Chapter 4

Establishing the Planning Horizon & MARR

Minimum acceptable rate of return (MARR) is the minimum rate of return on a project a manager or company is willing to accept before starting a project, given its risk and the opportunity cost of forgoing other projects.

Systematic Economic Analysis Technique

1. Identify the investment alternatives
2. Define the planning horizon
3. Specify the discount rate
4. Estimate the cash flows
5. Compare the alternatives
6. Perform supplementary analyses
7. Select the preferred investment

Determining the Planning Horizon

- **Least common multiple of lives**
- **Longest life**
- **Shortest life**
- **Standard horizon**
- **Organizational need**
- **Infinitely long**

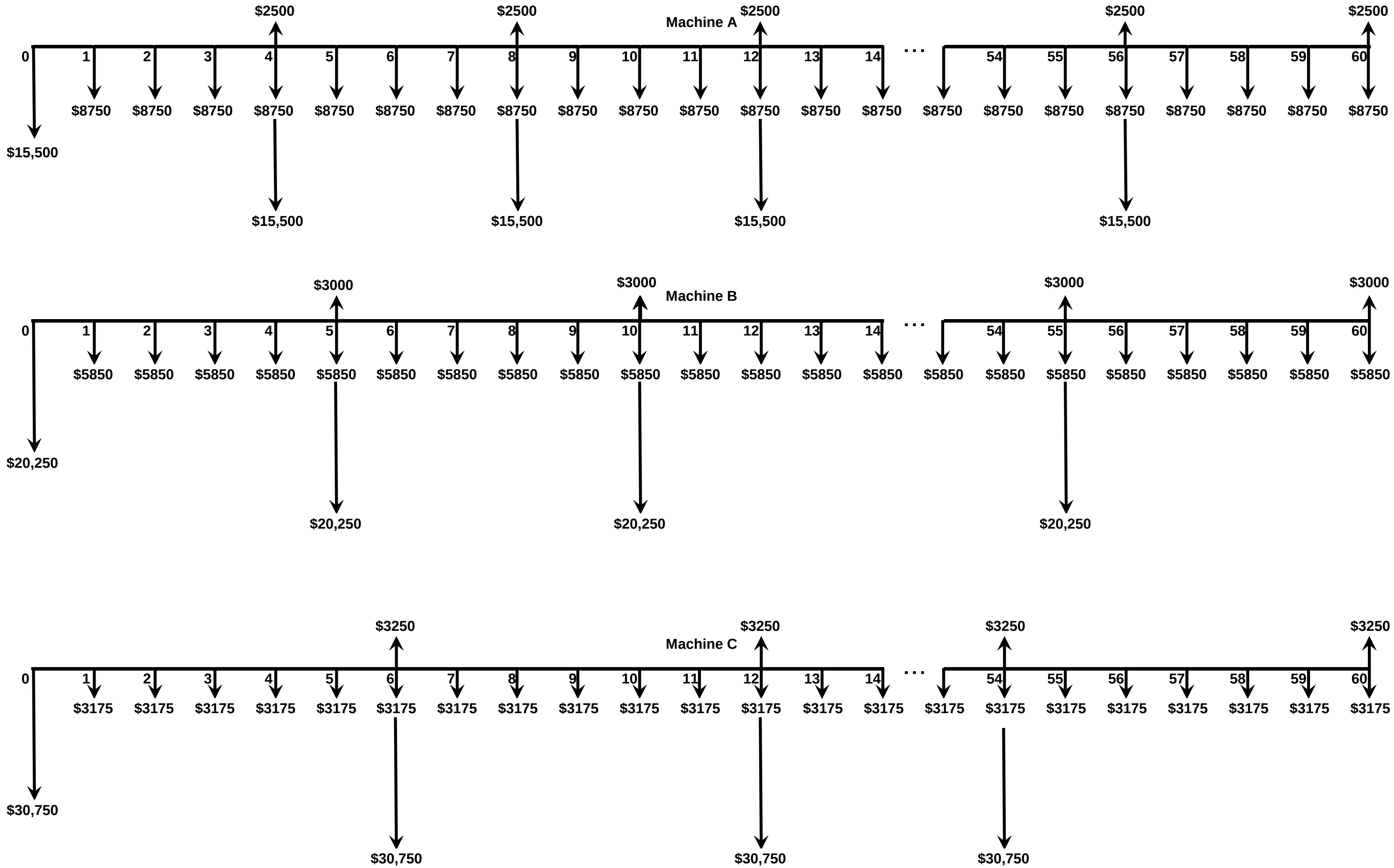
Example 4.1

Three production machines are being considered. The pertinent data are as follows:

Production Equipment	Useful Life	Initial Investment	Annual Operating Cost	Terminal Salvage Value
A	4 yrs	$15,500	$8,750	$2,500
B	5 yrs	$20,250	$5,850	$3,000
C	6 yrs	$30,750	$3,175	$3,250

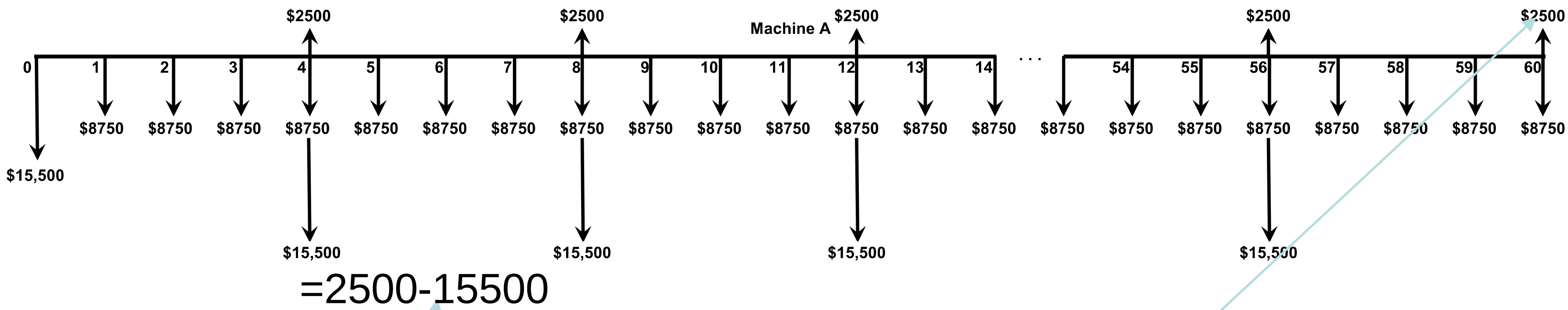
- **Based on the least common multiple of the lives, the planning horizon is 60 years** → 2*2*5*1*3
- **based on the shortest life, the planning horizon is 4 years**
- **based on the longest life, the planning horizon is 6 years**
- **based on the firm's "standard", the planning horizon is 10 years**

CFD for Least Common Multiple of Lives



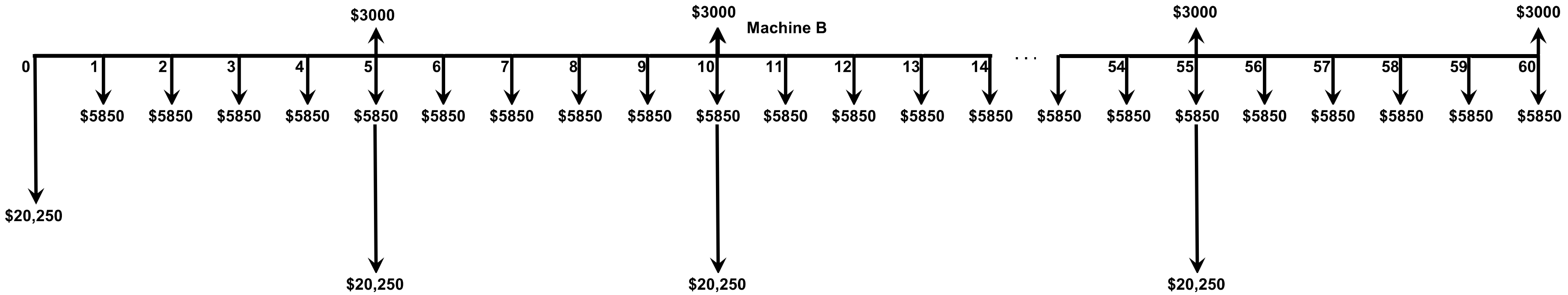
Example 4.1: 60-Year Planning Horizon

With a 60-yr planning horizon, it is assumed the successive replacements will have identical cash flow profiles. MARR = 12%

