Chapter 1  
Making Economic Decisions

1-1
Many engineers earn high salaries for creating profits for their employers, and then find themselves at retirement time insufficiently prepared financially. This may be because in college courses there is little or no discussion on using engineering economics for the direct personal benefit of the engineer. Among the goals of every engineer should be assuring that adequate funds will be available for anticipated personal needs at retirement.

A realistic goal of retiring at age 65 with a personal net worth in excess of two million dollars can be accomplished by several methods. An independent study ranked the probability of success of the following methods of personal wealth accumulation. Discuss and decide the ranking order of the following five methods.

(a) Purchase as many lottery tickets as possible with money saved from salary.
(b) Place money saved from salary in a bank savings account.
(c) Place all money saved from a salary in a money market account.
(d) Invest saved money into rental properties and spend evenings, weekends and vacations repairing and managing.
(e) Invest all money saved into stock market securities, and study investments 10 to 15 hours per week.

Solution

Independent studies can be misleading. If a recent winner of a two million dollar lottery drawing were asked to rank wealth accumulation methods, (a) would head his/her list. A workaholic with handyman talent might select (d) as his Number 1 choice. Lots of people have become millionaires by investing in real estate. The important thing is to learn about the many investment vehicles available and then choose the one or the several most suitable for you.

1-2
A food processor is considering the development of a new line of product. Depending on the
quality of raw material, he can expect different yields process-wise, and the quality of the final products will also change considerably. The product development department has identified three alternatives, and produced them in a pilot scale. The marketing department has used those samples for surveys to estimate potential sales and pricing strategies. The three alternatives would use existing equipment, but different process conditions and specifications, and they are summarized as follows. Indicate which alternative seems to be the best according to the estimated data, if the objective is to maximize total profit per year.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>lbs of raw material A per unit of product</td>
<td>0.05</td>
<td>0.07</td>
<td>0.075</td>
</tr>
<tr>
<td>lbs of raw material B per unit of product</td>
<td>0.19</td>
<td>0.18</td>
<td>0.26</td>
</tr>
<tr>
<td>lbs of raw material C per unit of product</td>
<td>0.14</td>
<td>0.12</td>
<td>0.17</td>
</tr>
<tr>
<td>Other processing costs ($/unit product)</td>
<td>$0.16</td>
<td>$0.24</td>
<td>$0.23</td>
</tr>
<tr>
<td>Expected wholesale price ($/unit product)</td>
<td>0.95</td>
<td>1.05</td>
<td>1.25</td>
</tr>
<tr>
<td>Projected volume of sales (units of product)</td>
<td>1,000,000</td>
<td>1,250,000</td>
<td>800,000</td>
</tr>
</tbody>
</table>

Cost of raw material A $3.45/lb
Cost of raw material B $1.07/lb
Cost of raw material C $1.88/lb

Solution

<table>
<thead>
<tr>
<th>Alternative</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Raw Material A ($/unit product)</td>
<td>.05 × 3.45 = 0.1725</td>
<td>0.2415</td>
<td>0.2587</td>
</tr>
<tr>
<td>Cost of Raw Material B ($/unit product)</td>
<td>.19 × 1.07 = 0.2033</td>
<td>0.1926</td>
<td>0.2782</td>
</tr>
<tr>
<td>Cost of Raw Material C ($/unit product)</td>
<td>.14 × 1.88 = 0.2632</td>
<td>0.2256</td>
<td>0.3196</td>
</tr>
<tr>
<td>Other processing costs ($/unit product)</td>
<td>$0.16</td>
<td>$0.24</td>
<td>$0.23</td>
</tr>
<tr>
<td>Total Cost ($/unit product)</td>
<td>0.799</td>
<td>0.8997</td>
<td>1.0865</td>
</tr>
<tr>
<td>Wholesale price ($/unit product)</td>
<td>0.95</td>
<td>1.05</td>
<td>1.25</td>
</tr>
<tr>
<td>Profit/unit</td>
<td>0.151</td>
<td>0.1503</td>
<td>0.1635</td>
</tr>
<tr>
<td>Projected sales (units of product)</td>
<td>1,000,000</td>
<td>1,250,000</td>
<td>800,000</td>
</tr>
<tr>
<td>Projected profits</td>
<td>151,000</td>
<td>187,875</td>
<td>130,800</td>
</tr>
</tbody>
</table>

Therefore, choose alternative 2.

1-3

Car A initially costs $500 more than Car B, but it consumes 0.04 gallons/mile versus 0.05 gallons/mile for B. Both last 8 years and B's salvage value is $100 smaller than A's. Fuel costs $1.70 per gallon. Other things being equal, beyond how many miles of use per year (X) does A become preferable to B?
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Solution

\[-500 + 100 + (0.05 - 0.04) (1.70) (8) X = 0\]
\[-400 + 0.136X = 0\]
\[X = 400/0.136\]
\[= 2,941 \text{ miles/year}\]

1-4
Sam decides to buy a cattle ranch and leave the big city rat race. He locates an attractive 500-acre spread in Montana for $1,000 per acre that includes a house, a barn, and other improvements. Sam's studies indicate that he can run 200 cow-calf pairs and be able to market 180 500-pound calves per year. Sam, being rather thorough in his investigation, determines that he will need to purchase an additional $95,000 worth of machinery. He expects that supplemental feeds, medications and veterinary bills will be about $50 per cow per year. Property taxes are $4000 per year, and machinery upkeep and repairs are expected to run $3,000 per year.

