

King Fahd University of Petroleum & Minerals
College of Environmental Design
Construction Engineering & Management Department
CEM 530
Construction Equipment & Methods
Fall 2004



Equipment economics

- Estimating owning & operating costs.
- Determining the optimum economic life.



Owning & operating costs

- **Owning costs (fixed costs).**
 - **Depreciation costs.**
 - **Investment costs.**
 - **Taxes.**
 - **Insurance.**
 - **Storage.**



Owning costs

- Depreciation costs

- Decrease in value of equipment through wear, deterioration, and obsolescence.

- Straight line depreciation.

$$Dep./ yr = \frac{Initial\ cost - Salvage\ value}{Life(yrs)}$$



Owning costs

- **Example:**

- Initial price of equipment including shipment = \$35,000.
- Expected life of equipment = 5 yrs.
- Expected salvage value after 5 yrs. = \$5,000.

Calculate the cost of depreciation per year.

Solution:

$$Dep./ yr = \frac{35,000 - 5,000}{5} = \$6,000$$



Owning costs

- Investment costs.

Return on money paid to acquire the equipment based on the rate of interest of banks.

Investment costs/yr. = Average value \times interest rate/yr.

If:

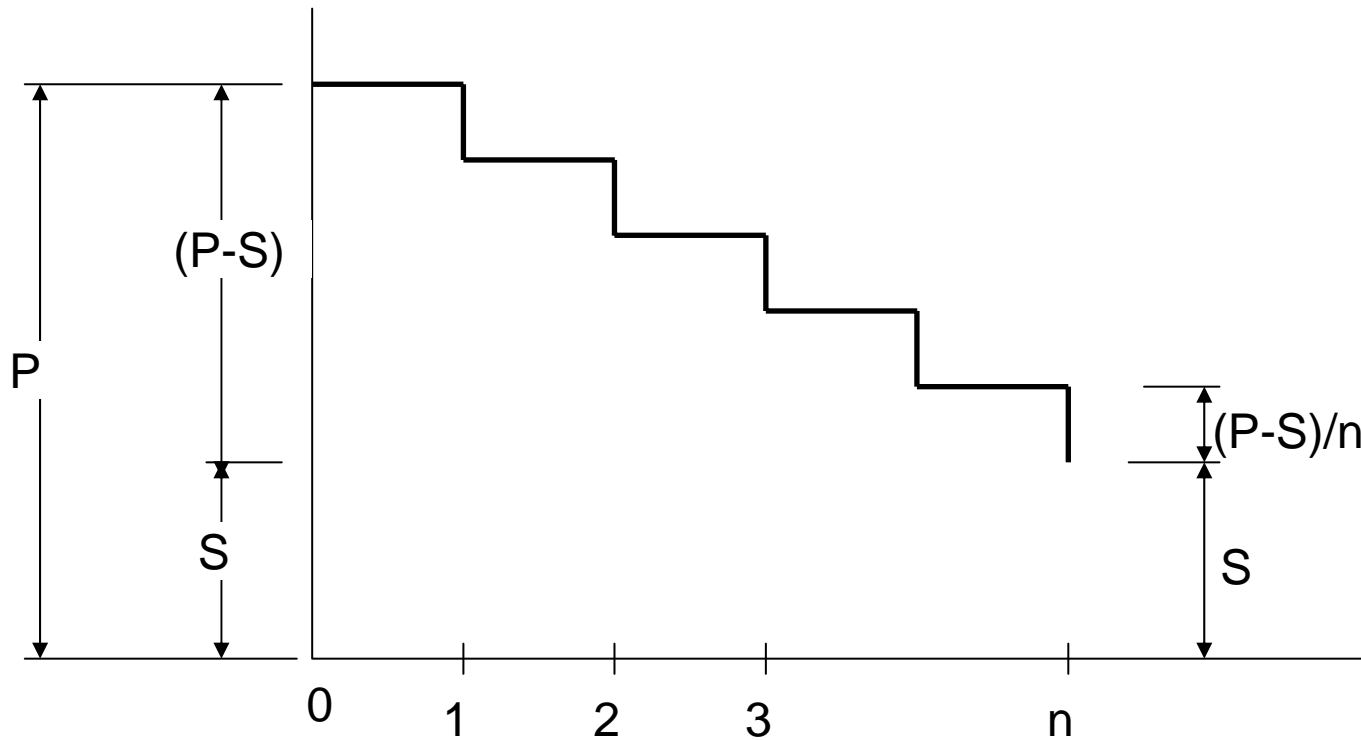
Initial price of equipment including shipment = P.

