Tikrit University

The College of Petroleum Processes Engineering

Petroleum and Gas Refining Engineering Department

Management and economics of petroleum projects

Fourth Class

Lecture (6)

By

Luay Ahmed Khamees

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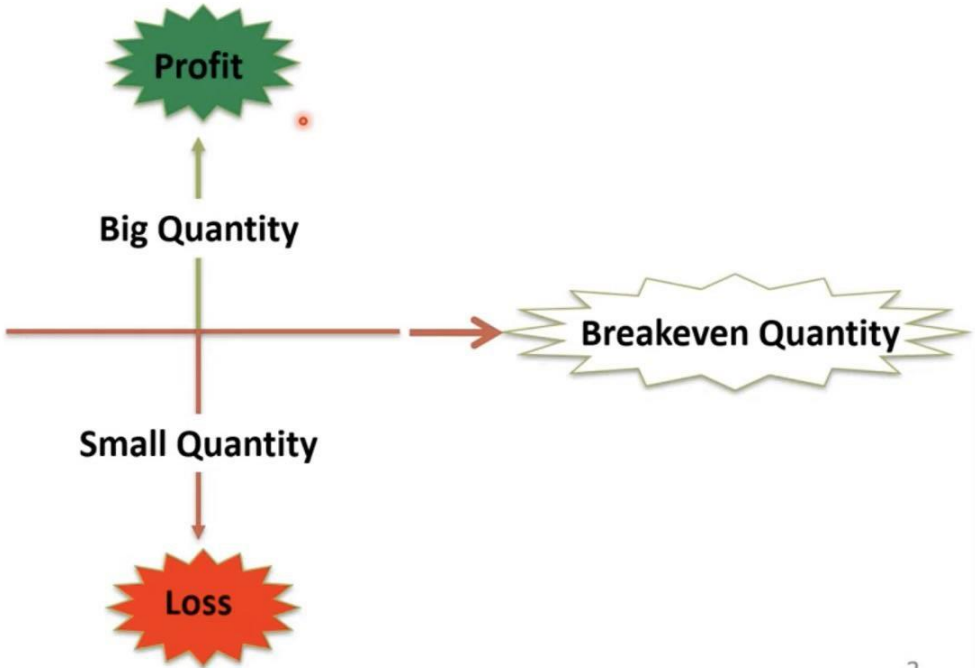
Breakeven Quantity



Profit Calculation

Profit = Total Revenue - Total Cost

Total Revenue

- Total Revenue for 1 unit = 1 * 3 = 3 $
- Total Revenue for 2 units = 2 * 3 = 6 $
- Total Revenue for 3 units = 3 * 3 = 9 $

- **Total Revenue = Quantity (Q)* unit price (P)**
- **$TR_Q = Q * P$**

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Total Cost (TC)

- Total Cost for 1 unit = 1000 + 1 * 1 = 1001 $
- Total Cost for 2 units = 1000 + 2 * 1 = 1002 $
- Total Cost for 3 units = 1000 + 3 * 1 = 1003 $

