EQUIPMENT COST

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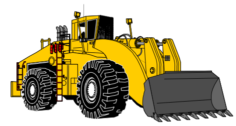

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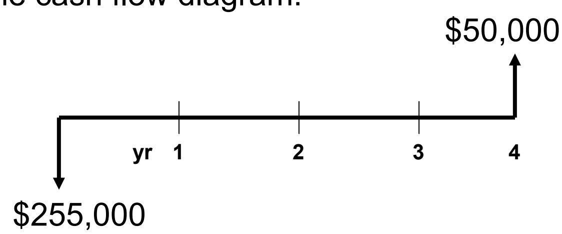
Example 2

- A company having a cost of capital rate of 8% purchases a $300,000 tractor. This machine has an expected service life of 4 years and will be used 2,500 hr per year. The tires on this machine cost $45,000. The estimated salvage value at the end of 4 years is $50,000. Calculate the depreciation portion of the ownership cost for this machine using the time value method.

Example 2 (cont'd)

Initial cost	$300,000
Cost of Tires	-45,000
Purchase Price less tires	$255,000

The cash flow diagram:



Example 2 (cont'd)

$$A_P = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right] = 255{,}000\left[\frac{0.08(1+0.08)^4}{(1+0.08)^4 - 1}\right] = \$76{,}990 \text{ per year}$$

$$A_s = F\left[\frac{i}{(1+i)^n - 1}\right] = 50{,}000\left[\frac{0.08}{(1+0.08)^4 - 1}\right] = \$11{,}096 \text{ per year}$$

Example 2 (cont'd)

- Therefore, using the time value method the depreciation portion of the ownership cost is

$$\text{Depreciation} = \frac{\$76{,}990/\text{yr} - \$11{,}096/\text{yr}}{2{,}500\ \text{hr/yr}}$$

$$= \$26.354\ /\text{hr}$$

AVERAGE ANNUAL INVESTMENT METHOD

A second approach to calculate the depreciation portion of ownership cost is the average annual investment (AAI) method

$$\text{AAI} = \frac{P(n+1) + S(n-1)}{2n} \qquad (1)$$

P = purchase price less the cost of tires.
S = the estimated salvage value.
n = expected service life in years.

AVERAGE ANNUAL INVESTMENT METHOD

- Notes on AAI
  - The AAI is multiplied by the corporate cost of capital rate to determine the ownership cost of money portion.
  - The straight-line depreciation of the cost of the machine less the salvage value and less the cost of tires, if a wheeled machine, is then added to the cost of money part to arrive at the depreciation portion of ownership cost.

Example 3

A company having a cost of capital rate of 8% purchases a $300,000 tractor. This machine has an expected service life of 4 years and will be used 2,500 hr per year. The tires on this machine cost $45,000. The estimated salvage value at the end of 4 years is $50,000. Calculate the depreciation portion of the ownership cost for this machine using the average annual investment method.

Example 3 (cont'd)

Using Eq. 1 (Eq. 3.6 Textbook), we have

$$\text{AAI} = \frac{P(n+1)+S(n-1)}{2n}$$
$$= \frac{255{,}000(4+1)+50{,}000(4-1)}{2(4)} = \$178{,}125 \text{ per year}$$

$$\text{Interest cost part} = \frac{178{,}125\text{ /yr}\,(0.08)}{2{,}500\text{ hr/yr}} = \$5.70\text{ / hr}$$

Example 3 (cont'd)

- Straight-line depreciation part:

Initial cost	$300,000
Cost of Tires	-45,000
Salvage value	-50,000
	$205,000

$$\frac{\$205{,}000}{4\text{yr}(2{,}500\text{hr / yr})} = \$20.500\text{ / hr}$$

$$\text{Depreciation} = 5.700 + 20.500 = \$26.2 \text{ per hr}$$

OWNERSHIP COST

- Comparison: Examples 2 and 3

Time Value Method $26.35/hr

Average Annual Investment Method $26.20/hr

Difference between the methods $0.15

METHODS FOR ESTIMATING OWNERSHIP COST

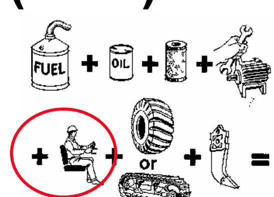
- Time Value Method versus AAI Method
  - The choice of which method to use is strictly a company preference.
  - Either method is satisfactory, especially considering the effect of unknowns such as service life, operating hours per year, estimating future salvage.
  - There is no single solution to calculating ownership cost.

