

## 1. Element of Investment Cost

Consider a situation in which the equipment and related support for a new Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM) workstation are being acquired for your engineering department. The applicable cost elements and estimated expenditures are as follows:

Cost Element	Cost
Lease a telephone line for communication	RM 1,100/month
Lease CAD/CAM software (includes installation and debugging)	
RM 550/month	
Purchase hardware (CA/CAM workstation)	
	RM 20,000
Purchase high-speed modem	
	RM 250
Purchase a high-speed printer	
	RM 1,500
Purchase a four-color plotter	
	RM 10,000
Shipping costs	
	RM 500
Initial training (in house) to gain proficiency with CAD/CAM software	
	RM 6,000

**What is the investment cost of this CAD/CAM System?**

**Solution:**

The investment cost in this is the sum of all the cost elements except the two monthly lease expenditures-specifically, the sum of the initial costs for the CAD/CAM workstation, modem, printer, and plotter (RM 31,750); shipping cost (RM500); and the initial training cost (RM 6,000). These cost elements result in a total investment cost of RM 38,250. The two cost elements that involve lease payments on a monthly basis (telephone line and CAD/CAM software) are part of the recurring costs in the operation phase.

## 2. Choosing the most Economic Material for Part

A good example of this situation is illustrated by the part below which annual demand is 100,000 units. The part shown is produced on a high-speed turret lathe, using 112 screw-machine steel costing RM 0.30 per kg. A study was conducted to determine whether it might be cheaper to use brass screw stock, costing RM 1.40 per kg. Because the weight of steel required per piece was 0.0353kg and that brass was 0.0384 kg, the material cost per piece was RM 0.016 for steel and RM 0.0538 for brass. However, when the manufacturing engineering department was consulted, it was found that, although 57.1 defects parts per hour were being produced by using steel, the output would be 102.9 defect-free part per hour if brass were used.

**Which material should be used for this part?**

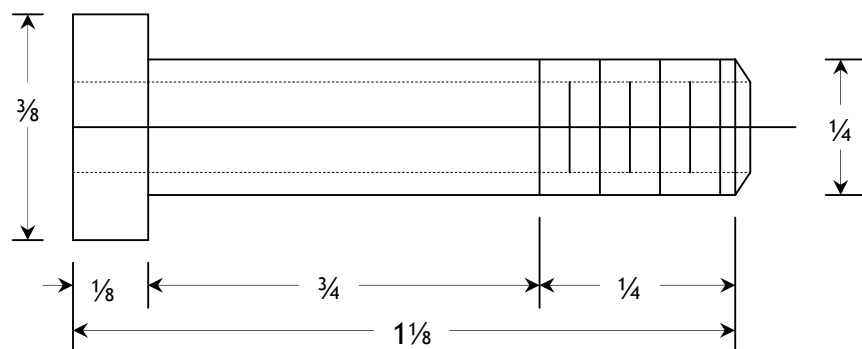


Figure1: Small Screw Machine Product

### Solution:

The machine attendant was paid RM 15.00 per hour, and the variable (i.e., traceable) overhead costs for the turret lathe were estimated to be RM 10.00 per hour. Thus, the total-cost comparison for the two materials was as follows:

	<b>112 STEEL</b>	<b>BRASS</b>
Material	$RM0.30 \times 0.0353 = RM\ 0.0106$	$RM\ 1.40 \times 0.03841 = RM\ 0.0538$
Labor	$RM\ 15.00 / 57.1 = 0.2627$	$RM15.00 / 102.9 = 0.1458$
Variable Overhead	$RM\ 10.00 / 57.1 = 0.1751$	$RM10.00 / 102.9 = 0.0972$
TOTAL COST per piece	<b>RM 0.4484</b>	<b>RM 0.2968</b>

$$\begin{aligned} \text{Saving per piece by use of brass} &= RM\ 0.4484 - RM\ 0.2968 \\ &= RM\ 0.1516 \end{aligned}$$

Because 100,000 parts are made each year, revenues are constant across the alternatives. And therefore, we select brass, its use will produce a savings of RM 151.60 per thousand (a total of RM 15,160 for the year). It is also clear that costs other than the cost of material were of basic importance in the study.

**When revenues and other economic benefits are not present or are constant among alternatives, consider only the costs and select the alternative that minimize total cost per defect-free unit of product or service output**

### 3. Personal Interest Problem

Don Ngoc prides himself on how much money he can save by being frugal. Today Don Ngoc need 15 gallons of gasoline to top off his automobile's gas tank. If he drives eight kilometer (round trip) to a gas station on the outskirts of town, Don Ngoc can save RM 0.10 per gallon on the price of gasoline. Suppose gasoline costs RM 2.00 per gallon and Don's car gets 25 km per gallon for in-town driving.

**Should Don Ngoc make the trip to get less expensive gasoline? What other factors (cost and otherwise) should Don Ngoc consider in his decision making?**

#### **Solution:**

- ⇒ Savings = **15 gallons x RM 0.10/gallon = RM 1.50** for the trip.
- ⇒ Savings per kilometer driven = **RM 1.50/ 8km = RM 0.1875** per km.
- ⇒ If Don Ngoc can drive his car for less than **RM 0.1875 per km**, he should make the trip.
- ⇒ The cost of gasoline only for the trip is  
 **$(8\text{km} \div 25 \text{ km per gallon}) (\text{RM } 2.00 \text{ per gallon}) = \text{RM } 0.64$** , but other costs of driving, such as insurance, maintenance, and depreciation, may also influence Don's decision. Hat is the cost of an accident, should Don have one during his trip to purchase less expensive gasoline? If Don makes the trip weekly for a year, should this influence his decision?