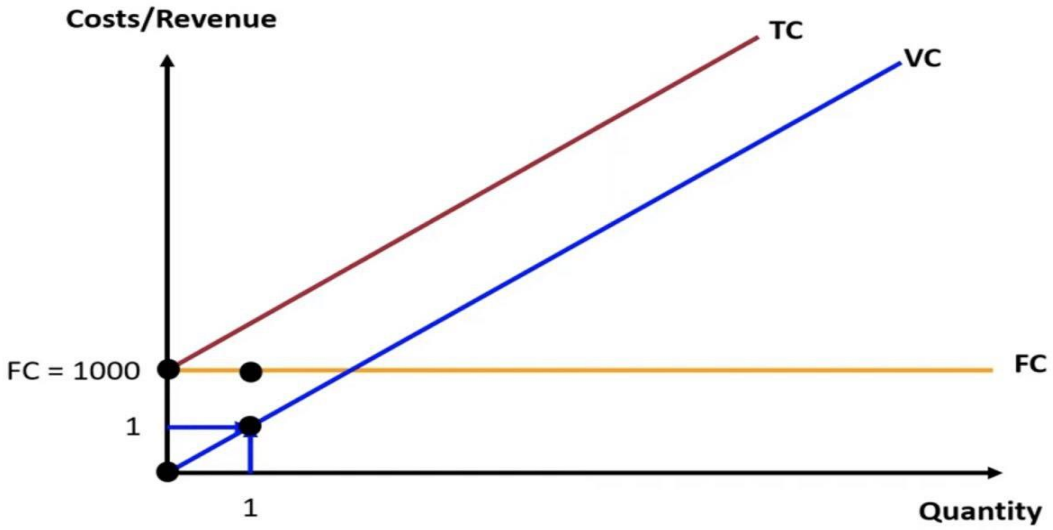
Total Cost = Fixed Cost + Variable cost

- Variable cost = Quantity (Q) * Variable cost per unit (v)

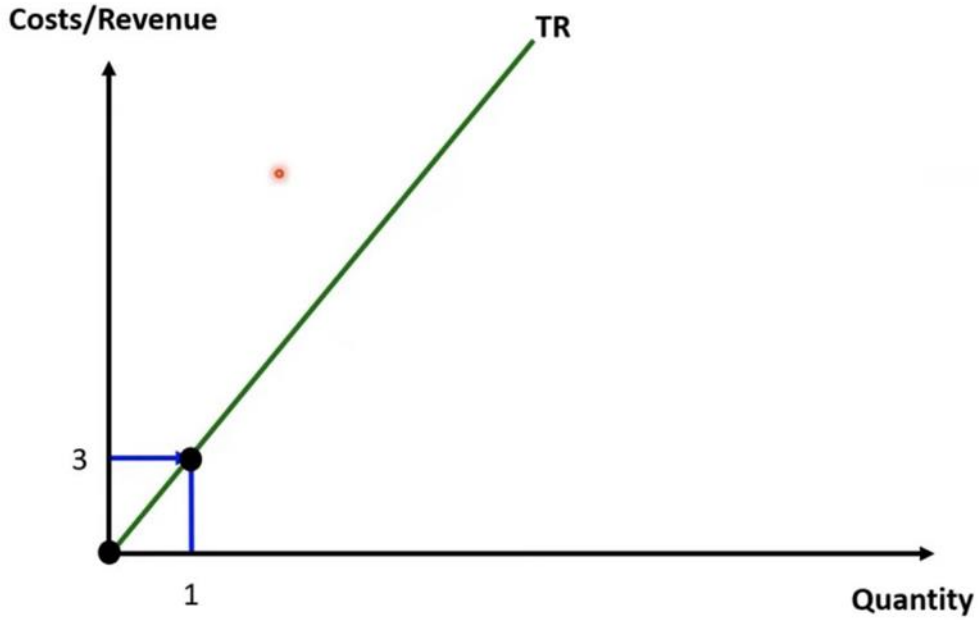
Cost Examples

- Fixed Costs (FC) do not change with volume of production
  - Building costs
  - Minimum labor costs
    (**500** $/Month or **400** $/month + 1 $/unit)
  - Depreciation cost - Capital recovery of equipment (SLM or SYM)
- Variable Costs (VC) change with the volume of production
  - Materials costs
  - Labor costs (500 $/Month or 400 $/month + **1** $/unit)
  - Depreciation cost - Capital recovery of equipment (Activity method)

Total Cost (TC)



Total Revenue (TR)