OPERATING COST

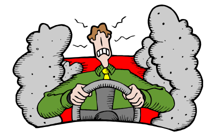
- Operating costs are those costs associated with the operation of a piece of equipment.
- Operating costs usually occur when the equipment is being used.

OPERATING COST

- **Consumables - fuel, oil, grease & filters (FOG)**
- **Repair**
- **Maintenance**
- **Tires or tracks**
- **High wear items - cutting edges, teeth**



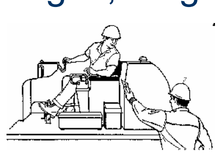
OPERATING COST



- Operator Wages
  - Operator (e.g., driver) wages are sometimes included under *operating cost*.
  - But because of wage variance between jobs, the general practice is to keep operator wages as a separate cost category.

OPERATING COST

- Operator Wages
  - Such a procedure aids in estimation of a machine cost for bidding purposes as the differing project wage rates can readily be added to the total machine O&O cost.
  - In applying operator cost, all benefits paid by the company must be included – direct wages, fringe benefits, insurance, etc.



OPERATING COST

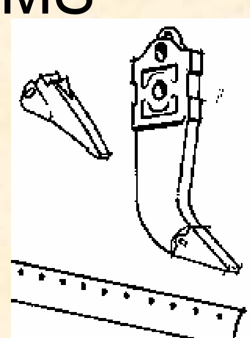
▪Question No. 4

Machine **operating** cost includes which of the expenses listed?

- $ Tires
- $ Shop expenses
- $ Taxes
- $ Repairs

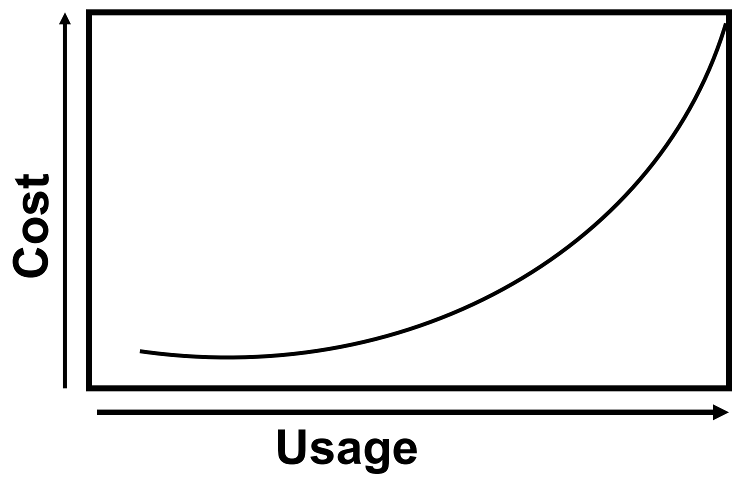
OPERATING COST

▪HIGH WEAR ITEMS



- ◆ Bucket teeth
- ◆ Cutting edges
- ◆ Truck body liners
- ◆ Ripper tips
- ◆ Ripper shank protectors

OPERATING COST



OPERATING COST

- Fuel Consumption
  - To consider operating cost of fuel and lubricants we must know the amounts consumed as a function of:
    - The type of equipment,
    - The conditions under which the equipment is used, and
    - The location where the equipment is used.

OPERATING COST

- Fuel Consumption and Cost
  - To calculate fuel cost, a consumption rate is found from tables and then multiplied by the unit price of fuel.
  - Fuel consumption formulas have been published for both gasoline and diesel engines.

OPERATING COST

- Fuel Consumption
  - Values from these formulas must be adjusted by
    - **Time Factor** – Percentage of an hour that the machine is actually working (e.g, 50/60, 40/60).
    - **Load Factor** – Percentage of rated horsepower.