#### **4. Student tuition**

---

**Suppose student tuition at Melaka University is RM 100 per semester credit hour. The state supplements school revenue by matching student tuition ringgit for ringgit. Average class size for a typical three-credit course is 50 students. Labor costs are RM 4,000 per class, materials costs are RM 20 per student per class, and overhead costs are RM 25,000 per class.**

- a. What is the multifactor productivity ratio for this course process?**
- b. If instructor work an average 14 hours per week for 16 weeks for each three-credit class of 50 students, what is the labor productivity ration?**

**Solution:**

a. Multifactor productivity is the ratio of the value of output to the value of input resources.

$$\Rightarrow \text{Value of output} = \left[ \frac{50 \text{ students}}{\text{Class}} \right] \left[ \frac{3 \text{ credit hours}}{\text{student}} \right] \left[ \frac{\text{RM100 (T)} + \text{RM 100 (SS)}}{\text{credit hours}} \right]$$

$$= \text{RM } 30,000$$

- \* T = Tutorial Cost
- \* SS = State Supplement

$\Rightarrow$  Value of input = Labor + Materials + Overheads

$$= \text{RM } 4,000 + (\text{RM}20/\text{student} \times 50\text{students}/\text{Class}) + \text{RM } 25,000$$

$$= \text{RM } 30,000/\text{ class}$$

$$\Rightarrow \text{Multifactor productivity} = \frac{\text{Output}}{\text{Input}} = \frac{\text{RM } 30,000 / \text{class}}{\text{RM } 30,000/ \text{ class}} = 1$$

b. Labor productivity is the ratio of the value of output to labor hours. The value of output is the same as in part (a), or RM 30,000/class, so...

$$\text{Labor hours input} = \left[ \frac{14 \text{ hours}}{\text{Week}} \right] \left[ \frac{16\text{weeks}}{\text{class}} \right] = 224 \text{ hours/class}$$

$$\text{Labor productivity} = \frac{\text{Output}}{\text{Input}} = \frac{\text{RM } 30,000 / \text{class}}{224 \text{ hours/ class}}$$

$$= \text{RM } 133.93$$

## 5. Productivity

---

Natalie Attire makes fashionable garments. During a particular week employees worked 360 hours to produce a batch of 132 garments, of which 52 were 'seconds' (meaning that they were flawed). Seconds are sold for RM 90 each at Attire's Factory Outlet Store. The remaining 80 garments are sold to retail distribution, at RM 200 each. What is the labor productivity ratio of this manufacturing process?

### Solution:

$$\begin{aligned}\Rightarrow \text{Value of output} \\ &= (52 \text{ defective} \times \text{RM}90 / \text{defective}) + (80 \text{ garments} \times \text{RM}200 / \text{garments}) \\ &= \text{RM } 20,680\end{aligned}$$

$$\Rightarrow \text{Labor hours of input} = 360 \text{ hours}$$

$$\Rightarrow \text{Labor productivity} = \frac{\text{Output}}{\text{Input}} = \frac{\text{RM } 20,680}{360 \text{ hours}}$$

$$= \text{RM } 57,44 \text{ in sales per hour.}$$



## Defining the Problem and Developing Alternatives

### 1. Manufacturing Company

The measurement team of a small furniture-manufacturing company is under pressure to increase profitability in order to get a much-needed loan from the bank to purchase a modern pattern-cutting machine. One proposed solution is to sell waste wood chips and shavings to a local charcoal manufacturer instead of using them to fuel space heaters for the company's office and factory areas.

- a. Define the company's problem. Next, reformulate the problem in a variety of creative ways.
- b. Develop at least one potential alternative for your reformulated problems in part (a).

#### Solution:

- a. The company's problem appears to be that revenues are not sufficiently covering costs. Several reformulations can be posed:
  1. The problem is to increase (↑) **revenues** while reducing (↓) **costs**
  2. The problem is to maintain **revenues** while reducing (↓) **costs**
  3. The problem is an accounting system that provides distorted cost information
  4. The problem is that the new machine is really not needed (and hence here is **no need** for a bank loan)

- b.** Based on reformulation 1, an alternative is to sell woods chips and shavings as long as **increased revenues** (↑) **exceed extra expenses** that may be required to heat the buildings.
- ⇒ Another alternative is **to discontinue** the manufacture of specialty items and concentrate on standardized, high volume products. Yet another alternative is to pool purchasing, accounting, engineering, and other white-collar support services with other mall firms in the area by contracting with a local company involved in providing these services.

## **2. Rent Building**

**A friend of yours bought a house building in Taman Tasik Utama for RM 100,000 in nearby Melaka University campus. She spent RM 10,000 of her own money for the building and obtained a mortgage from a local bank for the remaining RM 90,000. The annual mortgage payment to the bank is RM 10,500. Your friend also expects that annual maintenance on the house will be RM 15,000. There are four rooms (with two bedrooms each) in the house that can be each rented for RM 360 per month.**

- a. Does your friend have a problem? If so, what it is?**
- b. What are her alternatives? (Identify at least three)**
- c. Estimate the economic consequences and other required data for the alternatives in part (b)**
- d. Select the criterion for discriminating among alternatives, and use it to at least your friend on which course of action to pursue.**
- e. Attempt to analyze and compare the alternatives in view of at east one criterion in addition to cost**
- f. What should your friend do based on the information you and she have generated?**

## Solution:

- a. A quick set of calculations shows that your friend does indeed have a problem.
- ⇒ A lot more money is being spent by your friend each year (**RM 10,500 + RM 15,000 = RM 25,500**) than is **being received**
  - ⇒ **(4 X RM 360 X 12 = RM 17,280).**
  - ⇒ The problem could be that the monthly rent is too low. She's **losing RM 8,220** per year.  
(Now, that's problem)

- b. **Option (1). Raise rent.** (Will the market bear an increase)  
**Option (2). Lower maintenance expenses** (but not so far as to cause safety problems)  
**Option (3). Sell the house building.** (What about loss?)  
**Option (4). Abandon the building** (bad for your boy friend's reputation)

$4 \times 360$	$25,500/12$
----------------	-------------

c. **Option (1).**

- ⇒ Raise total monthly rent to **RM 1,440 + RM (R?)** for the four rooms to cover monthly expenses of **RM 2,125** and the interest that could be earned on **RM 10,000** if your friend had invested it elsewhere.
- ⇒ Note that the minimum increase in rent would be  
**(RM2,125 – RM1,440)/4 = RM 171.25** per room per month (almost a 50% increase!) *And this figure doesn't include the interest she could have been earning on the RM 10,000.*

♣ **Option (2).**

- ⇒ Lower monthly expenses to **RM 2,125 – RM (C?)** so that these expenses and the interest earning ability of **RM 10,000** is covered by the monthly revenue of **RM 1,440** per month.

- ⇒ This would have to be accomplished primarily by lowering the maintenance cost. **(There's not much to be done about the annual mortgage cost unless a favorable refinancing opportunity presents itself).**
- ⇒ If she could have earned just **0.25%** per month on the **RM 10,000** (which comes to **RM 25** per month in interest), monthly maintenance expenses would have to be reduced to

$$((\text{RM } 1,440 - \text{RM } 25 - (\text{RM } 10,500/12)) = \text{RM } 540.$$

This represents more than a 50% decrease in maintenance expenses.

