University of Diyala

Engineering Economy

Lecture 13

3rd Stage

Communication department / Engineering collage

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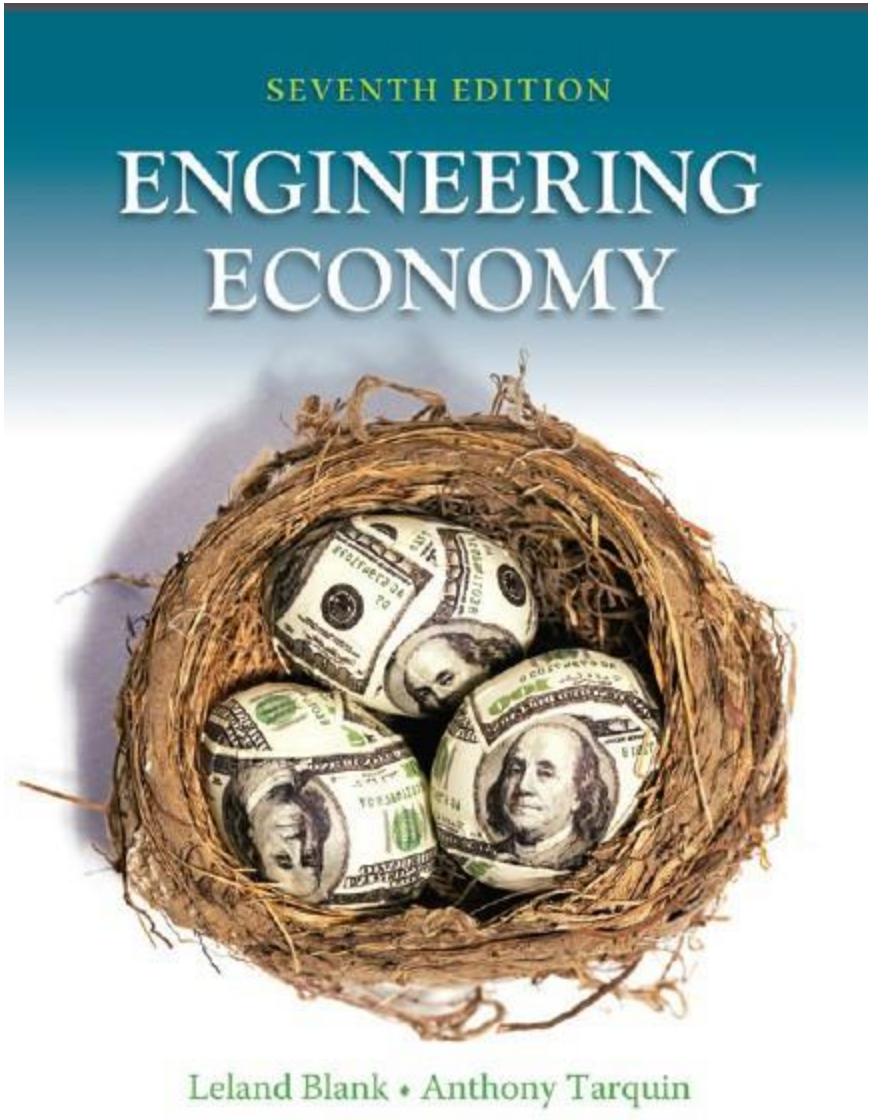


Chapter 6
Annual Worth Analysis (AW)

Annual Worth AW

- The annual worth (AW) method is commonly used for comparing alternatives.

- All cash flows are converted to an equivalent uniform annual amount over one life cycle of the alternative.

- The major advantage over all other methods is that the equal service requirement is met without using the least common multiple (LCM) of alternative lives.

- The AW value is calculated over one life cycle and is assumed to be exactly the same for any succeeding cycles, provided all cash flows change with the rate of inflation or deflation.

Advantages of AW Analysis

AW calculated for only one life cycle

Assumptions:

- Services needed for *at least the LCM* of lives of alternatives
- Selected alternative *will be repeated* in succeeding life cycles in same manner as for the first life cycle
- All cash flows *will be same* in every life cycle (i.e., will change by only inflation or deflation rate)

Alternatives usually have the following cash flow estimates

- **Initial investment, P – First cost of an asset**
- **Salvage value, S – Estimated value of asset at end of useful life**
- **Annual amount, A – Cash flows associated with asset, such as annual operating cost (AOC), etc.**