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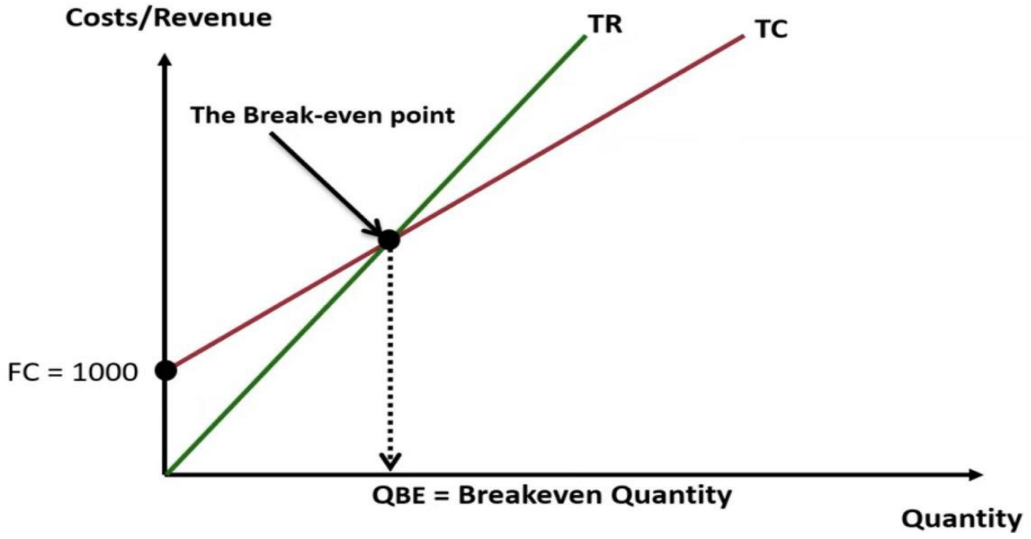
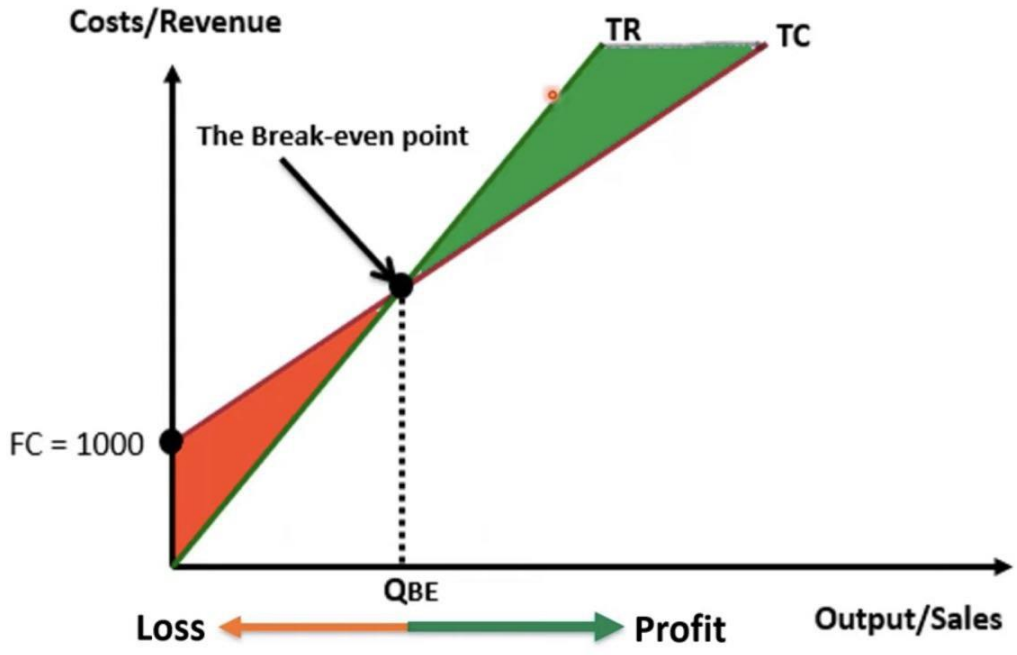
Break-Even Point

The Break-even point occurs where total revenue equals total costs



Breakeven Point



Breakeven Quantity (Q_{BE})

- Total Revenue (TR) = P * Q
- P = unit price
- Total Cost (TC) = FC + VC
- Variable Cost (VC) = v * Q
- v = variable cost per unit

- At breakeven point: TR = TC

$$P * Q_{BE} = FC + v * Q_{BE}$$

$$P * Q_{BE} - v * Q_{BE} = FC \rightarrow Q_{BE} (P - v) = FC$$

$$Q_{BE} = FC / (P - v)$$

Example 1

- Determine the Breakeven Quantity if FC = 1000$, v = 1 $/unit, and P = 3 $/unit.

