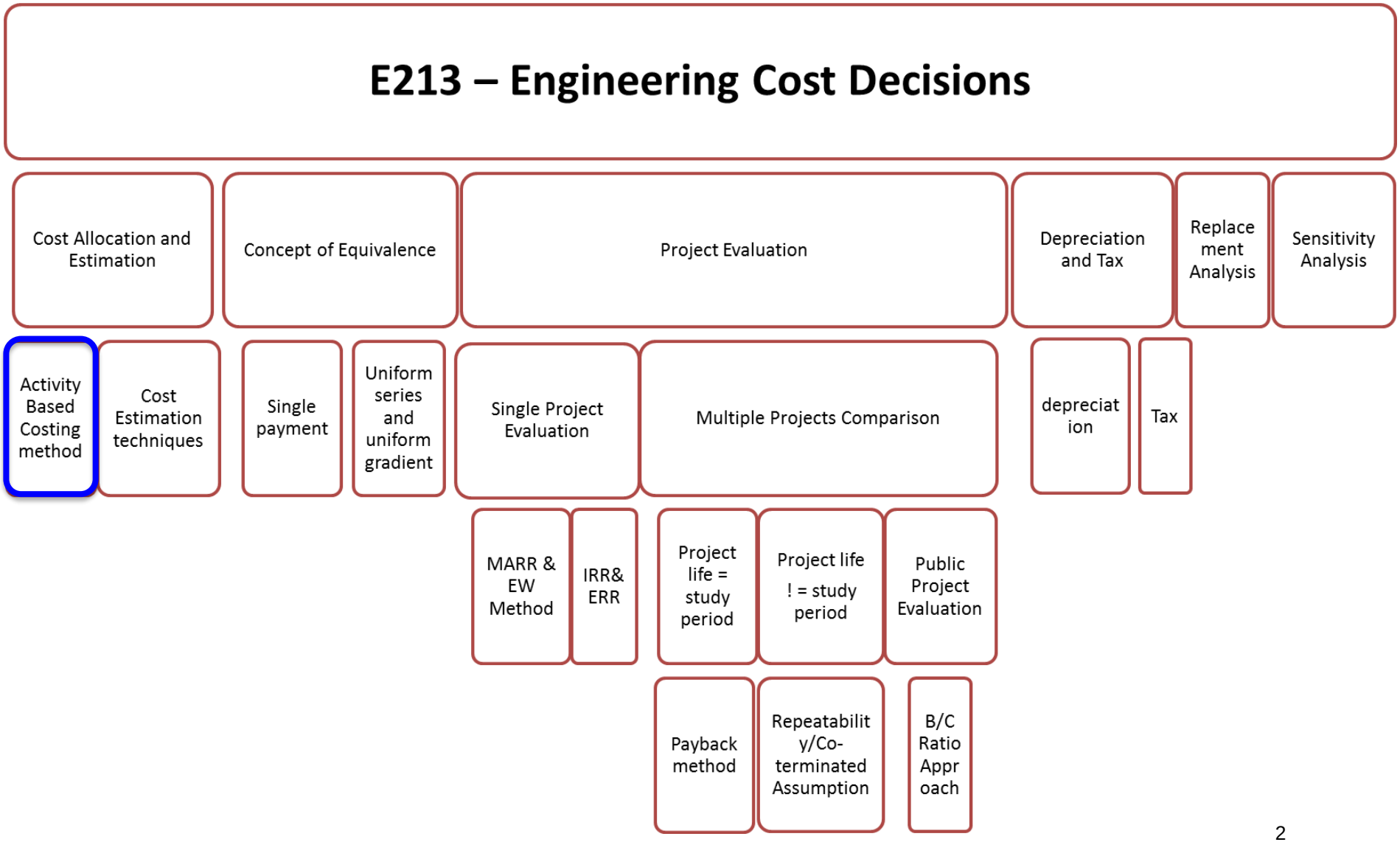
Problem 01

Cost of Making A Backpack

E213 – Engineering Cost Decisions

SCHOOL OF ENGINEERING

Module Coverage: Topic Tree



Cost Estimating and Cost Analysis

- Cost estimating and cost analysis are separate functions, but there is an inseparable relationship between them.