OPERATING COST

Table 1. Average Fuel Consumption – Wheel Loaders

	Type of Utilization		
Horsepower (fwhp)	Low (gal/hr)	Medium (gal/hr)	High (gal/hr)
90	1.5	2.4	3.3
140	2.5	4.0	5.3
220	5.0	6.8	9.4
300	6.5	8.8	11.8

OPERATING COST

- Fuel Consumption Under Standard Condition

Table 2

Gasoline Engine	Consumes **0.06** gal of fuel per flywheel horsepower hour (fwhp-hr)
Diesel Engine	Consumes **0.04** gal per fwhp-hr

Example 4

- A 220-fwhp wheel loader will be used at an asphalt plant to move aggregate from stock pile to the cold teed hoppers. This loader is diesel powered. It is estimated that the work will be steady at an efficiency equal to a 50-min hour. The engine will work at full throttle while the loading bucket (30% of the time) and at three-quarter throttle to travel and dump. Calculate the fuel consumption using

Example 4 (cont'd)

the engine consumption averages and compare the result to a medium rating in Table 1 (Table 3.2, Text). If diesel costs $1.07 gal, what is the expected fuel expense?

Fuel consumption diesel engine **0.04** (Table 2) gal per fwhp-hr.

Load Factor:

Loading bucket	$1.00 \times 0.30 = 0.30$
Travel and dump	$0.75 \times 0.70 = 0.53$
	0.83

Example 4 (cont'd)

$$\text{Time factor 50-min hr} = \frac{50}{60} = 0.83$$

Combined factor: 0.83 × 0.83 = 0.69

$$\text{Fuel consumption} = 0.69\left(\frac{0.04\text{ gal}}{\text{fwhp-hr}}\right)(220\text{ fwhp}) = 6.1\frac{\text{gal}}{\text{hr}}$$

Table 1 (Table 3.2, Text) medium rating 200 fwhp loader

= 6.8 gal/hr

Example 4 (cont'd)

There is considerable difference in the calculated results and those found in Table 1 (Table 3.2, Text), which is why it is recommended that a company establish historical data.

Cost:

Using the formula	6.1 gal/hr × \$1.07/gal = \$6.53/hr
Table 1	6.8 gal/hr × \$1.07/gal = \$7.28/hr

OPERATING COST

- Lubricants
  - The quantity of lubricants used by an engine will vary with the size of the engine, the capacity of the crankcase, the condition of the piston rings, and the number of hours between lubricant changes.
  - For extremely dusty operations it may be desirable to change lubricants every 50 hours, but this is an unusual condition.

OPERATING COST

- Lubricants
  - For extreme *dusty* conditions, it may be desirable to change oil every **50 hr**.
  - However, It is common practice to change lubricant every **100-200 hours**.
  - The quantity (q) of the lubricant consumed by an engine per change will include the amount added during the change plus the make-up lubricant (c/t) between changes.

OPERATING COST

- Lubricant Formula

$$q_{FC} = \frac{\text{hp} \times f \times 0.006\ \text{lb/hp-hr}}{7.4\ \text{lb/gal}} + \frac{c}{t} \qquad (2)$$

q_{FC} = quantity consumed, gph (gallons per hour)
hp = rated horsepower of the engine
c = operating factor
t = number of hours between changes

Example 5

Calculate the oil required, on a per hour basis, for the 220-fwhp wheel loader in Example 4. The operating factor will be 0.69 as calculated in that example. The crankcase capacity is 8 gal and the company has a policy to change oil every 150 hr.

Example 5 (cont'd)

Using Eq. 2, we have

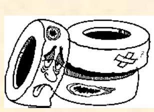
What the engine burns **Oil changes**

$$q_{FC} = \frac{\text{hp} \times f \times 0.006\ \text{lb/hp-hr}}{7.4\ \text{lb/gal}} + \frac{c}{t}$$

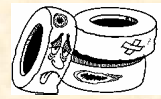
$$q_{FC} = \frac{220 \times 0.69 \times 0.006}{7.4} + \frac{8}{150} = 0.18\ \frac{\text{gal}}{\text{hr}}$$

OPERATING COST

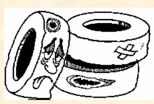
- Tires
  - Tire expenses include both tire repair and tire replacement.
  - Tire maintenance is commonly handled as a **percentage of straight-line** tire depreciation.
  - Tire hourly cost can be derived simply by dividing the cost of a set of tires by their expected life.



OPERATING COST



- Tires (cont'd)
  - This how many companies prorate this expense.
  - A more sophisticated approach is to use a **time-value calculation**.
  - In this approach, it is recognized that tire replacement expenses are single-point-in time outlays that take place over the life of a wheel-type machine.



Example 6

Calculate the hourly tire cost that should be part of machine operating cost if a set of tires can be expected to last 5,000 hr. Tires cost $38,580 per set of four. Tire repair cost is estimated to average 16% of the straight-line tire depreciation. The machine has a service life of 4 yr and operates 2,500 hr per year. The company cost of capital rate is 8%.

