Engineering Economy

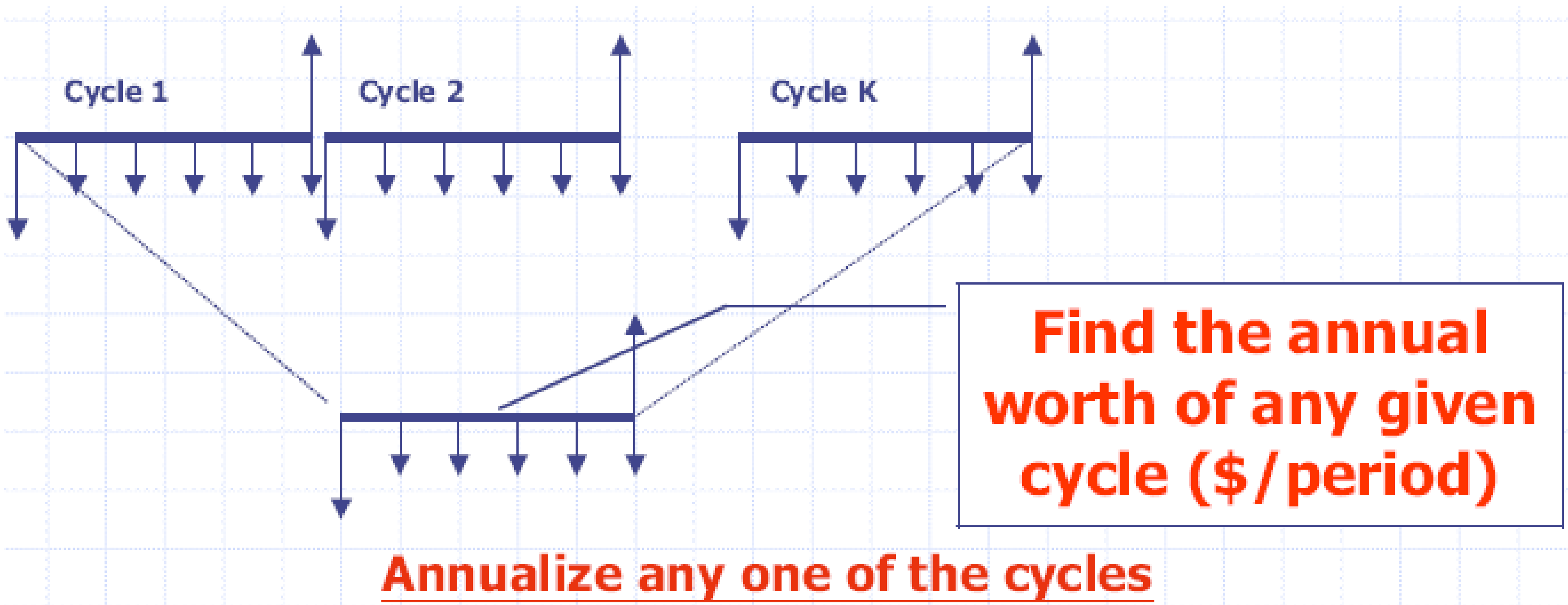
[6]

Annual Worth Analysis

Advantages of the Annual Worth Analysis

- Eliminates the LCM problem
- Only you evaluate one life cycle of a project
- The result is reported in terms of $/period
- Therefore, if two or more alternatives possess unequal lives then one need only evaluate the AW for any given cycle

Analysis for Different Cycles



AW assumes repeatability of CF's

Analysis for Different Cycles

6-year project

9-year project

Find the AW of any 6 – year cycle

Find the AW of any 9 – year cycle

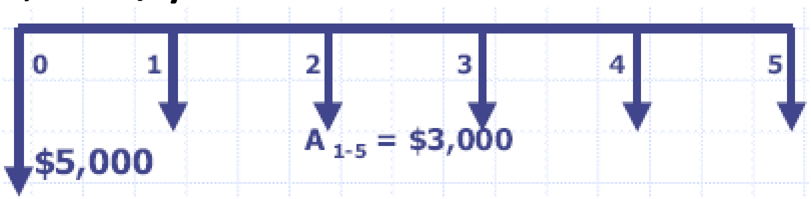
And then compare the AW_6/yr to AW_9/yr

Example [1]