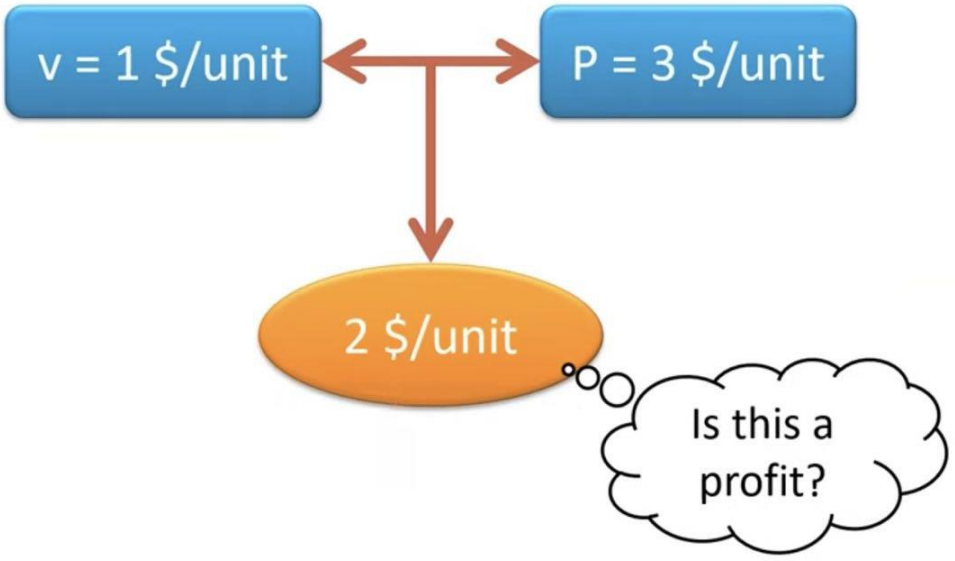
- Solution

Breakeven Quantity(Q_{BE}) = FC / (P – v)

= 1000 / (3-1)

= 500 units

Contribution



Contribution

- **Unit Contribution**
  - Unit Contribution = P – v
  - Unit Contribution = 3 - 1 = 2 $
- **Total Contribution**
  - Total Contribution = Unit Contribution * Q
  - Total Contribution = (P– v) * Q = P*Q – v*Q
  - Total Contribution = TR – VC
- **Profit**
  - Profit = TR– VC– FC = Total Contribution - Fixed Costs

Example 2

- Given
  - FC = 1000 $, v = 1 $/unit, and P = 3 $/unit and Q = 600 units
- Required
  - Calculate the Unit contribution, Total contribution and Profit
- Solution
  - Unit contribution = p – v = 3 - 1 = 2 $
  - Total contribution = 2 * 600 = 1200 $
  - Profit = 1200 – 1000 = 200 $

Example 3

- Water vending machine: FC = $900 per month per site, p = 30¢ per gallon, and v = 18¢ per gallon. Find the Breakeven Quantity?
- Solution

$$Q_{BE} = 900 / (0.30 – 0.18) = 7500 \text{ gallon}$$

- Must sell 7500 gallons per month per site to just breakeven.
- Selling more 7500 means a profit is realized

Example 4

- **For Example 3,** Determine the profit at sales of Q = 8,000 gallons/site

Solution:

- Profit = Total Revenue – Total cost

  = TR – (FC + VC)

  = 0.30 * 8000 - (900 + 0.18 * 8000) = 60 $

Or

- Profit = Total Contribution – Fixed Cost

  = (p - v) Q – FC = (0.30 – 0.18) * 8000 – 900 = 60$

Homework:

Problem (1): For a vending machine project, the site cost = 12,000 SR/month, material cost = 1 SR/unit, and insurance cost = 500 SR/month, the labor cost = 1,500 SR/month, unit price = 3 SR per unit, and electricity cost = 1000 SR/ month and = 0.5 SR/unit.

a) Find the **Unit Contribution** and the **Breakeven Quantity**.
b) Determine the **Total Contribution** and **Total Profit** at sales of Q =15,000 unit.