Example 6 (cont'd)

- Approach I:
  - **Not considering the time value of money:**

$$\text{Tire repair cost} = \frac{\$38{,}580}{5{,}000\ \text{hr}}(0.16) = \$1.235\ /\text{hr}$$

$$\text{Tire use cost} = \frac{\$38{,}580}{5{,}000\ \text{hr}} = \$7.716\ /\text{hr}$$

$$\therefore \text{The operating cost} = 1.235 + 7.716 = \boxed{\$8.95\ /\text{hr}}$$

Example 6 (cont'd)

- Approach II:
  - **Considering the time value of money**

Machine service life = 4 yr = 4 × 2,500 = 10,000 hr

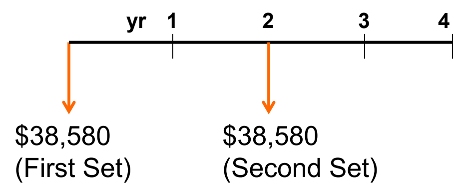
Tire life = 5,000 hr

A second set of tires will be purchased at the end of 10,000 / 5,000 = 2 years

The repair cost is the same = $1.235 / hr

Example 6 (cont'd)

- Approach II (cont'd):

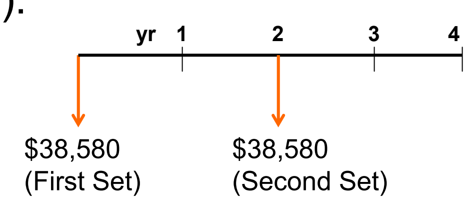


$$A_{1st\ Set} = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right] = 38{,}580\left[\frac{0.08(1+0.08)^4}{(1+0.08)^4 - 1}\right] = \$11{,}648 \text{ per year}$$

$$\text{First year cost per hr} = \frac{\$11{,}648}{2{,}500} = \$4.659\ /\text{hr}$$

Example 6 (cont'd)

- Approach II (cont'd):



$$A = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right] \qquad P = \frac{F}{(1+i)^n}$$

$$A_{2nd\ Set} = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right] = \frac{F}{(1+i)^n}\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

$$= \frac{38{,}580}{(1+0.08)^2}\left[\frac{0.08(1+0.08)^4}{(1+0.08)^4 - 1}\right] = \$9.986 \text{ per year}$$

$$\text{First year cost per hr} = \frac{\$9.986}{2{,}500} = \$3.995\ /\text{hr}$$

Example 6 (cont'd)

- Approach II (cont'd):
  - Therefore, considering the time value of money, tire operation cost is calculated as follows:

$$\text{The operating cost} = \text{Repair} + \text{First Set} + \text{Second Set}$$

$$= 1.235 + 4.659 + 3.995 = \boxed{\$9.89\ /\text{hr}}$$

Compare	Straight-Line	Time Value
	$7.72 /hr	$9.89 /hr

DEPRECIATION AND DEPRECIATION ACCOUNTING

- Depreciation
  - is the loss in value of a piece of equipment over time, generally caused by wear and tear from use, deterioration, obsolescence, or reduced need.
- Depreciation accounting
  - is the systematic allocation of the costs of a capital investment over some specific number of years

DEPRECIATION ACCOUNTING

Reasons for calculating the depreciation accounting value (usually termed book value) of a piece of equipment:

1. To provide the construction owner and project manager with an easily calculated estimate of the current market value of the equipment.
2. To provide a systematic method for allocating the depreciation portion of equipment ownership costs over a period of time and to a specific productivity rate.
3. To allocate the depreciation portion of ownership costs in such a manner that the greatest tax benefits will accrue.

DEPRECIATION ACCOUNTING

- Information needed for depreciation accounting
  1. The purchase price of the piece of equipment, *P*.
  2. The optimum period of time to keep the equipment or the recovery period allowed for income tax purposes, *N*.
  3. The estimated resale value at the close of the optimum period of time, *F*.

DEPRECIATION CALCULATION METHODS

Three methods are commonly used:

- Straight-line (SL) Method (widely used)
- Sum-of-the-years (SOY) Method
- Declining-balance (DB) Method

STRAIGHT-LINE (SL) METHOD

- The annual amount of depreciation D_m,,for any year m, is a constant value, and thus the book value BV_m decreases at a uniform rate over the useful life of the equipment.