- Consider a project with a $3,000 annual operating cost and a $5,000 investment required each 5 years. Assume i = 10%

- For <u>one</u> cycle:

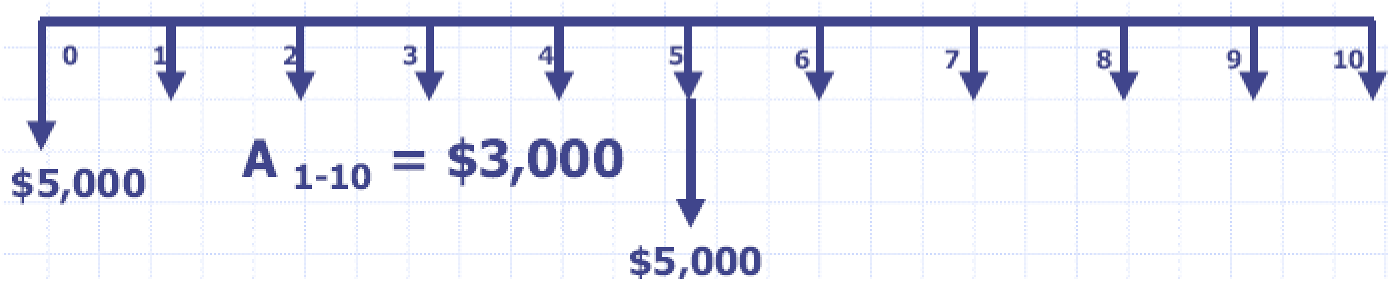
  AW = 3,000 + 5,000(A/P,10%,5) = $4,319/yr



- For <u>two</u> cycles:

  AW = 3,000 + 5,000(A/P,10%,10) + 5,000(P/F,10%,5)(A/P,10%,10)