- **Cost estimating**
  - ✓ is the process of *predicting* or *forecasting* the cost of work of an activity or work output
  - ✓ depends on inputs from cost analysis activity
  - ✓ is essentially a look forward into future occurrences

- **Cost analysis**
  - ✓ is the process of *studying and organizing* past costs and future estimates
  - ✓ is primarily a view into the past with an eye towards the future

Basic Cost Terms

- **Fixed Cost**
  - ✓ cost that is constant over a range of output
  - ✓ E.g. rent, tax, permit/license, PCB design, master mold making and software development can be classified as fixed costs
- **Variable Cost**
  - ✓ cost that changes according to level of activity
  - ✓ direct labour and direct material are variable costs
  - ✓ E.g. Ingredient and material cost
- **Direct Cost**
  - ✓ cost that is attributed directly to a specific output
  - ✓ E.g. labour cost, purchasing cost, etc
- **Indirect Cost**
  - ✓ cost that is difficult to allocate to a specific work activity
  - ✓ terms of overhead, indirect cost and burden are used interchangeably
  - ✓ E.g. utility cost, equipment maintenance and facility rental
  - ✓ Overhead Costs consist of all costs of manufacturing other than direct material and direct labour, including indirect labour and indirect material.

Basic Cost Terms

- **Recurring Cost**
  - ✓ cost that is repetitive over a range of activities
  - ✓ E.g. Material cost, labour cost
- **Non-recurring Cost**
  - ✓ cost that is non-repetitive
  - ✓ E.g. PCB design, master mould making and software development are non-recurring costs
- **Sunk Cost**
  - ✓ cost that has occurred in the past and has no relevance to estimates of future cost
  - ✓ E.g. Investment in machine
- **Opportunity Cost**
  - ✓ cost of forgoing best rejected alternative
  - ✓ E.g. opportunity cost of going for further studies is income from working
- **Life Cycle Cost**
  - sum of all costs, both recurring and non-recurring, related to a product or system during its life span
  - E.g. Research and development, project, production, customer service and warranty maintenance

Conventional Costing

- The conventional method of cost accounting assigns or allocates the factory's indirect costs to the items manufactured on the basis of volume such as the number of units produced, the direct labour hours, or the production machine hours.
- Example below is shown using direct labour hours.

  - Total Cost include direct material, direct labour and overhead costs
  - Overhead Costs typically allocated based on
    - Direct Labour Hours
    - Direct Labour Dollars

  Example:
  - Overhead Cost allocated based on Direct Labour Hours

    Total Overhead Cost = $5000

    Product A: Direct Labour Hours = 100 Hours
    Product B: Direct Labour Hours = 150 Hours

    Overhead Cost allocated to Product A = $\left(\frac{100}{100+150}\right)$ * $5000 = $2000

    Overhead Cost allocated to Product B = $\left(\frac{150}{100+150}\right)$ * $5000 = $3000

Limitations of Conventional Costing

- Conventional costing is not accurate to assume direct labour is the main cost contributor
  - Tremendous change in manufacturing and service industries.
  - Decrease in amount of direct labour usage.
  - Significant increase in total overhead costs.
- May be inappropriate to use plant-wide predetermined overhead rates based on direct labour or machine hours when a lack of correlation exists.
- Complex manufacturing processes may require multiple allocation bases.