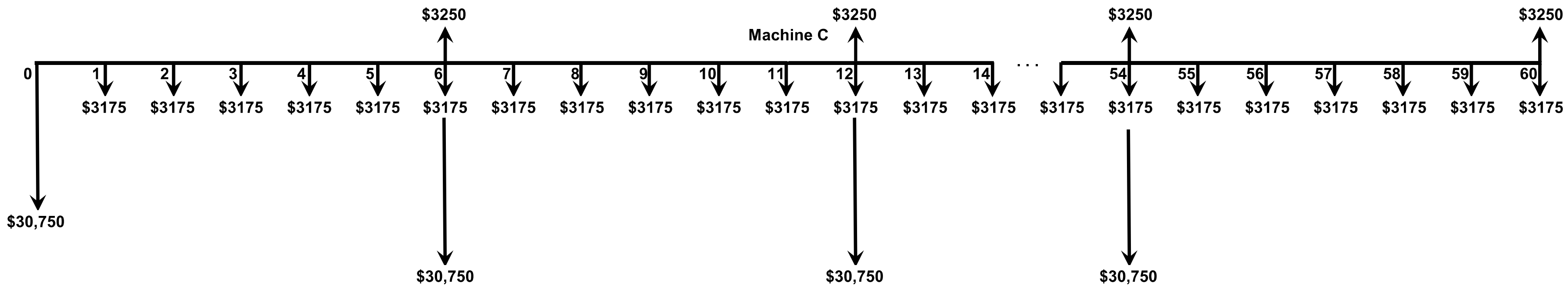


$$PW_A(12\%) = -\$15{,}500 - \$8{,}750(P|A\ 12\%,60) + \$2{,}500(P|F\ 12\%,60)$$
$$- \$13{,}000[(P|F\ 12\%,4) + (P|F\ 12\%,8) + \ldots + (P|F\ 12\%,56)]$$
$$= -\$110{,}959.97$$

Example 4.1: 60-Year Planning Horizon



$$PW_B(12\%) = -\$20,250 - \$5,850(P|A\ 12\%,60) + \$3,000(P|F\ 12\%,60)$$
$$- \$17,250[(P|F\ 12\%,5) + (P|F\ 12\%,10) + \ldots + (P|F\ 12\%,55)]$$
$$= -\$91,525.57$$



$$PW_C(12\%) = -\$30,750 - \$3,175(P|A\ 12\%,60) + \$3,250(P|F\ 12\%,60)$$
$$- \$27,500[(P|F\ 12\%,6) + (P|F\ 12\%,12) + \ldots + (P|F\ 12\%,54)]$$
$$= -\$85,352.36$$

Example 4.1: 4-Year Horizon

With a 4-yr planning horizon, it is assumed the salvage value for B will be $6,000 and the salvage value of C will be $11,000. MARR = 12%