### Option(3).

Try to sell the house building for **RM X**, which recovers the original **RM 10,000** investment and (ideally) recovers the **RM 685** per month loss (**RM 8,220 ÷ 12**) on the venture during the time it was owned. It would also be wonderful to recover the lost interest that could have been earned on the **RM 10,000**.

### Option (4).

Walk away from the venture and kiss your investment good-bye. The bank would likely assume possession through foreclosure and may try to collect fees from your fiend. This option would also be very bad for your friend's credit rating.

- d. One criterion could be minimize the expected loss of money. In this case, you might advise your friend to pursue option **(1)** or **(3)**
- e. For example, let's use "credit worthiness" as an additional criterion. Option **(4)** is immediately ruled out. Exercising option **(3)** could also harm your fiend's credit rating. Thus, option **(1)** and **(2)** may be her only realistic and acceptable alternatives.

- f. Your friend should probably do a market analysis of comparable housing in the area to see if the rent could be raised (*option 1*). Maybe a fresh coat of paint and new carpeting would make the house more appealing to prospective renters. If so, the rent can probably be raised while keeping 100% occupancy of the four rooms.

**EXAMPLE :1A**

An alternative machine speeds involves the planning of lumber. Lumber put through the planner increases in value by RM 0.10 per board foot. When the planner is operated at a cutting speed of 5,000 feet per minute, the blades have to be sharpened after 2 hours of operation, and the lumber can be planned at the rate of 1,000 board-feet per hour. When the machine is operated at 6,000 feet per minute, the blades have to be sharpened after 1 ½ hours of operation, and the rate of planning is 1,200 board-feet per hour. Each time the blades are changed, the machine has to be shut down for 15 minutes. The blades, unsharpened, cost RM 50 per set and can be sharpened 10 times before having to be discarded. Sharpening cost RM 10 per occurrence. The crew that operates the planer changes and resets the blades.

- The labor cost for the crew would be the same for either speed of operation and because there was no discernible difference in wear upon the planner, these factors did not have to be included in the case
- The operating time plus the delay time due to the necessity for tool changes constitute a cycle time that determines the output from the machine.

**Ψ At what speed should the planner be operated?**

**Solution:**

- ☞ The time required for a complete cycle determines the number of cycles that can be accomplished in a period of available time (e.g., one day) and a certain portion of each complete cycle is productive. The actual productive time will be the product of the productive time per cycle and the number of cycles per day.

	<b>Value per Day</b>
➤ At 5,000 feet per minute	
• Cycle time = 2 hours + 0.25 hour = 2.25 hours	
• Cycles per day = $8 \div 2.25 = 3.555$	
• Value added by planning = $3.555 \times 2 \times 1,000 \times \text{RM } 0.10$	RM 711.00*
• Cost of resharpening blades = $3.555 \times \text{RM } 0.10 = \text{RM } 35.55$	
• Cost of blades = $3.555 \times \text{RM } 50/10 = 17.78$	
<b>Total Cost Cash Flow</b>	- 53.33
<b><u>Net increase in value (profit) per day</u></b>	<b>RM 657.67</b>
➤ At 6,000 feet per minute	
• Cycle time = 1.5 hours + 0.25 hour = 1.75 hours	
• Cycles per day = $8 \div 1.75 = 4.57$	
• Value added by planning = $4.57 \times 1.5 \times 1,200 \times \text{RM } 0.10$	RM 822.60*
• Cost of resharpening blades = $4.57 \times \text{RM } 0.10 = \text{RM } 45.70$	
• Cost of blades = $4.57 \times \text{RM } 50/10 = 22.85$	
<b>Total Cost Cash Flow</b>	- 68.55
<b><u>Net increase in value (profit) per day</u></b>	<b>RM 754.05</b>

\* The units work out as follows: (cycles/day) (hours/cycle) (board feet/hours) (RM value/board-foot) = RM/day

### EXAMPLE :1B

Assume that every board-foot of lumber that is planed can be sold. If there is limited demand for the lumber, a correct choice of machining speeds can be made by minimizing total cost per unit of output. Suppose now we want to know the better machining speed when only one job requiring 6,000 board-feet of planning is considered.

**Solution:**

For fixed planning requirement of 6,000 board-feet, the value added by planning is 6,000 (RM 0.10) = RM 600 for either cutting speed. Hence, we want to minimize total cost per board-foot planed.

The total cost per board-foot planed is a combination of the blade cost and resharping cost. These costs are most easily stated on a per cycle basis (blade cost/cycle = RM 50/10 cycle and resharping coct/cycle = RM 10/cycle).

Now the total cost for a fixed job length can be determined by the number of cycles required.

Value Increase	RM 0.10
New Blade	RM 50.00
Sharpening Cost	RM 10.00

Speed	5,000	6,000
Sharpen Interval	2.0	1.5
Board-feet/hour	1,000	2,000

Change Over (hours)	0.25
Blade Life (Cycles)	10
Shift Length (hours)	8

Board-feet required	6,000
---------------------	-------

Speed	5,000	6,000
Output/cycle	2,000	1,800
Number of cycles	3.00	3.33
Reshaperning Cost	RM 30,00	RM 33,33
Blade Cost	RM 15.00	RM 16.67

$\div 2000$   
**3.00** x Sharpening Cost  
 Number of cycles x (New Blade  $\div$  Blade Life (Cycles))  
 = **3.00** x (RM 50.00  $\div$  10)

Speed	5,000	6,000
Total Expense	RM 45.00	RM 50.00
Cost per Board-foot	RM 0.0075	RM 0.0083

Reshaperning Cost + Blade Cost

Total Expense  $\div$  Board-feet required



**EXAMPLE :2**

In the design of a jet engine part, the designer has a choice of specifying either an aluminum alloy casting or a steel casting. Either material will provide equal service, but the aluminum casting will weigh 1.2 kg as compared with 1.35 kg for the steel casting. The aluminum can be cast for RM80 per kg and the steel one for RM35 per kg. The cost of machining per unit is RM150 for aluminum and RM170 for steel. Every kilogram of excess weight is associated with a penalty of RM1300 due to increased fuel consumption.

Ψ Which material should be specified and what is the economic advantage of the selection per unit?