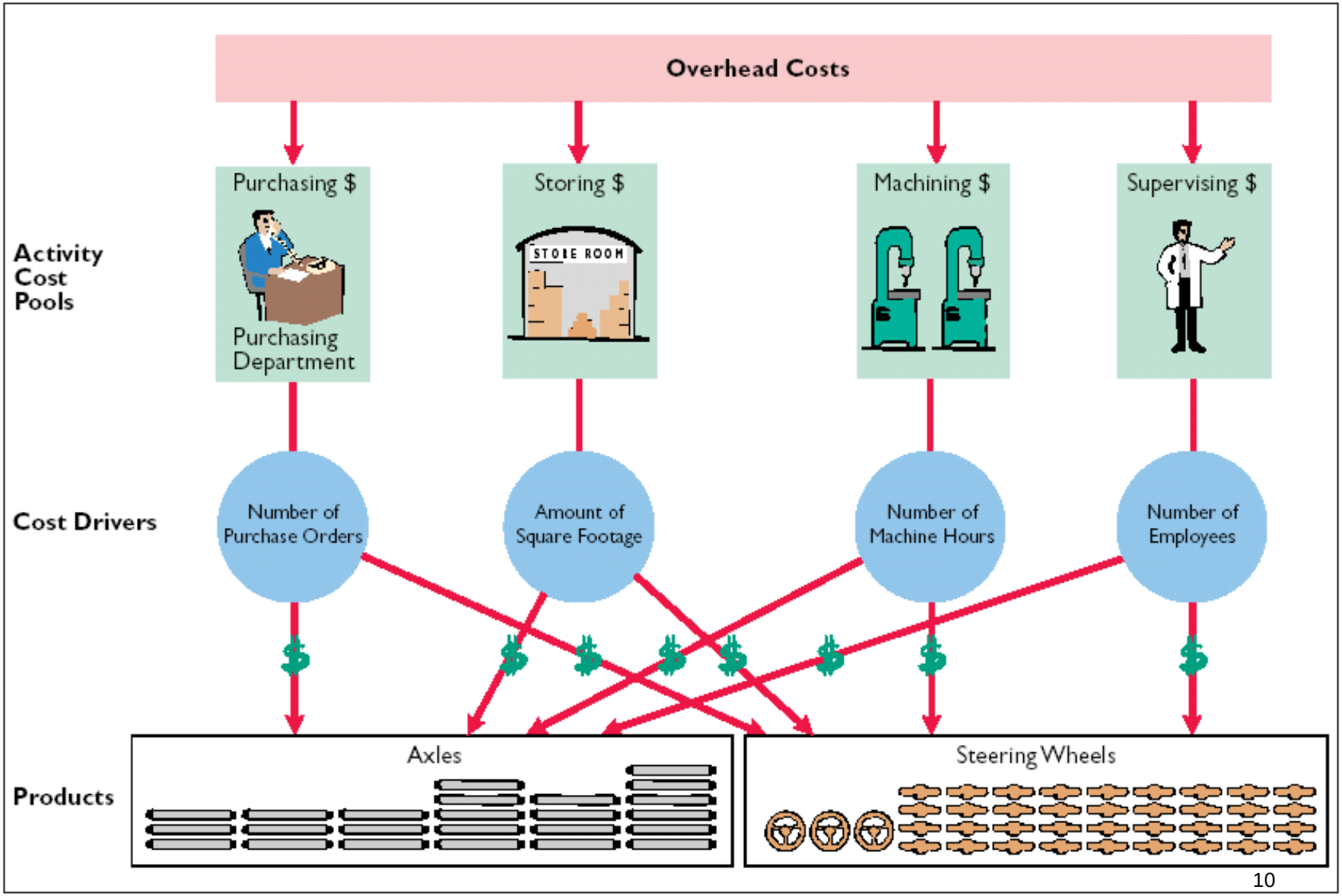
Activity Based Costing

- Activity Based Costing (ABC) is an overhead cost allocation system that
  - Allocates overhead to multiple activity cost pools and
  - Assigns the activity cost pools to products or services by means of cost drivers that represent the activities used.
- More accurate product costing compared to conventional costing
- Time consuming to identify cost drivers

Activity Based Costing

- Activity Based Costing is designed to associate costs with activities that drive them. ABC allocates overhead costs in two stages:
  - Stage 1: Overhead costs are allocated to activity cost pools.
  - Stage 2: The overhead costs allocated to the cost pools are assigned to products using cost drivers.
- Activity: any event, action, transaction, or work sequence that causes a cost to be incurred in producing a product or providing a service.
- Activity Cost Pool: cost associated with a distinct type of activity.
  - For example: machining cost, energy cost, ordering materials cost or setting up machines cost.
- Cost Drivers: any factors or activities that have a direct cause-effect relationship with the resources consumed.
  - For example, Machine Hours, Electricity Hours.