Problem (2): For a vending machine project, the site cost = 5,000 SR/month, material cost = 0.5 SR/unit, and insurance cost = 400 SR/month, the labor cost = 1,000 SR/month, unit price = 1 SR per unit, and electricity cost = 100 SR/ month and =0.1 SR/unit.

a) Find the **Unit Contribution** and the **Breakeven Quantity**.
b) Determine the **Total Contribution** and **Total Profit** at sales of Q = 25,000 unit.

a) $P = 1 \quad v = (0.1 + 0.5) = 0.6 \quad FC = (5{,}000 + 400 + 1{,}000 + 100) = 6{,}500$

Unit Contribution = $P - v = 1 - 0.6 = 0.4\ SR$

Breakeven Quantity = $Q_{Be} = \frac{FC}{P-v} = \frac{6{,}500}{1-0.6} = 16{,}250\ unit$

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REPLACEMENT AND RETENTION DECISIONS

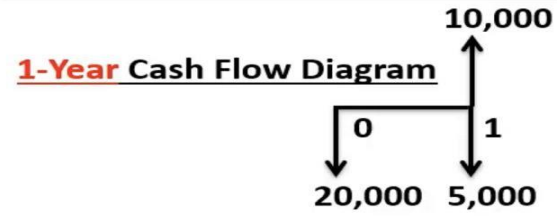
RETENTION DECISIONS
ECONOMIC SERVICE LIFE

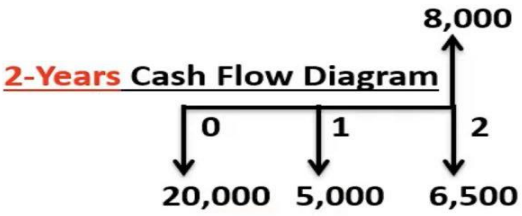
Example1: Economic Service Life

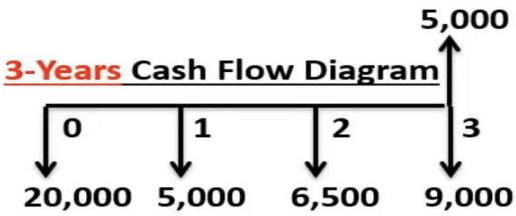
Determine the ESL of an asset which has the costs shown below.
Let i = 10%

End of Year	Cost, $	Salvage value,$
0	-20,000	-
1	-5,000	10,000
2	-6,500	8,000
3	-9,000	5,000
4	-11,000	5,000
5	-15,000	3,000

Solution: Cash Flows







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Solution

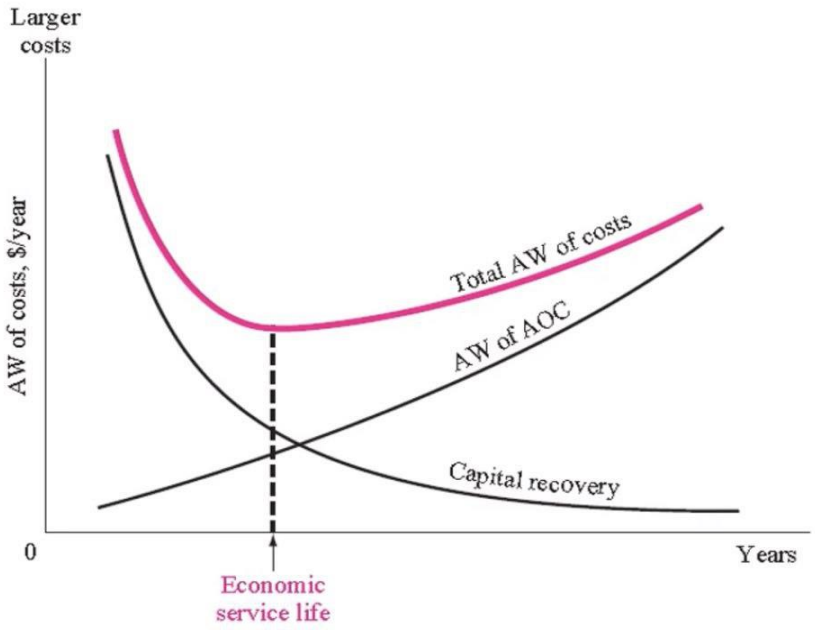
- AW_1 = - 20,000(A/P,10%,1) + 10,000(A/F,10%,1) – 5000(P/F,10%,1)(A/P,10%,1) = $ -17,000