**Solution:**

➤ Cost of using aluminum metal for the jet engine part:

- Weight of aluminum casting/unit = 1.2 kg
- Cost of making aluminum casting = RM80 per kg
- Cost of machining aluminum casting per unit = RM150

**Total cost of jet engine part made of aluminum/unit =**

$$\begin{aligned} & \text{Cost of making aluminum casting/unit} + \text{cost of machining aluminum casting/unit} \\ & = 80 \times 1.2 + 150 = 96 + 150 \\ & = \text{RM } \mathbf{246} \end{aligned}$$

➤ Cost of jet engine part made of steel /unit:

- Weight of steel casting/unit = 1.35 kg
- Cost of making steel casting = RM35 per kg
- Cost of machining steel casting per unit = RM170
- Penalty of excess weight of steel casting = RM1300 per kg

**Total cost of jet engine part made of steel/unit =**

$$\begin{aligned} & \text{Cost of making steel casting/unit} + \text{Cost of machining steel casting/unit} + \text{penalty for excess} \\ & \text{weight of steel casting} \\ & = 35 \times 1.35 + 170 + 1300(1.35 - 1.2) \\ & = \text{RM } \mathbf{412.25} \end{aligned}$$

Decision: the total cost/unit of a jet engine part made of aluminum is less than that for an engine made of steel. Hence, aluminum is suggested for making the jet engine part.

The economic advantage of using aluminum over steel/unit is

$$\text{RM}412.25 - \text{RM}246 = \text{RM}\mathbf{166.25}.$$

**EXAMPLE :3**

In the design of buildings to be constructed in Alpha State, the designer is considering the type of window frame to specify. Either steel or aluminum window frames will satisfy the design criteria. Because of the remote location of the building site and lacks of building materials in alpha state, the window frames will be purchased in Beta State and transported for a distance of 2500km to the site. The price of the window frames of the type required is RM1000 each for steel frames and RM1500 each for aluminum frames. The weight of steel window frames is 75kg each and that of aluminum window frame is 28 kg each and the shipping rate is RM1 per kg per 100km.

- Distance between Alpha State and Beta State = 2500 km
- Transportation cost = RM1/kg/100km

Ψ Which design should be specified and what is the economic advantage of the selection?

**Solution:**

## ➤ Steel window frame

- Price of steel window frame/unit = RM1000
- Weight of steel window frame/unit = 75kg

**Total cost of steel window frame/unit =**

$$\begin{aligned} & \text{Price of steel window frame/unit} + \text{Transportation cost of steel window frame/unit} \\ & = 1000 + (75 \times 2500 \times 1)/100 \\ & = \text{RM } \mathbf{2875} \end{aligned}$$

## ➤ Aluminum window frame

- Price of aluminum window frame/unit = RM1500
- Weight of aluminum window frame/unit = 28kg

**Total cost of aluminum window frame/unit =**

$$\begin{aligned} & \text{Price of aluminum window frame/unit} + \text{Transportation cost of aluminum window frame/unit} \\ & = 1500 + (28 \times 2500 \times 1)/100 \\ & = \text{RM } \mathbf{2200} \end{aligned}$$

Decision: the total cost/unit of aluminum window frame is less than that of steel window frame. Hence, aluminum window frame is recommended.

The economic advantage /unit of the aluminum window frame over the steel window frame =  

$$\text{RM}2875 - \text{RM } 2200 = \text{RM } \mathbf{675}$$

**EXAMPLE :4**

The process planning engineer of a firm listed the sequences of operations as shown in Table 1.0 to produce a component.

Table 1.0 Data for Q5

Sequence	Process sequence
1	Turning-Milling-Shaping-Drilling
2	Turning-Milling-Drilling
3	All operations are performed with CNC machine

The details of processing times of component for various operation and their machine hour rates are summarized in table 1.1.

Table 1.1 Machine Hour Rates and Processing Times (min)

Operation	Machine Hour Rate (RM)	Process sequence		
		1	2	3
Turning	200	5	5	-
Milling	400	8	14	-
Shaping	350	10	-	-
Drilling	300	3	3	-
CNC operation	1000	-	-	8

Ψ Find the most economical sequence of operations to manufacture the component.

**Solution:**

➤ Cost of component using process sequence 1. The process sequence 1 is as follows:

Turning-Milling-Shaping-Drilling

The calculations for the cost of the above process sequence are summarized as follows:

Operation No.	Operation	Time		Machine Hour Rate(RM)	Cost (RM)
		(min)	(hr)		
1	Turning	5	.083	200	16.60
2	Milling	8	.133	400	53.20
3	Shaping	10	.167	350	58.45
4	Drilling	3	.050	300	15.00
Total:					<b>143.25</b>

➤ Cost of component using process sequence 2. The process sequence 2 is as follows:  
Turning-Milling-Drilling

The calculations for the cost of the above process sequence are given as follows:

Operation No.	Operation	Time		Machine Hour Rate(RM)	Cost (RM)
		(min)	(hr)		
1	Turning	5	.083	200	16.60
2	Milling	14	.233	400	93.20
3	Drilling	3	.050	300	15.00
Total:					124.80

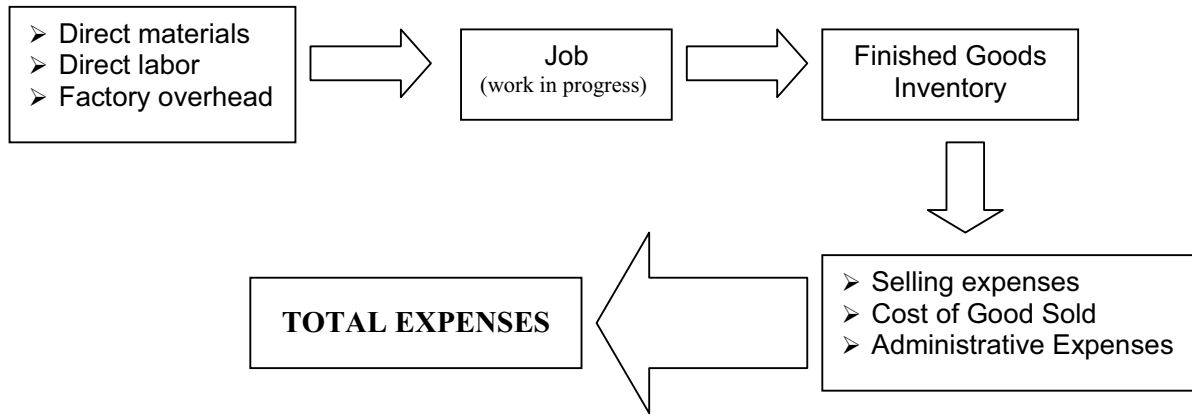
- Cost of component using process sequence 3. The process sequence 3 is as follows:

Operation No.	Operation	Time		Machine Hour Rate(RM)	Cost (RM)
		(min)	(hr)		
1	CNC operations	8	.133	1000	133

The process sequence 2 has the least cost. Therefore, it should be selected for manufacturing the component.