PW_A(12%) **= -$15,500 - $8,750(P|A 12%,4) + $2,500(P|F 12%,4)**

= -$15,500 - $8,750(3.03735) + $2,500(0.63552) = -$40,488.01

=PV(12%,4,8750,-2500)-15500 = -$40,488.01

PW_B(12%) **= -$20,250 - $5,850(P|A 12%,4) + $6,000(P|F 12%,4)**

= -$20,250 - $5,850(3.03735) + $6,000(0.63552) = -$34,205.38

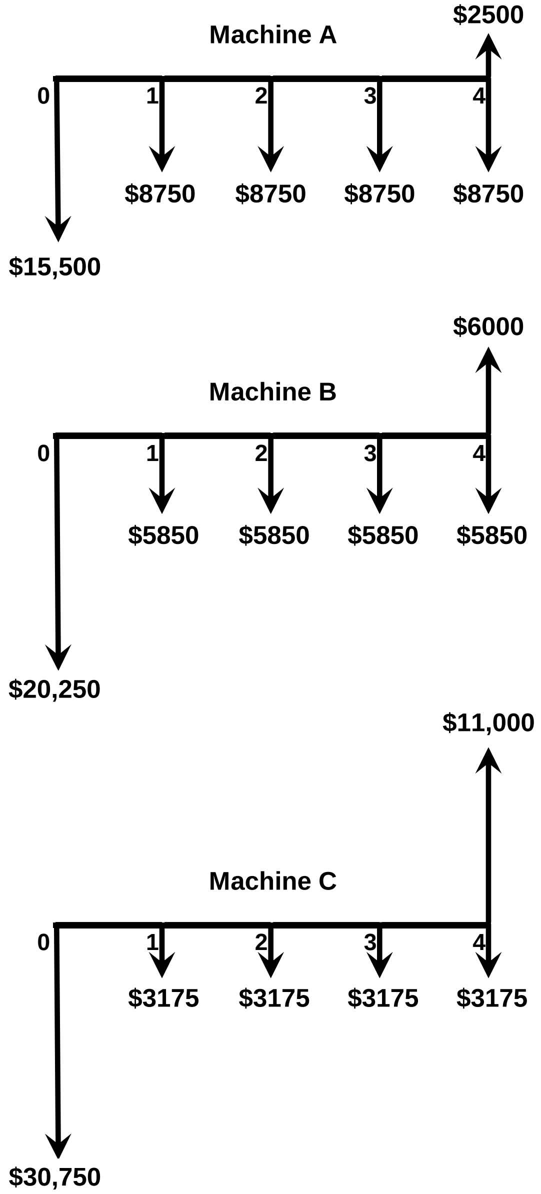
=PV(12%,4,5850,-6000)-20250 = -$34,205.39

PW_C(12%) **= -$30,750 - $3,175(P|A 12%,4) + $11,000(P|F 12%,4)**

= -$30,750 - $3,175(3.03735) + $11,000(0.63552) = -$33,402.87

=PV(12%,4,3175,-11000)-30750 = -$33,402.89

CFD for "Shortest Life" Planning Horizon



Example 4.1: 6-Year Horizon

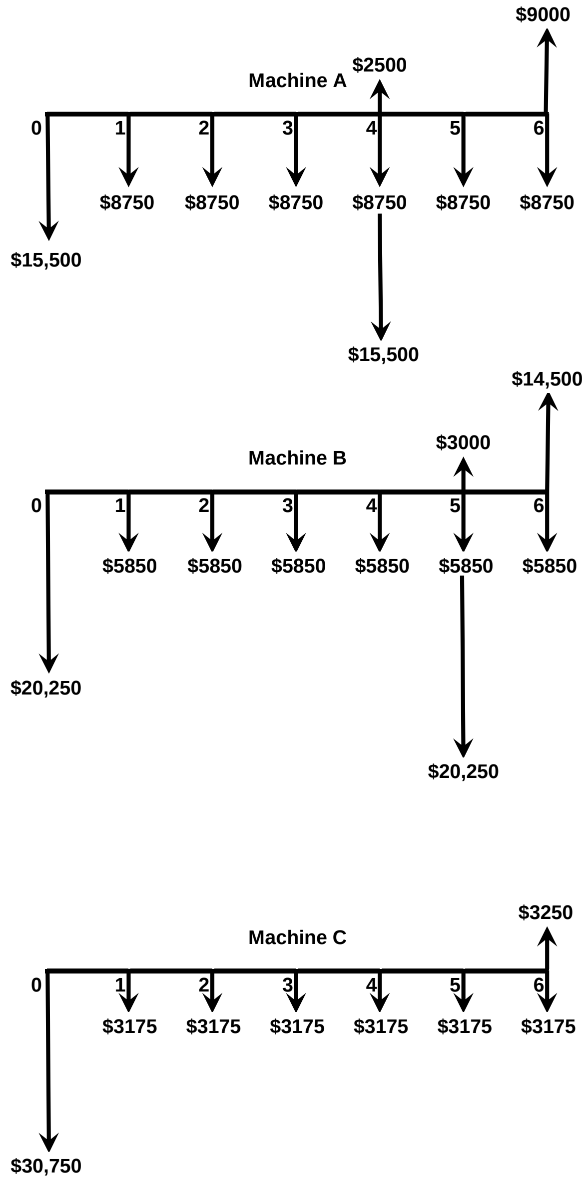
With a 6-yr planning horizon, it is assumed A will be replaced with an identical machine and have a $9,000 salvage value; similar assumptions are made for B, including a $14,500 salvage value.