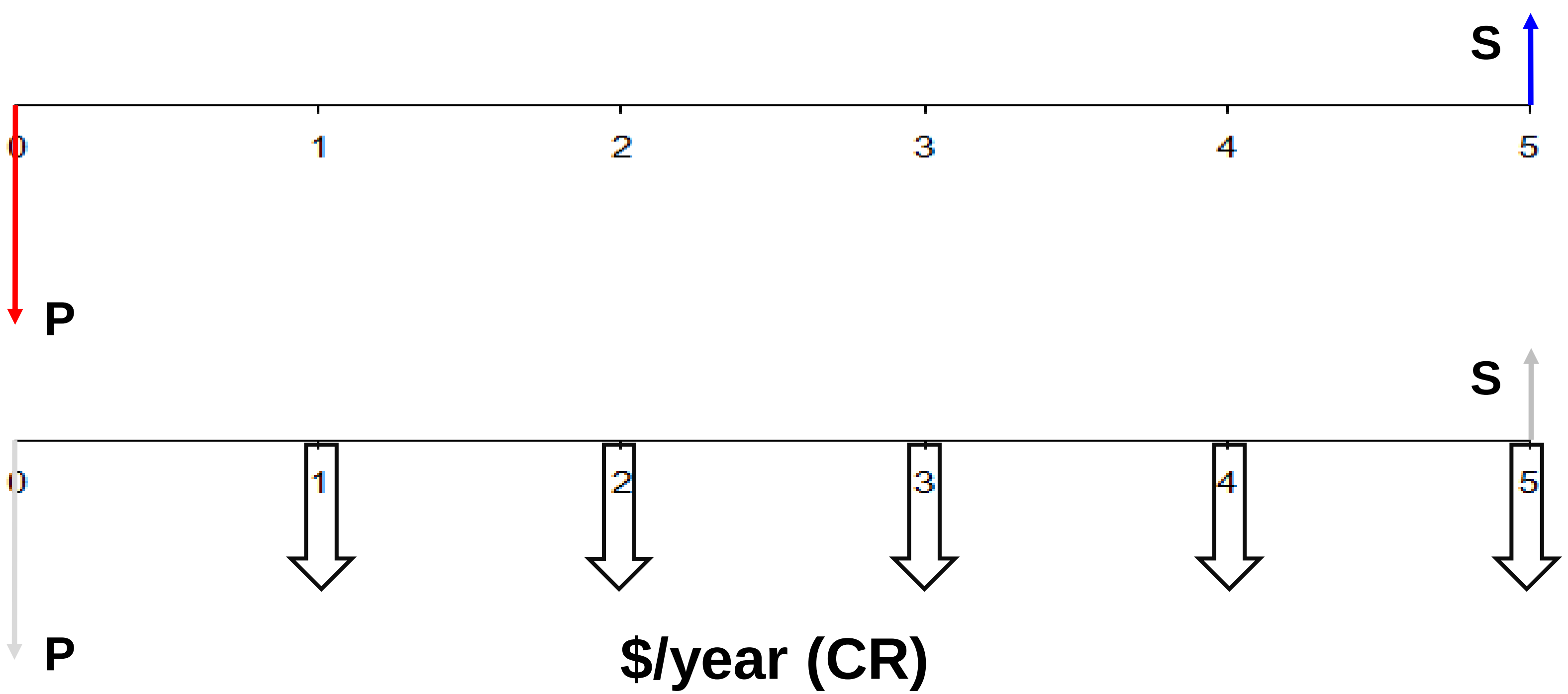
  = $4,319/yr



Capital Recovery and AW Values

- Capital recovery (CR) is the equivalent **annual** cost of *owning* the asset plus the *return* on the initial investment

- CR = - P(A/P,i,5) + S(A/F,i,5)