**EXAMPLE :5**

Cost accounting is a simple involved a job-order system in which costs are assigned to work by job number. Schematically, this process is illustrated as following diagram:



Costs are assigned to jobs in this manner:

1. Raw materials attach to jobs via material requirements
2. Direct labor to jobs via direct labor tickets
3. Overhead cannot be attached to jobs directly, but must have an allocation procedure that relates to one of the resources factors, such as direct labor, which is already accumulated by the job.

Consider how an order for 100 tennis racket accumulates costs at the Songheck Company:

Job	:100 tennis racket
Labor rate	: RM 7 per hour
Leather	: 50 yards at RM 2 per yard
Gut	: 300 yards at RM 0.50 per yard
Graphite	: 180 pounds at RM 3 per pound
Labor hours for the job	: 200 hours
Total annual factory overhead costs	: RM 600,000
Total annual direct labor hours	: 200,00 hours

The three major cots are now attached to the job. Direct labor and material expenses are straightforward:

Job		
Direct Labor	200 x RM 7	RM 1,400
Direct Material	Leather: 50 x 2	100
	Gut: 300 x RM 0.5	150
	Graphite: 180 x RM 3	540
		RM 2,190
Prime Costs (Direct Labor + direct Materials)		RM 2,190

Notice, that this cost is not the total cost. We must somehow find a way to attach (allocate) factory costs that cannot be directly identified to the job, but are nevertheless involved in producing the 100 rackets. Cost such as the power to run the graphite molding machine, the depreciation on this machine, the depreciation of the factory building, and the supervisor's salary constitute overhead for this company. These overhead costs are part of the cost structure of the 100 rackets but cannot be directly traced to the job. For instance, do we really know how much machine obsolescence is attributable to the 100 rackets?

Therefore, we must allocate these overhead costs to the 100 rackets by using the overhead rate determined as follows:

Overhead rate =  $\text{RM } 600,000 \div 200,000 = \text{RM } 3$  per direct labor hour.

This means that RM 600 ( $\text{RM } 3 \times 200$ ) of the total annual overhead cost of RM 600,000 would be allocated to Job. Thus, the total cost of Job would be as follows:

▪ Direct Labor	RM 1,400
▪ Direct Material	790
▪ Factory Overhead	600
	RM 2,790

The cost of manufacturing each racket is thus RM 27.90.

If selling expenses and administrative expenses are allocated as 40% of the cost of Goods sold, the total of a tennis racket becomes  $1.4 (\text{RM}27.90) = \text{RM } 39.06$

# TUTORIAL

1

## Manufacturing Companies

There are 3 major categories of manufacturing costs:

**Direct Materials**  
resources that can be feasibly observed being used to make a specific product.

**Direct Labor**  
The cost of paying employees who convert direct materials into finished product.

**Manufacturing Overhead**  
Indirect material  
Indirect labor  
Other overhead

2

## Manufacturing Companies

Prime Costs include:

**Direct Materials**

**Direct Labor**

**Manufacturing Overhead**

3

## Manufacturing Companies

Conversion Costs include:

**Direct Materials**

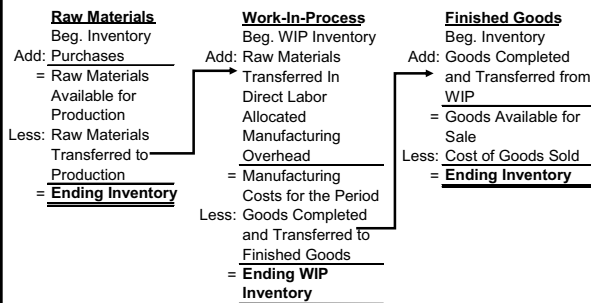
**Direct Labor**

**Manufacturing Overhead**

Non-manufacturing Costs are all the costs not used to produce products.

4

## Stages of Production and the Flow of Costs



## Stages of Production and the Flow of Costs – Example-1

**Raw Materials**  
Beg. Inventory  
Add: Purchases  
= Raw Materials Available for Production  
Less: Raw Materials Transferred to Production  
= **Ending Inventory**

**What is Ending Inventory in February?**

Jeprut Electronics makes toasters. On February 1, Jeprut has \$15,000 of raw material on hand. Jeprut's purchase and transfers to the production floor are indicated below.

Date	Purchases	Cost of Transfers
3-Feb	\$8,000	\$5,000
10-Feb	\$12,000	\$11,000
15-Feb	\$14,000	\$7,000
20-Feb		\$6,000
22-Feb	\$9,000	
27-Feb		\$16,000

### Stages of Production and the Flow of Costs – Example-1

<b>Raw Materials</b>		
	\$15,000	
Add:	43,000	
=	\$58,000	
Less:	45,000	
=	\$13,000	

<b>Cost of Purchases</b>			<b>Cost of Transfers</b>		
Date					
3-Feb	\$8,000		\$5,000		
10-Feb	\$12,000		\$11,000		
15-Feb	\$14,000		\$7,000		
20-Feb			\$6,000		
22-Feb	\$9,000				
27-Feb			\$16,000		

Jeprut Electronics makes toasters. On February 1, Axel has \$15,000 of raw material on hand. Jeprut's purchase and transfers to the production floor are indicated

Now let's look at Work-in-Process.

### Stages of Production and the Flow of Costs – Example-1

<b>Raw Materials</b>		<b>Work-In-Process</b>	
	\$15,000	Beg. WIP Inventory	\$30,000
Add:	43,000	Add: Raw Materials	45,000
=	\$58,000	Transferred In	92,000
Less:	45,000	Direct Labor	138,000
=	\$13,000	Allocated Manufacturing Overhead	283,000
		= Manufacturing Costs for the Period	\$305,000
		Less: Goods Completed and Transferred to Finished Goods	283,000
		= Ending WIP Inventory	\$22,000

On February 1, Jeprut had WIP of \$30,000 on the factory floor. During February, Jeprut paid \$92,000 in direct labor wages. Overhead is applied at 150% of direct labor. On 2/28, \$22,000 is still in WIP.