PW_A(12%) = -$15,500 - $8,750(P|A 12%,6) - $13,000(P|F 12%,4) +$9,000 (P|F 12%,6) = -$55,176.93

PW_B(12%) = -$20,250 - $5,850(P|A 12%,6) - $17,250(P|F 12%,5) +$14,500 (P|F 12%,6) = -$46,743.78

PW_C(12%) = -$30,750 - $3,175(P|A 12%,6) + $3,250(P|F 12%,6) = -$42,157.18

CFD for "Longest Life" Planning Horizon



Example 4.1: 10-Year Horizon

With a 10-yr planning horizon, it is assumed A will be replaced with an identical machine and have a $9,000 salvage value; for B, two complete life cycles occur; and for C, a salvage value of $11,000 is assumed.

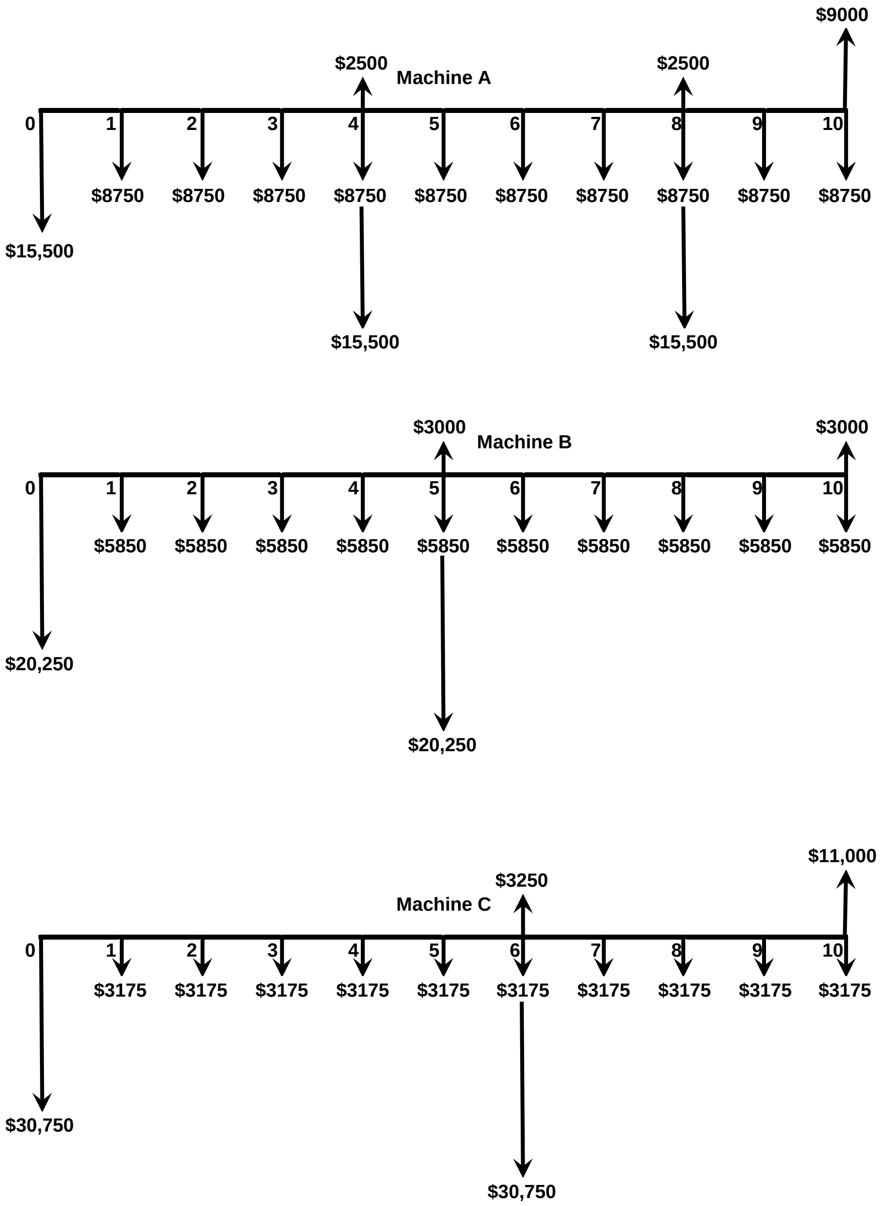
PW_A(12%) = -$15,500 - $8,750(P|A 12%,10) - $13,000(P|F 12%,4) - $13,000(P|F 12%,8) +$9,000 (P|F 12%,10)