Expected life of equipment = n yrs.

Expected salvage value after n yrs. = S.



Owning costs



$$\text{Avrg value } \bar{P} = \frac{P + (P-S)/n + S}{2}$$



Owning costs

$$\text{Avrg value } \bar{P} = \frac{P + (P - S) / n + S}{2}$$

$$\text{Avrg value } \bar{P} = \frac{Pn + P - S + Sn}{2n}$$

$$\text{Avrg value } \bar{P} = \frac{P(n+1) + S(n-1)}{2n}$$



Owning costs

- Example:

Initial cost of acquiring the equipment = \$25,000.

Expected life = 5 yrs.

Expected Salvage value after 5 yrs. = \$5,000

Interest rate = 10%

Calculate the interest costs per year.



Owning costs

Solution:

$$\bar{P} = \frac{25,000(5 + 1) + 5,000(5 - 1)}{2 \times 5} = \$17,000$$

Investment cost/yr. = $17,000 \times 0.10 = \$1,700.$



Owning & operating costs

- **Operating costs (Variable costs).**
 - **Fuel.**
 - **Lubricants & hydraulic fluids.**
 - **Repairs.**
 - **Tires.**
 - **Operator.**



Operating costs

- Fuel costs

Fuel consumption rates gallon/hr:

- Gasoline engines = $0.06 \times \text{HP} \times f$

- Diesel engines = $0.04 \times \text{HP} \times f$

Where:

f: operating efficiency



Operating costs

- Oil (Lubricants & hydraulic fluids)

$$q = \frac{HP \times f \times 0.006}{7.4} + \frac{c}{t} \quad (\text{gal./hr.})$$

Where:

q = quantity consumed, gallon per hour.

HP = rated horsepower.

c = crankcase efficiency.

f = operating efficiency.

t = number of hours between oil changes.



Operating costs

- **Repairs**

- overhauls, minor repairs, spare parts.
- Since it depends on the usage, it is usually determined as a percentage of the depreciation costs



Operating costs

- **Tire costs**

- Depreciation of tire is treated separately.

- Repairs of tires.



Owning & operating costs

Example:

Calculate the probable Owning & operating costs per hour for the following equipment:

Cost delivered, including freight and taxes = \$92,623.

Cost of new set of tires = \$12,113.

Useful life = 5 yrs.

Salvage value = 0.0

Life of tires = 5,000 hrs

Usage as the number of hours per year = 2000



Owning & operating costs

Diesel engine of 250 HP.

Operating factor = 0.6

Crankcase capacity = 14 gal.

Time between oil changes = 80 hrs.

Other lubricant use per hour = 0.5 lb.

Interest rate per year = 15%

Maintenance & repair = 50% of depreciation

Repairs of tires = 15% of cost of depreciation of tires.

Fuel costs = \$0.5/gal.

Lubricating oil = \$1.6/gal.

Other Lubricants costs = \$0.3/lb.

Operator costs = \$20/hr



Owning & operating costs

Solution:

Net cost less tires = $92,623 - 12,113 = \$80,510$

Annual costs:

- **Depreciation = $\$80,510 \div 5 = \$16,102$**
- **Maintenance & repair costs = $0.5 \times \$16,102 = \$8,051$**

$$\bar{P} = \frac{92,623(5+1) + 0(5-1)}{2 \times 5} = \$55,574$$

- **Invest. Costs = $55,574 \times 0.15 = \$8,336$**
- **Total annual costs = $16,102 + 8,051 + 8,336 = \$32,489$**



Owning & operating costs

Hourly costs

- Fixed & Maintenance costs = $32,489 \div 2,000 = \$16.24$
- Tire depreciation = $\$12,113 \div 5,000 = \2.42
- Tire repairs = $0.15 \times \$2.42 = \0.36
- Fuel = $(250 \times 0.04 \times 0.6) \times \$0.5 = \$3.0$
- *Lub. oil* = $\left(\frac{250 \times 0.6 \times 0.006}{7.4} + \frac{14}{80} \right) \times \$1.6 = \$0.48$
- Grease = $0.5 \times \$0.3 = \0.15

$$\text{Total costs/hr} = 16.24 + 2.42 + 0.36 + 3.0 + 0.15 + 20 = \$42.17$$



Economic equipment life

Factors affecting replacement decisions:

- Depreciation & replacement costs.
- Investments costs.
- Repair costs.
- Downtime costs.
- Obsolescence costs.