What is the amount of cost transferred to Finished Goods in February?

### Stages of Production and the Flow of Costs – Example-1

<b>Raw Materials</b>		<b>Work-In-Process</b>		<p>On February 1, Axel had WIP of \$30,000 on the factory floor. During February, Jeprut paid \$92,000 in direct labor wages. Overhead is applied at 150% of direct labor. On 2/28, \$22,000 is still in WIP.</p>
	\$15,000	Add:	\$30,000	
Add:	43,000		45,000	
=	\$58,000		92,000	
Less:	45,000		138,000	
=	\$13,000		\$305,000	
		Less:	283,000	<p>Transferred to Finished Goods</p>
		=	\$22,000	

Now let's look at Finished Goods.

### Stages of Production and the Flow of Costs – Example-1

<b>Raw Materials</b>		<b>Work-In-Process</b>		<b>Finished Goods</b>	
	\$15,000	Add:	\$30,000	Beg. Inventory	\$125,000
Add:	43,000		45,000	Add: Goods Completed and Transferred from WIP	408,000
=	\$58,000		92,000	= Goods Available for Sale	533,000
Less:	45,000		138,000	Less: Cost of Goods Sold	312,000
=	\$13,000		\$305,000	= Ending Inventory	\$96,000
		Less:	283,000		
		=	\$22,000		

On February 1, Jeprut had Finished Goods of \$125,000 on hand. At the end of February, a physical inventory count revealed \$96,000 in Finished Goods still on hand.

What was Cost of Goods Sold for February?

### Stages of Production and the Flow of Costs – Example-1

<b>Raw Materials</b>		<b>Work-In-Process</b>		<b>Finished Goods</b>	
	\$15,000	Add:	\$30,000	Add:	\$125,000
Add:	43,000		45,000		283,000
=	\$58,000		92,000	=	\$408,000
Less:	45,000		138,000	Less:	312,000
=	\$13,000		\$305,000	=	\$96,000
		Less:	283,000		
		=	\$22,000		

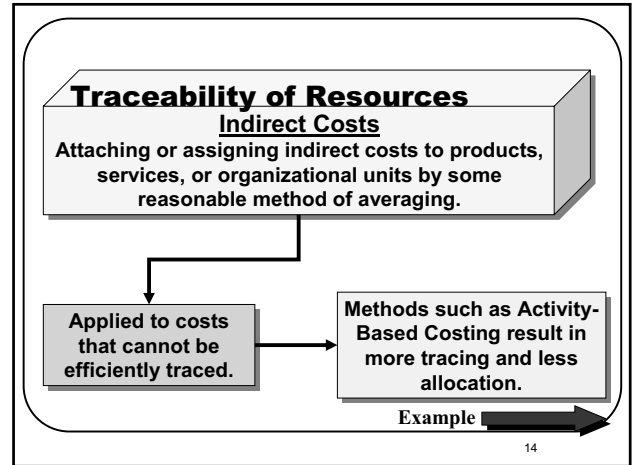
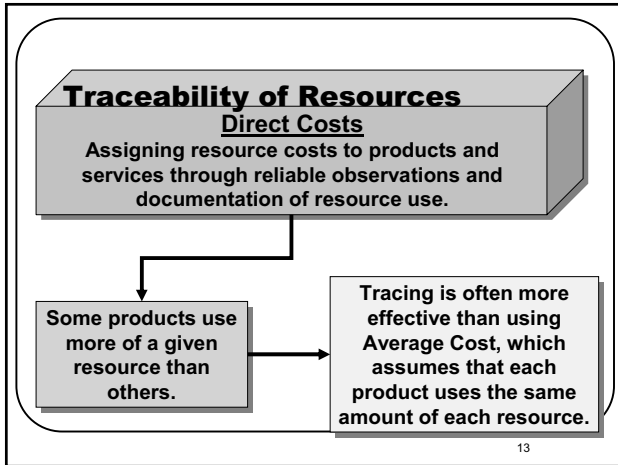
On February 1, Jeprut had Finished Goods of \$125,000 on hand. At the end of February, a physical inventory count revealed \$96,000 in Finished Goods still on hand.

What was Cost of Goods Sold for February?

### Cost Behavior Fixed vs. Variable

Summary of Variable and Fixed Cost Behavior		
Cost	In Total	Per Unit
Variable	Total variable cost is proportional to the activity level within the relevant range.	Variable cost per unit remains the same over wide ranges of activity.
Fixed	Total fixed cost remains the same even when the activity level changes within the relevant range.	Fixed cost per unit goes down as activity level goes up.





**Tracing versus Allocating Costs - Example-2**

Keusix makes two products; bricks and play sand. The products are produced in two separate facilities, and the plant supervisors work at both plants. Allocate rent and salaries based on revenues.

Product	Units Produced & Sold	Sales Price per Unit
Bricks	2,000,000	\$ 0.75
Sand	30,000 tons	\$ 90.00

Keusix's headquarters is downtown. →

15

**Tracing versus Allocating Costs - Example-2**

The brick operation consumes 70% of the material purchased. The play sand uses the remaining 30%. Labor has an average cost of \$10 per hour. The brick operation uses 21,000 labor hours. The play sand operation uses 14,000 labor hours. The company pays all utilities on one bill that goes to the headquarters. Headquarters allocates 50% of the utilities cost to each product. →

16

**Tracing versus Allocating Costs - Example-2**

Cost Type	Total Cost	Bricks	Sand	How Assigned
Sales Revenue	\$ 4,200,000	?	?	?
Materials	800,000	?	?	?
Labor	350,000	?	?	?
Supervisors	140,000	?	?	?
Plant Rent	700,000	?	?	?
Total Utilities	160,000	?	?	?

Compute the missing values and information.

17

**Tracing versus Allocating Costs - Example-2**

Cost Type	Total Cost	Bricks	Sand	How Assigned
Sales Revenue	\$ 4,200,000	\$1,500,000	\$2,700,000	Direct
Materials	800,000	?	?	?
Labor	350,000	?	?	?
Supervisors	140,000	?	?	?
Plant Rent	700,000	?	?	?
Total Utilities	160,000	?	?	?