Activity Based Costing – An Example



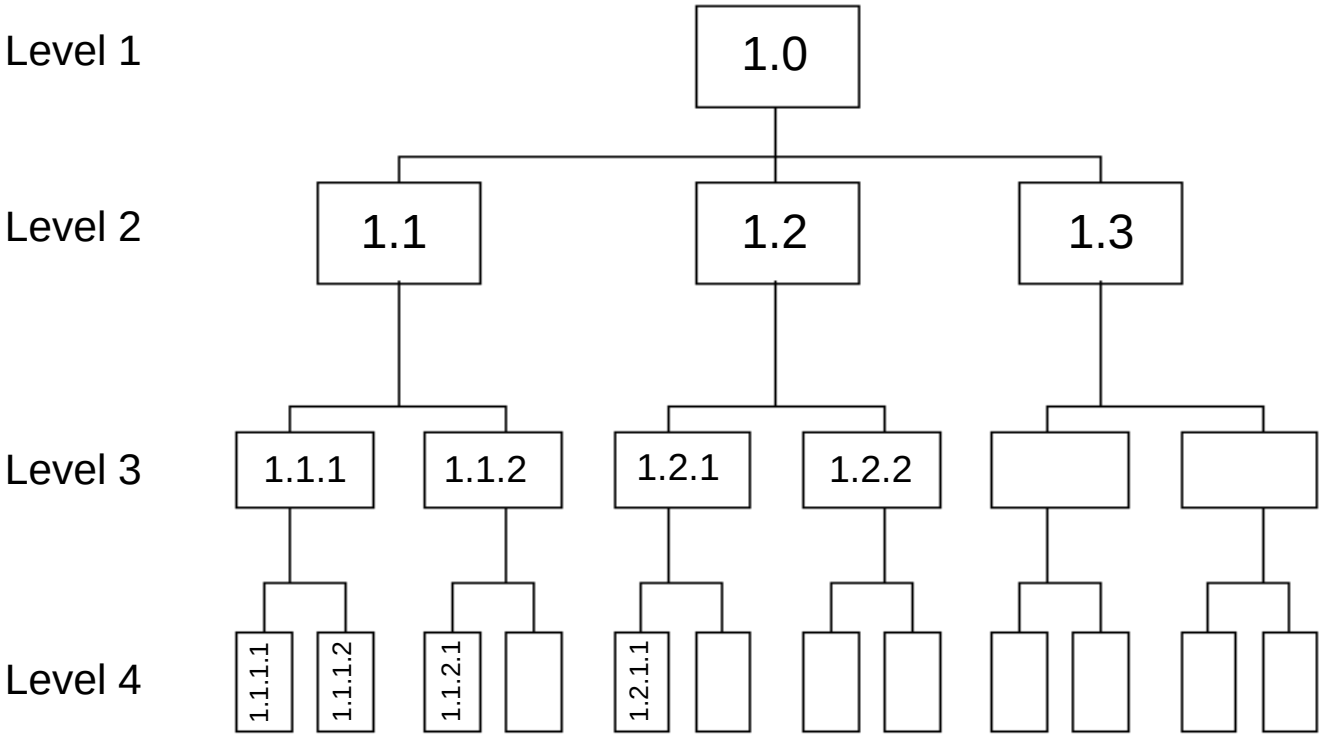
Work Breakdown Structure (WBS)

- WBS is a basic tool of project management used in engineering economic analysis

- WBS serves as a framework for
  1. Defining all project work elements and their relationships
  2. Collecting and organizing information
  3. Developing relevant cost and revenue data
  4. Integrating project management activities

- WBS ensures that all work elements are included. It helps to eliminate duplications and avoid non-related activities.