= -$75,553.90

PW_B(12%) = -$20,250 - $5,850(P|A 12%,10) - $17,250(P|F 12%,5) +$3,000(P|F 12%,10) = -$62,126.04

PW_C(12%) = -$30,750 - $3,175(P|A 12%,10) - $27,500(P|F 12%,6)+ $11,000(P|F 12%,10) = -$59,080.10

CFD for 10-Year Planning Horizon



Example 4.1: Infinitely Long Horizon

With an indefinitely long planning horizon, we assume successive replacements have identical cash flow profiles, as with the LCML approach.

Here, we compute the annual worth for an individual life cycle (LC), recognizing the annual worth will occur indefinitely. (Assume to convert the CF to equivalent annual CF)

$AW_A(12\%)$ = -$15,500(A|P 12%,4) - $8,750+ $2,500(A|F 12%,4) = -$13,329.99

$AW_B(12\%)$ = -$20,250(A|P 12%,5) - $5,850+ $3,000(A|F 12%,5) = -$10,995.32

$AW_C(12\%)$ = -$30,750(A|P 12%,6) - $3,175+ $3,250(A|F 12%,6) = -$10,254.38

Observation

Consider the ratios of annual worths for the indefinitely long planning horizon versus the ratios of present worths for the least common multiple of lives planning horizon.