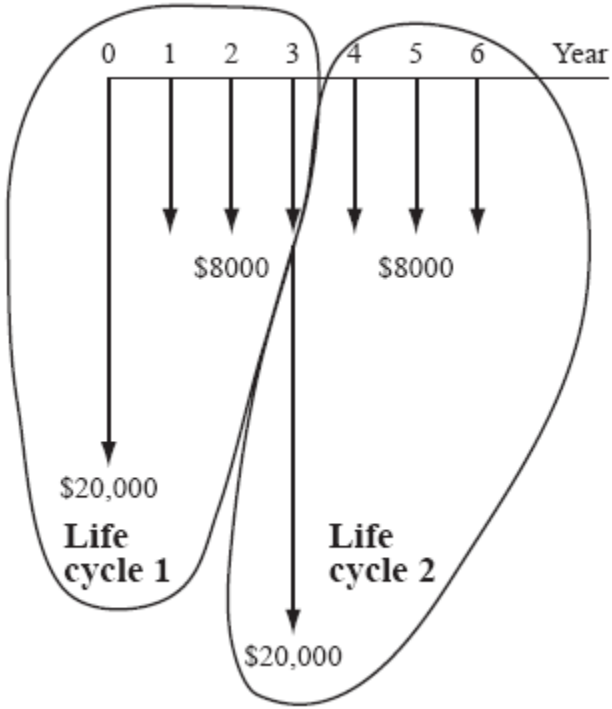
Relationship between AW, PW and FW

$$AW = PW(A/P,i\%,n) = FW(A/F,i\%,n)$$

n is years for equal-service comparison (value of LCM or specified study period)

Calculation of Annual Worth

New digital scanning graphics equipment is expected to cost $20,000, to be used for 3 years, and to have an annual operating cost (AOC) of $8000. Determine the AW values for one and two life cycles at $i = 22\%$ per year.



Calculation of Annual Worth

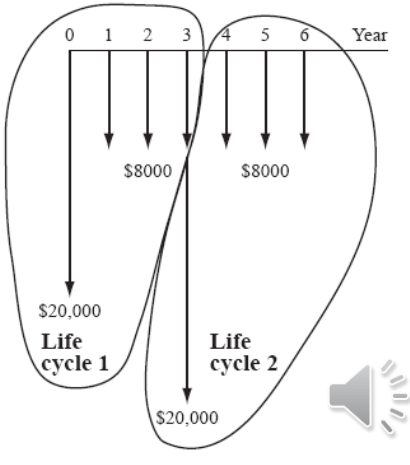
First use the cash flows for one life cycle (Figure 5.1) to determine AW.

$$AW = -20{,}000(A/P,22\%,3) - 8000 = \$-17{,}793$$

For two life cycles, calculate AW over 6 years. Note that the purchase for the second cycle occurs at the end of year 3, which is year zero for the second life cycle (Figure 5.1).

$$AW = -20{,}000(A/P,22\%,6) - 20{,}000(P/F,22\%,3)(A/P,22\%,6) - 8000$$
$$= \$-17{,}793$$

The same AW value can be obtained for any number of life cycles, thus demonstrating that the AW value for one cycle represents the equivalent annual worth of the alternative for every cycle.



Important

The same AW value can be obtained for any number of life cycles, thus demonstrating that the AW value for one cycle represents the equivalent annual worth of the alternative for every cycle.

Calculation of Annual Worth

AW for one life cycle is the *same for all* life cycles!!

An asset has a first cost of $20,000, an annual operating cost of $8000 and a salvage value of $5000 after 3 years. Calculate the AW for one and two life cycles at i = 10%

AW_{one} = - 20,000(A/P,10%,3) – 8000 + 5000(A/F,10%,3)

= **$-14,532**

AW_{two} = - 20,000(A/P,10%,6) – 8000 – 15,000(P/F,10%,3)(A/P,10%,6) + 5000(A/F,10%,6)

= **$-14,532**

Capital Recovery and AW

Capital recovery (CR) is the equivalent annual amount that an asset, process, or system must earn each year to just recover the first cost and a stated rate of return over its expected life. Salvage value is considered when calculating CR.

$$CR = -P(A/P,i\%,n) + S(A/F,i\%,n)$$

Use previous example: (note: AOC not included in CR)

CR = -20,000(A/P,10%,3) + 5000(A/F,10%,3) = $ – 6532 per year

Now $$AW = CR + A$$

AW = – 6532 – 8000 = $ – 14,532

ME Alternative Evaluation by AW

Not necessary to use LCM for different life alternatives

A company is considering two machines. Machine X has a first cost of $30,000, AOC of $18,000, and S of $7000 after 4 years.
Machine Y will cost $50,000 with an AOC of $16,000 and S of $9000 after 6 years.
Which machine should the company select at an interest rate of 12% per year?

Solution:

$$AW_X = -30{,}000(A/P,12\%,4) - 18{,}000 + 7{,}000(A/F,12\%,4)$$
$$= \$-26{,}412$$
$$AW_Y = -50{,}000(A/P,12\%,6) - 16{,}000 + 9{,}000(A/F,12\%,6)$$
$$= \$-27{,}052$$

Select Machine X; it has the numerically larger AW value

AW of Permanent Investment

Use A = Pi for AW of *infinite* life alternatives Find AW over *one life cycle* for *finite* life alternatives

Compare the alternatives below using AW and i = 10% per year

	C	D
First Cost, $	-50,000	-250,000
Annual operating cost, $/year	-20,000	-9,000
Salvage value, $	5,000	75,000
Life, years	5	∞

Solution: Find AW of C over 5 years and AW of D using relation A = P*i*

$$AW_C = -50{,}000(A/P,10\%,5) - 20{,}000 + 5{,}000(A/F,10\%,5)$$
$$= \$-32{,}371$$

$$AW_D = Pi + AOC = -250{,}000(0.10) - 9{,}000$$
$$= \$-34{,}000$$

Select alternative C