Annual Equivalent Worth Criterion

Lecture No. 17
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Fundamentals of Engineering Economics
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Which Brand Would you Pick?

<table>
<thead>
<tr>
<th>Brand A</th>
<th>Brand B</th>
</tr>
</thead>
<tbody>
<tr>
<td>$799</td>
<td>$699</td>
</tr>
<tr>
<td>$55/Year</td>
<td>$85/Year</td>
</tr>
</tbody>
</table>

How Would you calculate the hourly operating cost?
Chapter 6
Annual Equivalence Analysis

- Annual equivalent criterion
- Applying annual worth analysis
- Mutually exclusive projects

Chapter Opening Story

- Capstone Turbine Corporation
- Manufacturer of micro-turbine (mini-Power Plant)
- At Issue: Economics of MicroCHP

Example of MicroCHP Economics

- C60 + Unifi NG 2C2
- 60 kW electrical
- 50 MW thermal
- $1,400/kW installed
- 1,000 hr/year operation
- Electric utility
- $0.10/kWh energy
- $0.15/kWh demand
- Gas utility
- $0.01/MMBtu
- $0.01/kWh maintenance

3 Year Payback!
Annual Worth Analysis

- **Principle**: Measure an investment worth on annual basis
- **Benefit**: By knowing the annual equivalent worth, we can:
  - Seek consistency of report format
  - Determine the unit cost (or unit profit)
  - Facilitate the unequal project life comparison

Example 6.1 Computing Equivalent Annual Worth

\[
PW(15\%) = $6.946 \\
AE(12\%) = $6.946 \left( \frac{A}{P}, 15\%, 6 \right) = $1.835
\]
Annual Equivalent Worth - Repeating Cash Flow Cycles

First Cycle:

\[ PW(10\%) = -\$1,000 + \$500 \left(\frac{P}{F}, 10\%, 1\right) + \ldots + \$400 \left(\frac{P}{F}, 10\%, 5\right) = \$1,155.68 \]

\[ AE(10\%) = \$1,155.68 \left(\frac{A}{P}, 10\%, 5\right) = \$304.87 \]

Both Cycles:

\[ PW(10\%) = \$1,155.68 + \$1,155.68 \left(\frac{P}{F}, 10\%, 5\right) + \ldots + \$400 \left(\frac{P}{F}, 10\%, 5\right) = \$1,873.27 \]

\[ AE(10\%) = \$1,873.27 \left(\frac{A}{P}, 10\%, 10\right) = \$304.87 \]
Annual Equivalent Cost

- When only costs are involved, the AE method is called the annual equivalent cost.
- Revenues must cover two kinds of costs: Operating costs and capital costs.

Capital (Ownership) Costs

- **Def:** Owning an equipment is associated with two transactions—(1) its initial cost \((I)\) and (2) its salvage value \((S)\).
- **Capital costs:** Taking these items into consideration, we calculate the capital costs as:

\[
CR(i) = I(A/P,i,N) - S(A/F,i,N) = (I - S)(A/P,i,N) + iS
\]
<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Value after three years</th>
<th>Monthly lease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acura MDX 4WD</td>
<td>$21,400</td>
<td>588</td>
</tr>
<tr>
<td>Toyota 4Runner 4WD 4-door Limited (with moonroof)</td>
<td>$18,750</td>
<td>646</td>
</tr>
<tr>
<td>Lexus RX300 2 WD</td>
<td>$18,750</td>
<td>651</td>
</tr>
<tr>
<td>GMC Envoy 4WD 4-door SLT (with Bose audio, CD changer and moonroof)</td>
<td>$15,050</td>
<td>733</td>
</tr>
<tr>
<td>Mitsubishi Montero 4WD 4 door Limited</td>
<td>$15,225</td>
<td>743</td>
</tr>
<tr>
<td>Ford Explorer 4WD 4-door Eddie Bauer edition (with moonroof, rear air and third seat)</td>
<td>$14,425</td>
<td>754</td>
</tr>
<tr>
<td>Isuzu Trooper 4WD 4-door Limited</td>
<td>$11,675</td>
<td>823</td>
</tr>
</tbody>
</table>

Source: Automotive Lease Guide
Example - Capital Cost Calculation for Mini Cooper

- **Given:**
  - $I = 19,800$
  - $N = 3$ years
  - $S = 12,078$
  - $i = 6%$

- **Find:** $CR(6%)$

\[
CR (i) = (I-S)(A/P, i, N) + iS
\]

\[
CR (6%) = ($19,800 - $12,078)(A/P, 6%, 3)
+ (0.06)$12,078
= 3,613.55
\]

Example 6.2

Justifying an investment based on AE Method

- **Given:** $I = 20,000$, $S = 4,000$, $N = 5$ years, $i = 10%$
- **Find:** see if an annual revenue of $4,400 is large enough to cover the capital costs.
- **Solution:**
  - $CR(10%) = 4,620.76$
- **Conclusion:** Need an additional annual revenue in the amount of $220.76.