- AW_2 = - 20,000(A/P,10%,2) + 8000(A/F,10%,2) – [5000(P/F,10%,1) + 6500(P/F,10%,2)](A/P,10%,2) = $ -13,429

- Similarly, AW_3 = $ -13,239, AW_4 = **$ -12,864,** AW_5 = $ -13,623

Economic service life is 4 years

Annual Worth Curve



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- Aw1 = - 10 Continue
- Aw2 = - 8 Continue
- Aw3 = - 7 Continue
- Aw4 = - 7.2 Stop

- **The ESL is 3 Years and Aw = - 7**

REPLACEMENT DECISIONS

asset or system is: "Should it be replaced now or later?"

- If the decision is to replace, the study is complete.
- If the decision is to retain, the cost estimates and decision will be revisited each year.

Replacement or Retention?

- The fundamental question answered by a replacement study about a currently installed asset or system is: "Should it be replaced now or later?"
- If the decision is to replace, the study is complete.
- If the decision is to retain, the cost estimates and decision will be revisited each year.

Basics

The need for a replacement study can develop from several sources:

1. **Reduced performance**: Physical deterioration, reduced reliability or productivity.

2. **Altered requirements**: New requirements of accuracy, speed, or other specifications cannot be met by the existing equipment or system

3. **Obsolescence**: International competition and rapidly changing technology make currently used systems and assets perform acceptably but less productively than equipment coming available.

Definitions

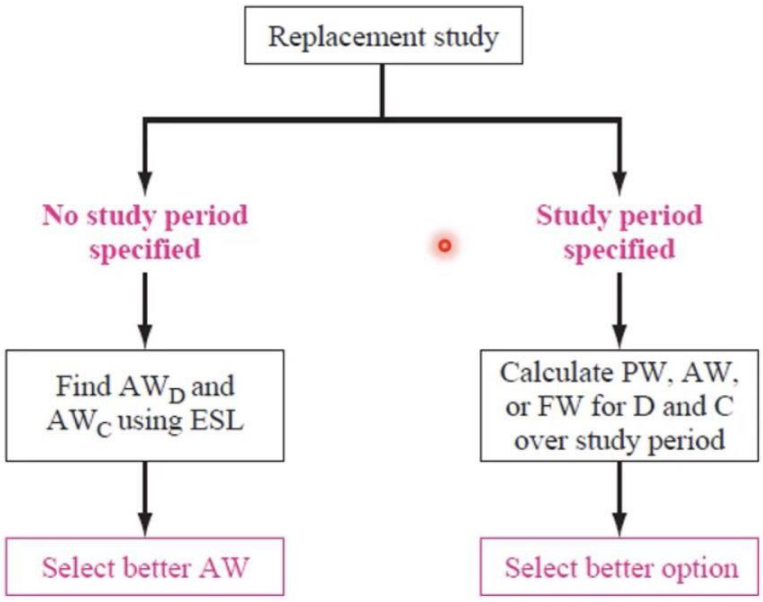
- **Defender** – currently installed asset
- **Challenger** – the "best" alternative to replace the defender
- **AW** – primary economic measure of comparison between defender and challenger.
- **Economic Service Life (ESL)** – the number of years at which the lowest AW of cost for an alternative occurs
- **Defender First Cost** – the current market value of the defender
- **Challenger First Cost** – is the actual investment needed for acquisition and installation.

Challenger First Costs

- **On occasion**, an unrealistically high trade-in value may be offered for the defender compared to its fair market value. In this event, the net cash flow required for the challenger is reduced.
- The correct amount to recover and use in the economic analysis for the challenger is its first cost minus the difference between the trade-in value (TIV) and market value (MV) of the defender.
- In equation form,

  The challenger First Cost = P- (TIV - MV)

Performing a Replacement Study



1- No Study Period Specified

Decision Rule

Defender	Challenger
➢ Aw1 = - 10 ➢ Aw2 = - 8 ➢ Aw3 = - 7 ➢ Aw4 = - 7.2 **The ESL is 3 Years and AWd = - 7**	➢ Aw = - 5 **AWc = - 5**

AWc > AWd

Replace Now

Decision Rule (Cont.)