Example

Determine the economic life of the piece of equipment:

- Initial cost = \$20,000
- Cost increase per year = \$1,000
- Hours of use per year = 2,000 hr.
- Annual interest rate = 15%
- Owning & operation hourly costs = \$6.0



Depreciation and replacement costs

End of year	Replacement cost	Salvage value	Loss on replacement	Cumulative hrs of use	Cumulative cost per hour
1	21,000	15,000	6,000	2,000	3.00
2	22,000	12,000	10,000	4,000	2.50
3	23,000	10,000	13,000	6,000	2.17
4	24,000	8,500	15,500	8,000	1.94
5	25,000	7,000	18,000	10,000	1.80
6	26,000	6,000	20,000	12,000	1.67
7	27,000	5,200	21,800	14,000	1.56
8	28,000	4,500	23,500	16,000	1.47



Investment costs

End of year	Investment Start of year	Investment cost	Cum. Invest. cost	Cum. use in hours	Cum. cost per hour
1	20,000	3,000	3,000	2,000	1.50
2	15,000	2,250	5,250	4,000	1.32
3	12,000	1,800	7,050	6,000	1.18
4	10,000	1,500	8,550	8,000	1.07
5	8,500	1,275	9,825	10,000	0.98
6	7,000	1,050	10,875	12,000	0.91
7	6,000	900	11,775	14,000	0.84
8	5,200	780	12,555	16,000	0.79



Maintenance & repair costs

End of year	Annual costs	Cumulative cost	Cum. use in hours	Cum. cost per hour
1	880	880	2,000	0.44
2	1,620	2,500	4,000	0.63
3	2,250	4,750	6,000	0.79
4	2,740	7,490	8,000	0.94
5	3,360	10,850	10,000	1.09
6	3,870	14,720	12,000	1.23
7	4,740	19,460	14,000	1.39
8	5,480	24,940	16,000	1.56



Downtime costs

End of year	Downtime percentage	Downtime cost/year	Cum. Downtime cost	Cum. use in hours	Cum. cost per hour
1	3	360	360	2,000	0.18
2	6	720	1,080	4,000	0.27
3	8	960	2,040	6,000	0.34
4	10	1,200	3,240	8,000	0.41
5	12	1,440	4,680	10,000	0.47
6	14	1,680	6,360	12,000	0.53
7	17	2,040	8,400	14,000	0.60
8	20	2,400	10,800	16,000	0.68



Obsolescence costs

End of year	Obsolescence factor	Obsolescence cost/year	Cumulative cost	Cum. use in hours	Cum. cost per hour
1	0.0	0	0	2,000	0.0
2	0.05	600	600	4,000	0.15
3	0.10	1,200	1,800	6,000	0.30
4	0.15	1,800	3,600	8,000	0.45
5	0.20	2,400	6,000	10,000	0.60
6	0.25	3,000	9,000	12,000	0.75
7	0.30	3,600	12,600	14,000	0.90
8	0.35	4,200	16,800	16,000	1.15



Economic life

Item	Year							
	1	2	3	4	5	6	7	8
Depreciation & replacement	3.00	2.50	2.17	1.94	1.80	1.67	1.56	1.47
Investment	1.50	1.32	1.18	1.07	0.98	0.91	0.84	0.79
Maintenance & repair	0.44	0.63	0.79	0.94	1.09	1.23	1.39	1.56
Downtime	0.18	0.27	0.34	0.41	0.47	0.53	0.60	0.68
Obsolescence	0.00	0.15	0.30	0.45	0.60	0.75	0.90	1.15
Total	5.12	4.87	4.78	4.81	4.94	5.09	5.29	5.65



Economic life

- Descending trend

Depreciation & replacement – Investment

- Ascending trend

Maintenance & repair – Downtime - Obsolescence

Item	Year							
	1	2	3	4	5	6	7	8
Descending trends	4.50	3.82	3.35	3.01	2.78	2.58	2.40	2.26
Ascending trends	0.62	1.05	1.43	1.80	2.16	2.51	2.89	3.39
Total	5.12	4.87	4.78	4.81	4.94	5.09	5.29	5.65



Economic life