$AW_A(12\%)/AW_B(12\%) = -\$13{,}330.05/-\$10{,}995.32 = 1.212$

$AW_A(12\%)/AW_C(12\%) = -\$13{,}330.05/-\$10{,}253.71 = 1.300$

$AW_B(12\%)/AW_C(12\%) = -\$10{,}995.32/-\$10{,}253.71 = 1.072$

$PW_A(12\%)/PW_B(12\%) = -\$110{,}959.97/-\$91{,}525.57 = 1.212$

$PW_A(12\%)/PW_C(12\%) = -\$110{,}959.97/-\$85{,}352.36 = 1.300$

$PW_B(12\%)/PW_C(12\%) = -\$91{,}525.57/-\$85{,}352.36 = 1.072$

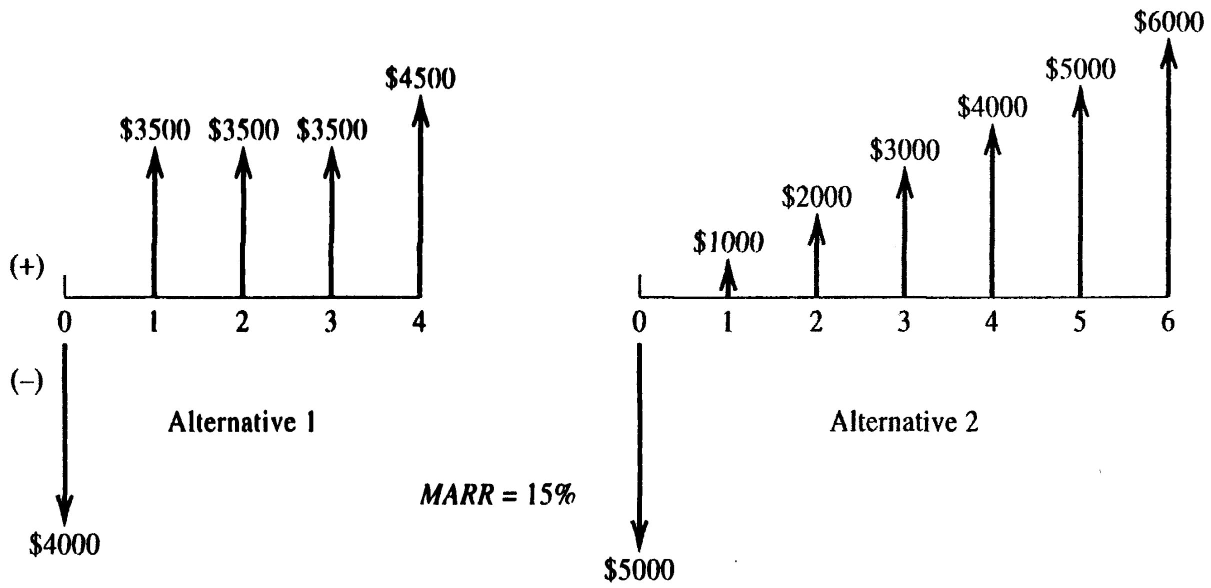
Observations

1. Evaluating alternatives based on a LCML planning horizon will yield the same recommendations as for an infinitely long planning horizon *under the assumption of identical replacements over the planning horizon*.
2. When we consider capitalized worth and capitalized cost in the next chapter, we will explicitly consider an infinitely long planning horizon, because we will be interested in knowing the magnitude of the present worth for an infinitely long planning horizon.
3. PW(LCML) = AW(LC)(P|A MARR,LCML)

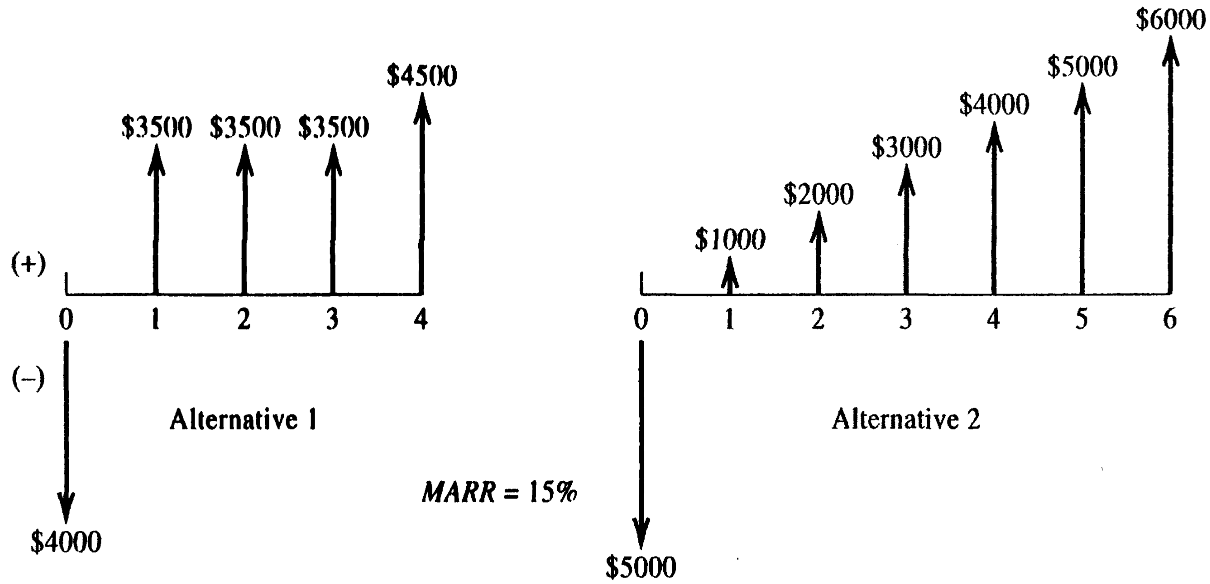
   The present worth over a LCML horizon equals the product of the annual worth for a life cycle and the P|A factor for a period of time equal to the LCML. (See the text for the calculations for Example 4.1.)

Example 4.2: One-Shot Investments

Consider the two investments shown below, only one of which can be chosen. They are one-shot investments. Given a MARR of 15%, which (if either) should be chosen?



Example 4.2: One-Shot Investments



$FW_1(15\%)$ = \$4,500(F|P 15%,2) + \$3,500(P|A 15%,3) (F|P 15%,6) - \$4,000(F|P 15%,6)= \$15,183.38

$FW_2(15\%)$ = \$1,000(F|A 15%,6) + \$1,000(A|G 15%,6) (F|A 15%,6) - \$5,000(F|P 15%,6)= \$15,546.70

Example 4.2: One-Shot Investments (Continued)

If we had assumed LCML for the planning horizon, then

AW$_1$(15%) =1000*PMT(15%,4,4,-1)+3500

= $2,299.20

AW$_2$(15%) =1000*PMT(15%,6,5-NPV(15%,1,2,3,4,5,6)) = $1,776.01

With one-shot investments, use a longest life planning horizon and assign $0 to "missing years" for the shorter lived alternatives.