Defender	Challenger
➢ Aw1 = - 10 ➢ Aw2 = - 8 ➢ Aw3 = - 7 ➢ Aw4 = - 7.2 **The ESL is 3 Years and AWd = - 7**	➢ Aw = - 10 **AWc = - 10**

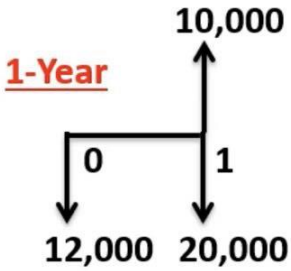
AWd > Awc

Keep for 3 years then replace

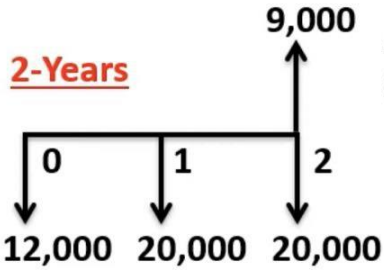
Example 2

- An asset purchased 2 years ago for $40,000 is harder to maintain than expected. It can be sold now for $12,000 or kept for a maximum of 2 more years, in which case its operating cost will be $20,000 each year, with a salvage value of $10,000 after 1 year or $9000 after two years. A suitable challenger will have an annual worth of $-24,000 per year. At an interest rate of 10% per year, should the defender be replaced now, one year from now, or two years from now?

Solution (Defender)



AW_{D1} = -12,000(A/P,10%,1) + 10,000(A/F,10%,1) – 20,000 = -23,200



AW_{D2} = -12,000(A/P,10%,2) + 9,000(A/F,10%,2) – 20,000 = -22,629

ESL is n = 2 years; AW_D = $-22,629

Solution (Decision)

Defender	Challenger
• AW_{D1} = -23,200 • AW_{D2} = -22,629	• AW_C = -24,000

Lower AW_{D2} = $-22,629 Keep defender for 2 years

Note: *conduct one-year-later analysis next year*

2- Specified Study Period

- Same procedure as before, except *calculate AW values over study period* instead of over ESL years of n_D and n_C
- It is necessary to develop *all viable defender-challenger options* and calculate AW or PW for each one *over study period*
- Select option with lowest cost or highest income

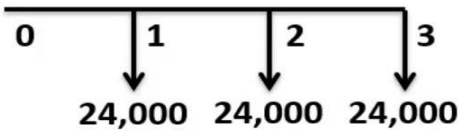
Example 3

- An asset purchased 2 years ago for $40,000 is harder to maintain than expected. It can be sold now for $12,000 or kept for a maximum of 2 more years, in which case its operating cost will be $20,000 each year, with a salvage value of $10,000 after 1 year or $9000 after two years. A suitable challenger will have an annual worth of $-24,000 per year. At an interest rate of 10% per year and over a study period of exactly 3 years, determine when the defender should be replaced.

Developing all viable options

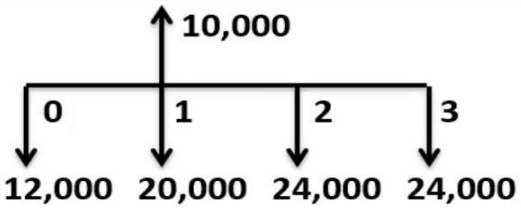
OPTION	YEAR 1	YEAR 2	YEAR 3
1	C	C	C
2	D	C	C
3	D	D	C

Solution 3: Cash Flows



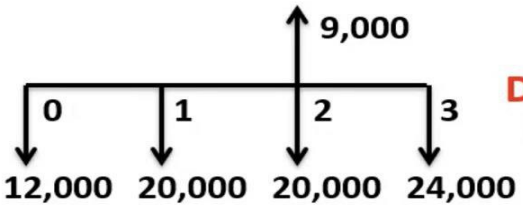
Option 1 : CCC

AW_{Op1} = $-24,000



Option 2 : DCC

AW_{Op2} = $-23,708



Option 3 : DDC

AW_{Op2} = $-23,042

Decision: Option 3; **Keep D for 2 years**, then replace

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Solution 3 (Cont.)