Example: A Four-Level WBS



Level number	Breakdown	Common term
1	Total Job	Project, product,process,service
2	Major subdivision	System or primary activity
3	Minor subdivision	Subsystem or secondary activity
4	Tasks	Major components or tasks
5	Subtasks	Subcomponents, parts or subtasks

Applying WBS to Cost Computation

Work Breakdown Structure

Total Project Cost:	$2,178		
System A	$678		
System B	$600		
System C	$900		
System A			
Sub system A-1	$572		
Sub system A-2	$106		
Sub system A-1	**QTY**	**COST**	**TOTAL**
Component 1	1	$10	$10
Component 2	5	$50	$250
Component 3	2	$34	$68
Component 4	1	$117	$117
Component 5	1	$59	$59
Component 6	1	$68	$68
Sub system A-2	**QTY**	**COST**	**TOTAL**
Component 1	6	$5	$30
Component 2	6	$2	$12
Component 3	1	$15	$15
Component 4	1	$49	$49

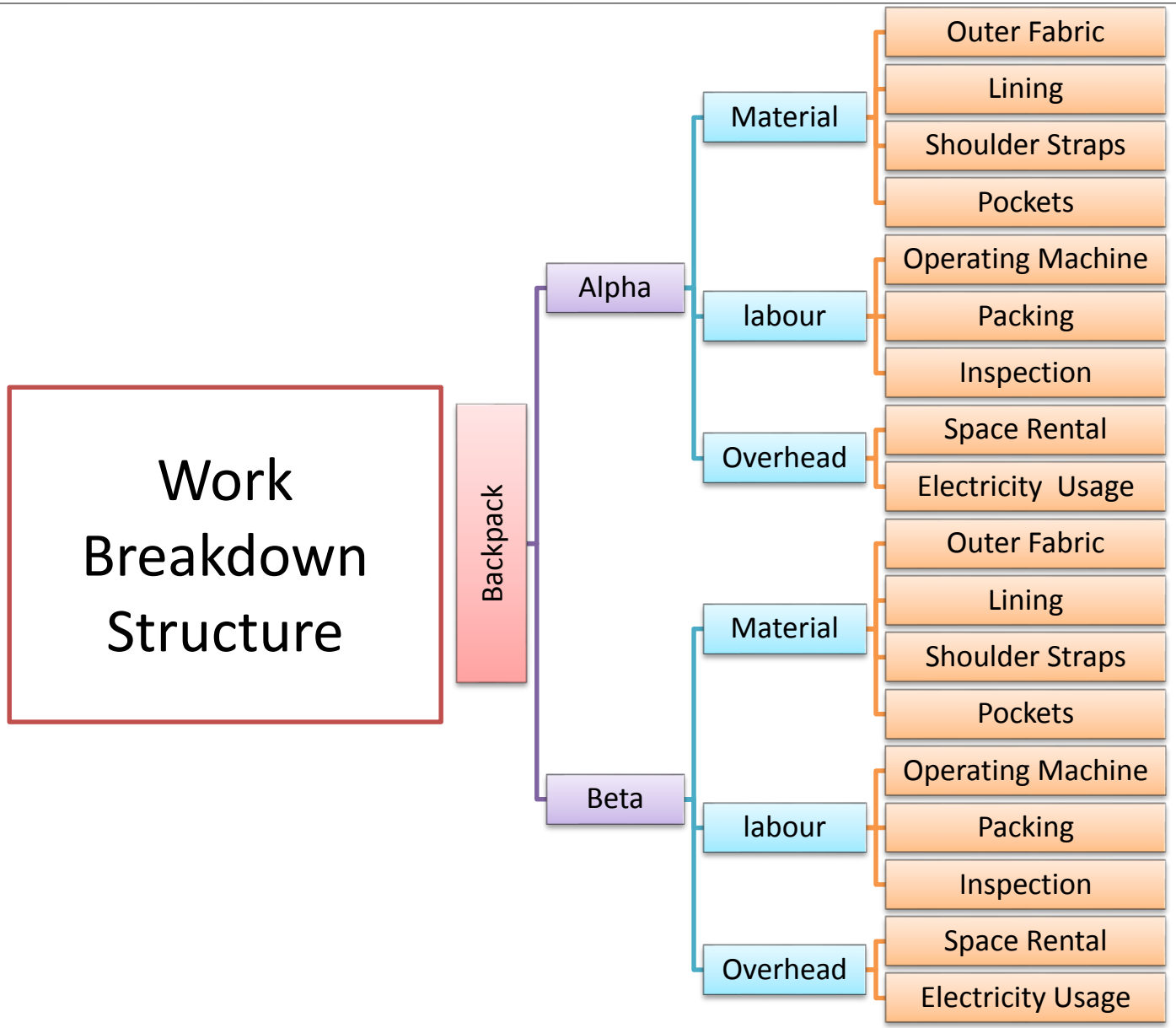
Cost Allocation Methods Comparison

Conventional Costing	Activity Based Costing
Focuses on *final products or services*	Focuses on *process costs* and not product costs
Allocates overhead costs in terms of *volume-based* indicator or *labour hours* in production	Assumes that not all overhead resources are consumed in proportion to the number of units produced.
Spread an overhead cost (such as utility expenses or process engineering support) in *direct proportion* to the volume-based indicator for each cost center	Traces overhead costs back to the *activities* that consume resources and result in costs. Offers product profitability insights in areas that might cloud product costing.
Appropriate for firms where overhead is still primarily driven by volume	Appropriate for firms with significant investment and utilization of automation and technology.

Problem 01

- Suggested Solution

Work Breakdown Structure



Data Collected

Alpha	
Materials	Cost ($)
Outer Fabric	$125,500
Lining	$8,500
Shoulder Straps	$16,500
Pockets	$24,500

Beta	
Materials	Cost ($)
Outer Fabric	$170,000
Lining	$12,500
Shoulder Straps	$20,000
Pockets	$30,500

Labour Cost	$ 7.50	Per hour
Total monthly backpack production	10000	Units
Alpha backpack produced monthly	4000	Units
Beta backpack produced monthly	6000	Units

Labor and Overhead Cost