If interest is 10% and Sam would like a net salary of $10,000 per year, how much will he have to get for each 500-pound calf?

Solution

Land Cost :   $500 Acre x $1,000/Acre   = $500,000
Machinery:    Lump sum = 95,000
Total Fixed Cost   = $595,000

Assume lands and machinery to have a very long life
At 10% Annual Cost = (.10)($595,000) = $59,500
Other Annual Costs:
    Feeds, medications, vet bills $50 x 200 = $ 10,000
    Property taxes 4,000
    Upkeep & Repairs 3,000
    Salary 10,000
Total Annual Cost $86,500

Net sale price of each calf would have to be: $86,500/180 = $480.56

Note: If Sam were to invest his $595,000 in a suitable investment vehicle yielding 10% interest his salary would be almost six times greater and he could go fishing instead of punching cows.

1-5
The following letter was a reply from Benjamin Franklin to Joseph Priestley, a friend of Franklin's. Priestley had been invited to become the librarian for the Earl of Shelburne and had asked for Franklin's advice. What engineering economy principle does Franklin suggest Priestley use to aid in making his decision?

London, September 19, 1772
Dear Sir:

In the affair of so much importance to you wherein you ask my advice, I cannot, for want of
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To get over this, my way is to divide a half a sheet of paper by a line into two columns; writing over the one PRO and over the other CON. Then during three or four days' consideration I put down under the different heads short hints of the different motives that at different times occur to me, for or against the measure. When I have thus got them all together in one view, I endeavour to estimate their respective weights; and where I find two (one on each side) that seem equal, I strike them both out. If I find a reason Pro equal to some two reasons Con, I strike out the three. If I judge some two reasons Con equal to three reasons Pro, I strike out the five; and thus proceeding I find at length where the balance lies; and if after a day or two of further consideration, nothing new that is of importance occurs on either side, I come to a determination accordingly. And though the weight of the reasons cannot be taken with the precision of algebraic quantities, yet when each is thus considered separately and comparatively and the whole lies before me, I think I can judge better, and am less likely to make a rash step; and in fact I have found great advantage from this kind of equation in what may be called moral or prudential algebra.

Wishing sincerely that you may determine for the best, I am ever, my dear friend, your most affectionately...

s/Ben Franklin

Solution

Decisions should be based on the differences between the alternatives. Here the alternatives are taking the job (Pro) and not taking the job (Con).

1-6

Assume that you are employed as an engineer for Wreckall Engineering, Inc., a firm specializing in demolition of high-rise buildings. The firm has won a bid to tear down a 30-story building in a heavily developed downtown area. The crane owned by the company only reaches to 29 stories. Your boss asks you to perform an economic analysis of buying a new crane to complete the job. How would you handle the analysis?

Solution

The important point of this problem is to realize that your boss may not have recognized what the true problem is in this case. To buy a new crane is only one alternative, and quite likely not the best alternative.

Other alternatives:
- extension on current crane
- ramp for current crane
rent a crane to remove top story
explosive demolition
……………. etc.

If this is a fixed output project (e.g., fixed fee for demolishing building) we want to minimize costs. Weigh alternatives using economic criteria to choose the best alternative.

1-7
The total cost of a building (TC) is given by

\[ TC = (200 + 80X + 2X^2)A \]
\[ X = \text{Number of floors} \]
\[ A = \text{Floor area in ft}^2 \text{ per floor} \]

If the total number of square feet required is \(10^6\), what is the optimal (minimum cost) number of floors?

Solution

\[ TC = \left(200 + 80X + 2X^2\right)\left(\frac{10^6}{X}\right) \]

\[ \frac{dTC}{dx} = \left(10^6\right)\left(\frac{-200}{X^2} + 2\right) = 0 \]

\[ X^* = \sqrt{\frac{200}{2}} = \sqrt{100} = 10 \text{ floors} \]

1-8
By wisely saving and investing, Helen finds she has accumulated $400,000 in savings while her salaried position is providing her with $40,000 per year, including benefits, and after income taxes and other deductions.

Helen's salaried position is demanding and allows her little free time, but the desire to pursue other interests has become very strong. What would be your advice to her if you were asked?

Solution

First, Helen should decide what annual income she needs to provide herself with the things she wants. Depending on her age, she might be able to live on the interest income (maybe \(10\% \times \$400,000 = \$40,000\)), or a combination of interest and principal. The important thing that Helen should realize is that it may be possible for her to lead a more fulfilling lifestyle if she is fully aware of the time value of money. There are many people with large sums of money in bank checking accounts (drawing no interest) because they can write "free" checks.
Charles belongs to a square dance club that meets twice each month and has quarterly dues of $9.00 per person. The club moved its meeting place to a location with increased cost. To offset the cost each member agrees to pay 50 cents each time they attend the meeting. Later the treasurer suggests that the quarterly dues be increased to $12.00 per person as an alternative to the meeting charge. Discuss the consequences of the proposal. Do you think the club members would agree to the proposal?

**Solution**

The members who attend regularly would pay the same amount with the new dues as with the older method of $9.00 plus 50 cents per meeting. Many would like the added advantage of covering their quarterly expenses in one check. The members who attend infrequently would pay more by the new method and might oppose the action.

Since the people who attend infrequently are in the minority in this club, the members voted to approve the proposal.