Sales Revenue is TRACED to each product based on the actual revenue each product generates.

Example: Sand Revenue = 30,000 tons × \$90 per ton

18

### Tracing versus Allocating Costs - Example-2

Cost Type	Total Cost	Bricks	Sand	How Assigned
Sales Revenue	\$ 4,200,000	\$1,500,000	\$2,700,000	Direct
Materials	800,000	\$ 560,000	\$ 240,000	Direct
Labor	350,000	\$ 210,000	\$ 140,000	Direct
Supervisors	140,000	?	?	?
Plant Rent	700,000	?	?	?
Total Utilities	160,000	?	?	?

Material and Labor are traced to each product based on how much of each resource each product uses.

Example; Bricks labor = 21,000 hours × \$10 per hour

19

### Tracing versus Allocating Costs - Example-2

Cost Type	Total Cost	Bricks	Sand	How Assigned
Sales Revenue	\$ 4,200,000	\$1,500,000	\$2,700,000	Direct
Materials	800,000	\$ 560,000	\$ 240,000	Direct
Labor	350,000	\$ 210,000	\$ 140,000	Direct
Supervisors	140,000	\$ 50,000	\$ 90,000	Indirect
Plant Rent	700,000	\$ 250,000	\$ 450,000	Indirect
Total Utilities	160,000	?	?	?

Supervisor salaries and rent are allocated on the basis of relative revenues. Approximately 35.7% goes to Bricks. Approximately 64.3% goes to Sand.

20

### Tracing versus Allocating Costs - Example-2

Cost Type	Total Cost	Bricks	Sand	How Assigned
Sales Revenue	\$ 4,200,000	\$1,500,000	\$2,700,000	Direct
Materials	800,000	\$ 560,000	\$ 240,000	Direct
Labor	350,000	\$ 210,000	\$ 140,000	Direct
Supervisors	140,000	\$ 50,000	\$ 90,000	Indirect
Plant Rent	700,000	\$ 250,000	\$ 450,000	Indirect
Total Utilities	160,000	\$ 80,000	\$ 80,000	Indirect

The utilities are allocated from the home office with 50% of the utilities being charged to each product.

21

### Income-Reporting Effects of Alternative Product-Costing Methods

**Variable Costing** measures product cost by the unit-level resources used.

**Absorption Costing** allocates indirect costs to products along with unit-level and variable costs.



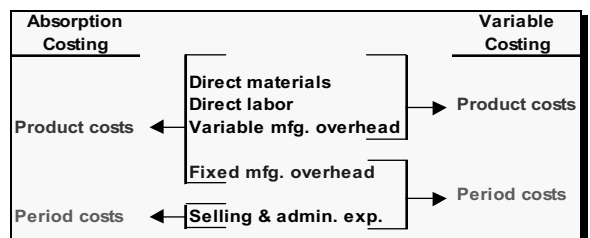
22

### Overview of Absorption and Variable Costing

Absorption Costing		Variable Costing	
Product Costs	Direct Materials	Product Costs	Direct Materials
	Direct Labor		Direct Labor
	Variable Manufacturing Overhead		Variable Manufacturing Overhead
Period Costs	Fixed Manufacturing Overhead	Period Costs	Fixed Manufacturing Overhead
	Variable Selling and Administrative Expenses		Variable Selling and Administrative Expenses
	Fixed Selling and Administrative Expenses		Fixed Selling and Administrative Expenses

23

### Income-Reporting Effects of Alternative Product-Costing Methods



24

### Absorption Costing vs. Variable Costing – Example-3

Bemo, Inc. produces a single product with a sales price of \$40 and the following cost information:

Number of units produced annually	30,000
Variable costs per unit:	
Direct materials, direct labor, and variable mfg. overhead	\$ 12
Selling & administrative expenses	\$ 4
Fixed costs per year:	
Manufacturing overhead	\$ 210,000
Selling & administrative expenses	\$ 250,000

25

### Absorption Costing vs. Variable Costing – Example-3

Unit product cost is determined as follows:

	Absorption Costing	Variable Costing
Direct materials, direct labor, and variable mfg. overhead	\$ 12	\$ 12
Fixed mfg. overhead (\$210,000 ÷ 30,000 units)	7	-
Unit product cost	<u>\$ 19</u>	<u>\$ 12</u>

Selling and administrative expenses are always treated as period expenses and deducted from revenue.

26

### Absorption Costing vs. Variable Costing – Example-3

Bemo, Inc. had no beginning inventory, produced 30,000 units and sold 28,000 units this year.

	Absorption Costing
Sales (28,000 × \$40)	\$ 1,120,000
Less cost of goods sold:	
Beginning inventory	\$ -
Add COGM (30,000 × \$19)	570,000
Goods available for sale	570,000
Ending inventory (2,000 × \$19)	38,000
Gross margin	532,000
Less selling & admin. exp.	
Variable (28,000 × \$4)	\$ 112,000
Fixed	250,000
Net income	<u>\$ 226,000</u>

27

### Absorption Costing vs. Variable Costing – Example-3

	Variable costs only.	Variable Costing
Sales (28,000 × \$40)		\$ 1,120,000
Less variable expenses:		
Beginning inventory	\$ -	
Add COGM (30,000 × \$12)	360,000	360,000
Goods available for sale	360,000	
Ending inventory (2,000 × \$12)	24,000	
Variable cost of goods sold	336,000	
Variable selling & administrative expenses (28,000 × \$4)	112,000	448,000
Contribution margin		672,000
Less fixed expenses:		
Manufacturing overhead	\$ 210,000	
Selling & administrative expenses	250,000	460,000
Net income		<u>\$ 212,000</u>

All fixed manufacturing overhead is expensed.

### Absorption Costing vs. Variable Costing – Example-4

Olenk Company produces a single product with the following information available:

Number of units produced annually	25,000
Variable costs per unit:	
Direct materials, direct labor, and variable mfg. overhead	\$ 10
Selling & administrative expenses	\$ 3
Fixed costs per year:	
Manufacturing overhead	\$ 150,000
Selling & administrative expenses	\$ 100,000

29

### Absorption Costing vs. Variable Costing – Example-4

	Absorption Costing	Variable Costing
Direct materials, direct labor, and variable mfg. overhead	\$ 10	\$ 10
Fixed mfg. overhead (\$150,000 ÷ 25,000 units)	6	-
Unit product cost	<u>\$ 16</u>	<u>\$ 10</u>

Selling and administrative expenses are always treated as period expenses and deducted from revenue as incurred.