Monthly Labor Cost (machine, packing, inspection)	**$125,000**
Monthly Overhead Cost (Rental, Electricity)	**$85,000**

Detailed breakdown of the overhead and labour cost

Activity Cost Pools Per Month	Cost Driver	Overhead Rate ($/Unit)	Alpha (Unit)	Beta (Unit)
Operating Machine	Number of hours	7.5	3000	2000
Packing	Number of hours	7.5	4000	3600
Inspection	Number of hours	7.5	1500	1250
Space Rental	Number of m^2	50	800	700
Electricity	Number of KWH	0.8	3250	3000

Conventional Costing

labour and overhead cost is allocated based on 'Direct Machining Time'

	Alpha	Beta
Operating Machine (hours)	3000	2000

Total monthly backpack production	10000	Units
Alpha backpack produced monthly	4000	Units
Beta backpack produced monthly	6000	Units

Labor and Overhead cost	
Monthly Labour Cost	$125,000
Monthly Overhead Cost (e.g.	$85,000

Alpha

Direct Materials Cost

Materials	Cost ($)	Cost/unit ($)
Outer Fabric	$125,500	$31.38
Lining	$8,500	$2.13
Shoulder Straps	$16,500	$4.13
Pockets	$24,500	$6.13
Total	**$175,000**	**$43.75**
Labour Cost		
Labour	**$ 75,000.00**	**$ 18.75**
OverHead Cost		
OverHead	$ 51,000.00	$ 12.75
Cost of 1 unit of Alpha		**$ 75.25**

Beta

Direct Materials Cost

Materials	Cost ($)	Cost/unit ($)
Outer Fabric	$170,000	$28.33
Lining	$12,500	$2.08
Shoulder Straps	$20,000	$3.33
Pockets	$30,500	$5.08
Total	**$233,000**	**$38.83**
Labour Cost		
Labour	**$ 50,000.00**	$ 8.33
OverHead Cost		
OverHead	$ 34,000.00	$ 5.67
Cost of 1 unit of Beta		**$ 52.83**

125,000 * 3,000 / (2,000+3,000)

75,000 / 4,000

85,000 * 2,000 / (2,000+3,000)

34,000 / 6,000

ABC Costing

Detailed breakdown of the overhead and labour cost

Activity Cost Pools Per Month	Cost Driver	Overhead Rate ($/Unit)	Alpha (Unit)	Beta (Unit)
Operating Machine	Number of hours	7.5	3000	2000
Packing	Number of hours	7.5	4000	3600
Inspection	Number of hours	7.5	1500	1250
Space Rental	Number of m^2	50	800	700
Electricity	Number of KWH	0.8	3250	3000

Labour Cost	$ 7.50	Per hour
Total monthly backpack production	10000	Units
Alpha backpack produced monthly	4000	Units
Beta backpack produced monthly	6000	Units

Activity based costing using known cost drivers and tracers gives a more detailed and accurate approximation.