- AW_{o1} = - 24,000

- AW_{o2} = - 12,000(*A*/*P*,10%,3) – 10,000(*P*/*F*,10%,1) (*A*/*P*,10%,3)- 24,000(*F*/*A*,10%,2) (*A*/*F*,10%,3) = - 23,708

- AW_{o3} = - 12,000(*A*/*P*,10%,3) – 20,000(*P*/*A*,10%,2)(*A*/*P*,10%,3)+ 9,000(*P*/*F*,10%,2) (*A*/*P*,10%,3)- 24,000(*A*/*F*,10%,3) = - 23,042

Example 4

- Replacement study information for an equipment placed into service 5 years ago:
  - The current equipment will have to serve for either 2, 3 or 4 more years before replacement.
  - The equipment has a current market value of $100,000; expected to decrease by $25,000 per year.
  - The AOC is $25,000 per year.
  - The replacement challenger is a fixed-price contract to provide the same services at $60,000 per year for a minimum of 2 years and a maximum of 5 years.
  - Use MARR of 12% per year to perform a replacement study over a 6-year period to determine when to sell the current equipment and purchase the contract services.

Solution 4

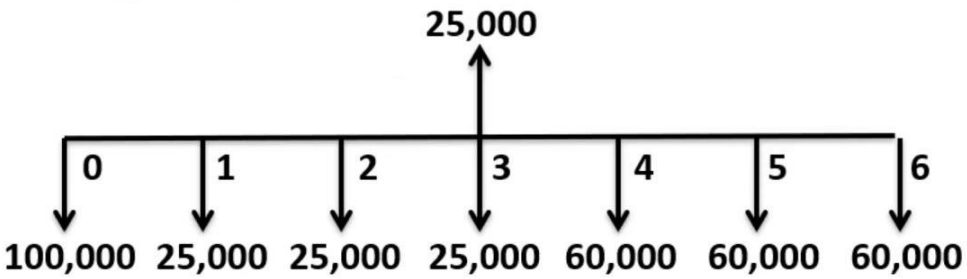
- Since the defender will be retained for 2, 3 or 4 years, there are three viable options. And the challenger shall be used 2, 3, 4, or 5 years

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Option 1	D	D	C	C	C	C
Option 2	D	D	D	C	C	C
Option 3	D	D	D	D	C	C

Solution 4: Cash Flows (Cont.)

A sample PW computation for option 2 is:

Option 2 Cash Flow Diagram

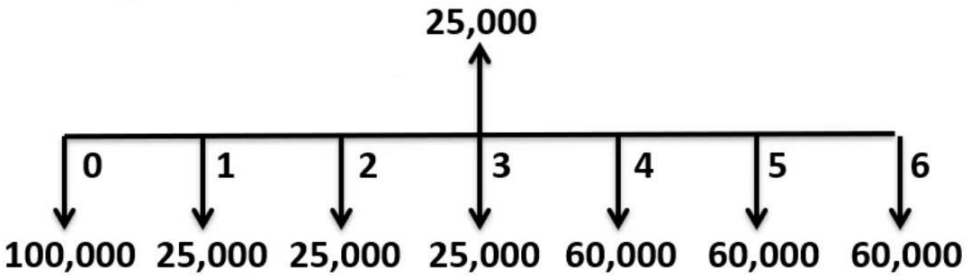


PW_2 = - 100,000 - 25,000(*P/A*,12%,3) + 25,000(*P/F*,12%,3) – 60,000(*F/A*,12%,3)(*P/F*,12%,6) = - 244,817

Solution 4: Cash Flows (Cont.)

A sample PW computation for option 2 is:

Option 2 Cash Flow Diagram



PW_2 = - 100,000 - 25,000(*P/A*,12%,3) + 25,000(*P/F*,12%,3) – 60,000(*F/A*,12%,3)(*P/F*,12%,6) = - 244,817

Solution 4

Results table

Option	Def.	Ch.	PW
Option 1	2	4	-247,666
Option 2	3	3	-244,817
Option 3	4	2	-240,369

Option 3 has the lowest cost PW value ($240,369). Keep the defender all 4 years, then replace it.