30

## Income Comparison of Absorption and Variable Costing

Let's assume the following additional information for Olenk Company.

- 20,000 units were sold during the year at a price of \$30 each.
- There were no units in beginning inventory.

Now, let's compute net operating income using both absorption and variable costing.



31

## Absorption Costing Example-5

	Absorption Costing	
Sales (20,000 × \$30)		\$600,000
Less cost of goods sold:		
Beginning inventory	\$ -	
Add COGM (25,000 × \$16)	400,000	
Goods available for sale	400,000	
Ending inventory (5,000 × \$16)	80,000	320,000
Gross margin		280,000
Less selling & admin. exp.		
Variable (20,000 × \$3)	\$ 60,000	
Fixed	100,000	160,000
Net operating income		<u>\$120,000</u>

32

## Variable Costing

	Variable Costing	
Sales (20,000 × \$30)		\$600,000
Less variable expenses:		
Beginning inventory	\$ -	
Add COGM (25,000 × \$10)	250,000	
Goods available for sale	250,000	
Less ending inventory (5,000 × \$10)	50,000	
Variable cost of goods sold	200,000	
Variable selling & administrative expenses (20,000 × \$3)	60,000	260,000
Contribution margin		340,000
Less fixed expenses:		
Manufacturing overhead	\$150,000	
Selling & administrative expenses	100,000	250,000
Net operating income		<u>\$ 90,000</u>

Variable manufacturing costs only.

All fixed manufacturing overhead is expensed.

33

## Income Comparison of Absorption and Variable Costing

Let's compare the methods.

	Cost of Goods Sold	Ending Inventory	Period Expense	Total
<b>Absorption costing</b>				
Variable mfg. costs	\$200,000	\$ 50,000	\$ -	\$250,000
Fixed mfg. costs	120,000	30,000	-	150,000
	<u>\$320,000</u>	<u>\$80,000</u>	<u>\$ -</u>	<u>\$400,000</u>
<b>Variable costing</b>				
Variable mfg. costs	\$200,000	\$ 50,000	\$ -	\$250,000
Fixed mfg. costs	-	-	150,000	150,000
	<u>\$200,000</u>	<u>\$ 50,000</u>	<u>\$150,000</u>	<u>\$400,000</u>

34

## Reconciliation

We can reconcile the difference between absorption and variable income as follows:

Variable costing net operating income	\$ 90,000
Add: Fixed mfg. overhead costs deferred in inventory (5,000 units × \$6 per unit)	30,000
Absorption costing net operating income	<u>\$ 120,000</u>

$$\frac{\text{Fixed mfg. Overhead}}{\text{Units produced}} = \frac{\$150,000}{25,000 \text{ units}} = \$6.00 \text{ per unit}$$

35

## Extended Comparison of Income Data Olenk Company Year Two

Number of units produced	25,000
Number of units sold	30,000
Units in beginning inventory	5,000
Unit sales price	\$ 30
Variable costs per unit:	
Direct materials, direct labor	
variable mfg. overhead	\$ 10
Selling & administrative expenses	\$ 3
Fixed costs per year:	
Manufacturing overhead	\$150,000
Selling & administrative expenses	\$100,000

36

## Unit Cost Computations

	Absorption Costing	Variable Costing
Direct materials, direct labor, and variable mfg. overhead	\$ 10	\$ 10
Fixed mfg. overhead ( $\$150,000 \div 25,000$ units)	6	-
Unit product cost	<u>\$ 16</u>	<u>\$ 10</u>

Since there was no change in the variable costs per unit, total fixed costs, or the number of units produced, the unit costs remain unchanged.

37

## Absorption Costing

	Absorption Costing	
Sales ( $30,000 \times \$30$ )		\$900,000
Less cost of goods sold:		
Beg. inventory ( $5,000 \times \$16$ )	\$ 80,000	
Add COGM ( $25,000 \times \$16$ )	<u>400,000</u>	
Goods available for sale	480,000	
Less ending inventory	-	480,000
Gross margin		420,000
Less selling & admin. exp.:		
Variable ( $30,000 \times \$3$ )	\$ 90,000	
Fixed	<u>100,000</u>	190,000
Net operating income		<u>\$230,000</u>

These are the 25,000 units produced in the current period.

38

## Variable Costing

	Variable Costing	
Sales ( $30,000 \times \$30$ )		\$900,000
Less variable expenses:		
Beg. inventory ( $5,000 \times \$10$ )	\$ 50,000	
Add COGM ( $25,000 \times \$10$ )	<u>250,000</u>	
Goods available for sale	300,000	
Less ending inventory	-	300,000
Variable cost of goods sold	300,000	
Variable selling & administrative expenses ( $30,000 \times \$3$ )	<u>90,000</u>	390,000
Contribution margin		510,000
Less fixed expenses:		
Manufacturing overhead	\$ 150,000	
Selling & administrative expenses	<u>100,000</u>	250,000
Net operating income		<u>\$260,000</u>

Variable manufacturing costs only.

All fixed manufacturing overhead is expensed.

## Reconciliation

We can reconcile the difference between absorption and variable income as follows:

Variable costing net operating income	\$ 260,000
Deduct: Fixed manufacturing overhead costs released from inventory ( $5,000$ units $\times$ $\$6$ per unit)	<u>30,000</u>
Absorption costing net operating income	<u>\$ 230,000</u>

$$\text{Fixed mfg. Overhead} = \frac{\$150,000}{25,000 \text{ units}} = \$6.00 \text{ per unit}$$

40

## Income Comparison

Costing Method	1st Period	2nd Period	Total
Absorption	\$ 120,000	\$ 230,000	\$350,000
Variable	90,000	260,000	350,000



41

## Summary

Relation between production and sales	Effect on inventory	Relation between variable and absorption income
Production > Sales	Inventory increases	Absorption > Variable
Production < Sales	Inventory decreases	Absorption < Variable
Production = Sales	No change	Absorption = Variable

42

## **Impact on the Manager**

**Opponents of absorption costing argue that shifting fixed manufacturing overhead costs between periods can lead to misinterpretations and faulty decisions.**

**Those who favor variable costing argue that the income statements are easier to understand because net operating income is only affected by changes in unit sales. The resulting income amounts are more consistent with managers' expectations.**