Alpha (1 Unit)

Direct Materials Cost

Materials	Cost ($)	Cost/unit ($)
Outer Fabric	$125,500	$31.38
Lining	$8,500	$2.13
Shoulder Straps	$16,500	$4.13
Pockets	$24,500	$6.13
Total	$175,000	$43.75

3,000 X $7.5

22,500 / 4,000

Labour Cost

Type of Labour	Labour Cost	Cost/unit ($)
Operating Machine	$ 22,500.00	$ 5.63
Packing	$ 30,000.00	$ 7.50
Inspection	$ 11,250.00	$ 2.81
Total	$ 63,750.00	$ 15.94

Cost Drivers

800 m^2 X $50

40,000 / 4,000

OverHead Cost

Type of Overhead	Overhead Cost	Cost/unit ($)
Space Rental Cost (m^2)	$ 40,000.00	$ 10.00
Electricity Cost (KWH)	$ 2,600.00	$ 0.65
Total	$ 42,600.00	$ 10.65

Cost Drivers

Cost of 1 unit of Alpha	$ 70.34

Beta (1 Unit)

Direct Materials Cost

Materials	Cost ($)	Cost/unit ($)
Outer Fabric	$170,000	$28.33
Lining	$12,500	$2.08
Shoulder Straps	$20,000	$3.33
Pockets	$30,500	$5.08
Total	$233,000	$38.83

Labour Cost

Type of Labour	Labour Cost	Cost/unit ($)
Operating Machine	$ 15,000.00	$ 2.50
Packing	$ 27,000.00	$ 4.50
Inspection	$ 9,375.00	$ 1.56
Total	$ 51,375.00	$ 8.56

OverHead Cost

Type of Overhead	Overhead Cost	Cost/unit ($)
Space Rental Cost (m^2)	$ 35,000.00	$ 5.83
Electricity Cost (KWH)	$ 2,400.00	$ 0.40
Total	$ 37,400.00	$ 6.23

Cost of 1 unit of Beta	$ 53.63

Analysis

Backpack	Conventional Costing	Activity Based Costing
Alpha	**$75.25**	**$70.34**
Beta	**$52.83**	**$53.63**

Difference:
75.25 - 70.34 =
$4.91

Difference:
52.83 – 53.63 =
-$0.80

- Cost of Alpha backpack will be overestimated by $4.90 using Conventional Costing Method compared to Activity Based Costing
- Cost of Beta backpack will be under-estimated by $0.80 using Conventional Costing Method compared to Activity Based Costing
- To identify where the differences came from – allocation of the labour cost and overhead (indirect cost) between the two types of backpacks.
- Recommend Brian to use Activity Based Costing for better accuracy

Learning Objectives

- Explain the need for cost estimation
- Classify the common cost terms
- Differentiate between conventional costing with Activity-Based Costing
- Allocate indirect cost using conventional and Activity-Based Costing methods

E213 Engineering Cost Decisions (Topic Flow)

Today's learning

- Application of ABC costing method in cost management
- Application of different cost estimating techniques
- Comparison of alternatives using the concept of equivalence
- Alternatives evaluation using single, uniform series and uniform gradient cash flows
- Project evaluation using MARR and Equivalent Worth method
- Evaluate alternatives of equal life spans using payback method
- Project evaluation based on Internal Rate of Return and External Rate of Return
- Evaluate alternatives with different life spans
- Evaluate public projects through incremental B/C analysis
- Depreciation estimation and consideration in economic analysis
- Tax consideration in economic analysis
- Replacement analysis application
- Risk and uncertainties handling in economic analysis

Announcement

Pre-reading resources for each problem will be uploaded to Workbin before the week for that problem.

Do come PREPARED for ALL problems!