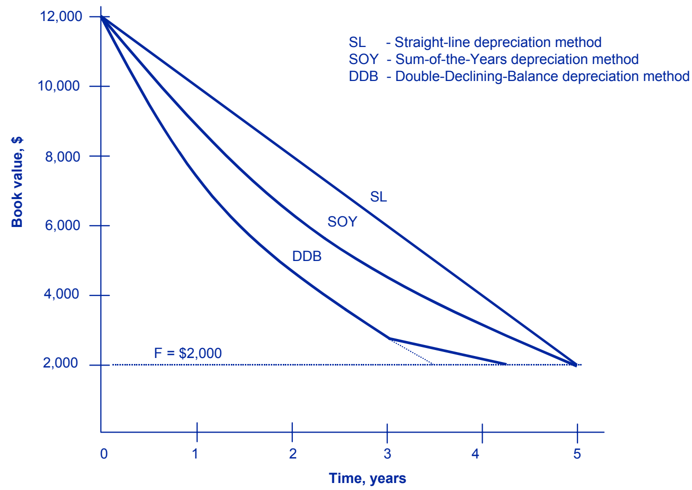
$$\text{Depreciation rate, } R_m = \frac{1}{N} \quad \text{(3a)}$$

$$\text{Annual depreciation amount, } D_m = R_m(P-F) = \frac{P-F}{N} \quad \text{(3b)}$$

$$\text{Book value at year } m,\ BV_m = P - mD_m \quad \text{(3c)}$$

<u>Note:</u>The value (*P - F*) is often referred to as the depreciable value of the investment.

DEPRECIATION CURVES



Example 7

A piece of equipment is available for purchase for $12,000, has an estimated useful life of 5 years, and has an estimated salvage value of $2,000. Determine the depreciation and the book value for each of the 5 years using the SL method.

$$R_m = \frac{1}{N} = \frac{1}{5} = 0.2$$

$$D_m = R_m(P - F) = 0.2(12{,}000 - 2000) = \$2{,}000 \text{ per yr}$$

The following table can be constructed for depreciation:

Example 7 (cont'd)

$$BV_2 = 12{,}000 - 2(2{,}000) = \$8{,}000$$

m	BV_{m-1}	D_m	BV_m
0	\$0	\$0	\$12,000
1	12,000	2,000	10,000
2	10,000	2,000	8,000
3	8,000	2,000	6,000
4	6,000	2,000	4,000
5	4,000	2,000	2,000

If the equipment is expected to be used about 1,400 hours per year then its estimated hourly depreciation portion of the ownership cost is

\$2,000/1,400 = \$1.428 = \$1.43 per hour

ECONOMIC LIFE OF CONSTRUCTION EQUIPMENT

- There are several different "lives" of equipment:
  1. The time it is actually owned (actual life),
  2. The depreciable life used in depreciation accounting,
  3. The life used for tax purposes (taxable life), and
  4. The optimum time that the equipment should be held from an overall income/cost viewpoint (economic life).

ECONOMIC LIFE

- **Economic life** - the life in which the annual worth is maximized.

  Worth = f(cost, income)

- If no income is generated, the economic life is the life for which the annual costs are minimized
  - **Ideally**, when a piece of equipment is purchased, the estimated useful life will equal the actual economic life.
  - **Realistically**, useful lives are estimated from historical records and manufacturers' data.

ACTUAL VS. ESTIMATED VALUE OF EQUIPMENT

- Profitable equipment owners keep accurate records of:
  - Actual equipment use,
  - Equipment charges,
  - Ownership costs, and
  - Operating costs
- Periodically, actual values are compared with estimated values. If actual values are different, the equipment charges are adjusted.

ACTUAL VS. ESTIMATED VALUE OF EQUIPMENT

- The estimated useful life is also checked with the actual economic life.
- In order to determine the actual economic life, net annual worth (or cost) calculations are made for several trial time periods using the market value of the equipment, if sold, at the end of these periods.

EQUIPMENT REPLACEMENT CALCULATIONS

- It is important to realize that as equipment ages through time and use, its operating costs always increase.
- To maintain profitability, equipment owners should periodically compare each piece of equipment's worth with the estimated worth of such alternatives as:
  - Replacement with a new or used piece of equipment.
  - Sale without replacement, then either leasing or renting as needed.