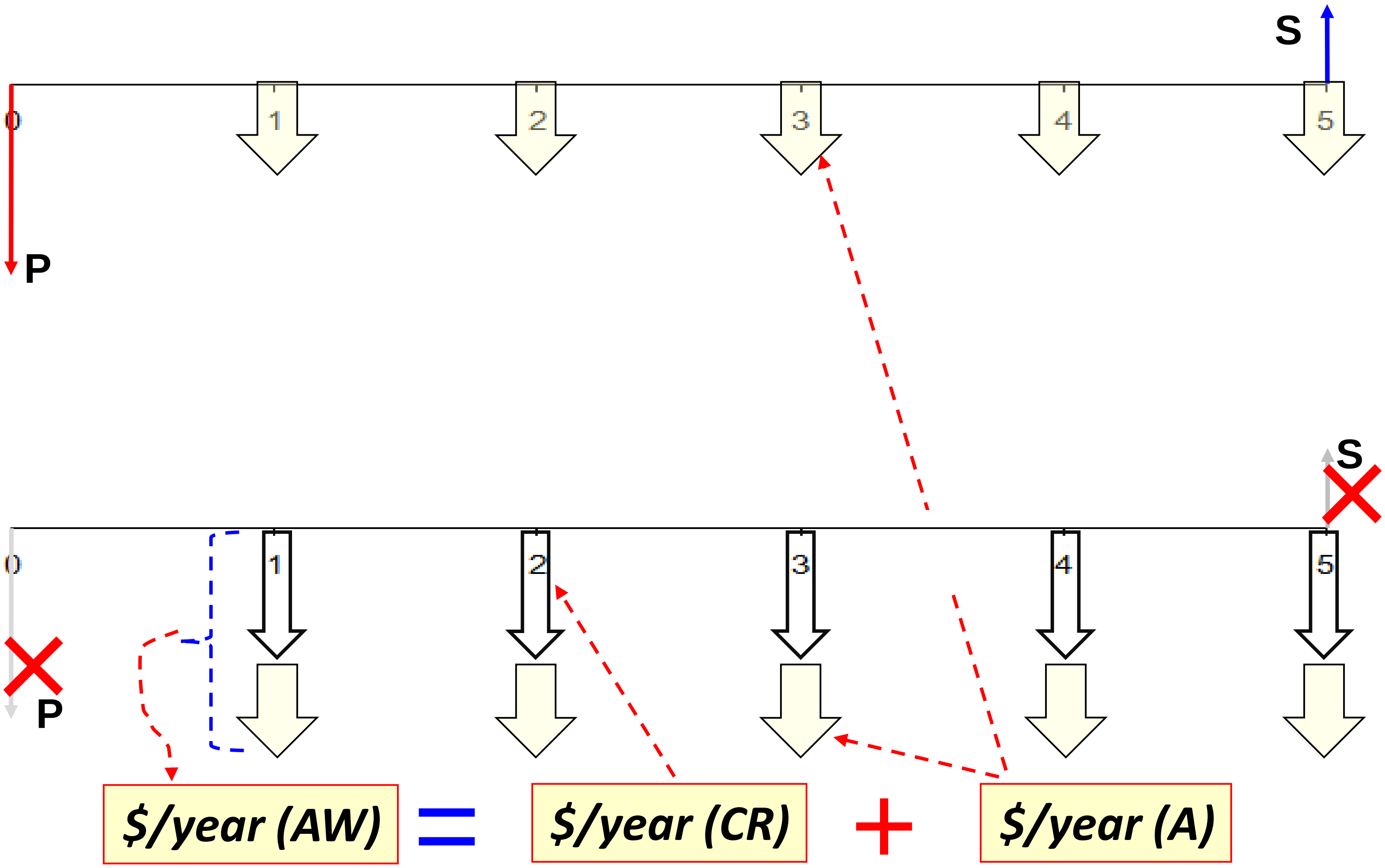
Capital Recovery and AW Values

- *Initial investment (P)*: this is the total **first** cost required to initiate the alternative. When ***portions*** of these investments take place over several years, their present worth is an equivalent initial investment

- *Salvage value (S)*: this is the estimated value of assets at the end of their useful life

- If we have annual costs (A) of the alternatives then the annual worth (AW) value for an alternative is comprised of two components: *capital recovery* for the initial investment P (plus the return on the initial investment) and the *equivalent* annual amount A

Capital Recovery and AW Values



Example [2]

- An equipment is expected to require an investment of \$13 million with \$8 million *committed now* and the remaining \$5 million will be paid at the end of year 1 of the project

- Annual operating costs for the system are expected to start the first year and continue at \$0.9 million per year

- The useful life is 8 years with a salvage value of \$0.5 million

- Compute the AW value for the system if MARR is 12%

Example [2]

- CR = – {[8 + 5(P/F,12%,1)](A/P,12%,8)} + 0.5(A/F,12%,8)

  = – (12.46)(0.2013) + 0.04

  = $ -2.47 (in millions/year)

- The $ -2.47 indicates that each and every year for 8 years we have to have a revenue of at least $2,470,000 *just to recover the initial worth investment plus the required return of 12% per year*

- This does not include the $0.9 million each year

- Total AW = -2.47 – 0.9 = $ -3.37 million per year

Evaluating Alternatives by Annual Worth Analysis – Example [3]

Two pumps are being considered for purchase. If interest is 7%, which pump should be bought?

Pump	A	B
Initial cost	$7,000	$5,000
Salvage value	$1,500	$1,000
Useful life, years	12	6

$$AW_A = \$-7{,}000(A/P,7\%,12) + \$1{,}500(A/F,7\%,12)$$

$$AW_B = \$-5{,}000(A/P,7\%,6) + \$1{,}000(A/F,7\%,6)$$

$AW_A = \$-797$ $AW_B = \$-909$ **Choose Pump A**

Evaluating Alternatives by Annual Worth Analysis – Example [4]

- Three plans are considered for an engineering design problem:

- Plan A: purchase an equipment at $650,000 with a 10 year lifetime and a $17,000 salvage value. Equipment annual operating cost is $50,000 while the annual cost of a control program is $120,000

- Plan B: Initial cost is $4 million, annual maintenance cost is $5,000, repairs occurs every 5 years at $30,000. However, this plan provides a ***permanent*** solution

- Plan C: Initial cost is $ 6 million and the annual maintenance cost is $3,000 with a lifetime of 50 years

- Assume i = 5%

Evaluating Alternatives by Annual Worth Analysis – Example [4]

- We need to compute AW for each plan for one cycle

- Plan A:

  CR_A = -650,000(A/P,5%,10) + 17,000(A/F,5%,10) = $ -82,824

  A1 = -50,000 and A2 = -120,000

  AW_A = -82,824 + (-50,000) + (-120,000) = $ -252,824

- Plan B:

  CR_B = -4,000,000 × 5% = $ -200,000

  CR_B = CC × i

  A = $ -5,000

  Repair cost = -30,000(A/F,5%,5) = $ -5,429

  AW_B = -200,000 + (-5,000) + (-5,429) = $ -210,429

- Plan C:

  CR_C = -6,000,000(A/P,5%,50) = $ -328,680

  A = $ -3,000

  AW_C = -328,680 + (-3,000) = $ -331,680

Plan B is selected due to the lowest AW of costs