Cost Estimation

- Every engineering project has a cost associated with it.
- How those costs are justified and presented will have more of an effect on the project's outcome than the technical merits.
- An engineer must estimate those costs, and be able to communicate effectively with accountants, managers and bankers.

Cost Estimation

- Engineers maybe required to perform:
  - Sophisticated cost/benefit analyses
  - Amortizations
  - Return on investment analyses
  - Time value of money analyses
  - Estimations of both future economic and non-economic benefits

Cost Estimation

- Manufacturing/construction costs of a project will determine whether it will be built.
- High initial costs or low profitability will kill almost all engineering projects.
- In manufacturing, after the first production run most engineering effort will be spent on reducing production costs.
- In construction, there is more of a requirement to get it right the first time.

Cost Estimation

- Material costs will dictate almost all other costs.
- Was the build material bought retail, wholesale, or direct from the manufacturer?
- Large scale purchases?
- Standardized parts?
- Product longevity?

*Laws of Supply/Demand will ultimately control prices.*
Cost Estimation

- 1-3 (4)-9 Rule of thumb.
  - 1 unit cost of raw materials
  - 3 (4) unit cost of manufactured products
  - 9 unit selling price
- Material waste
  - 1.1 unit multiplier
- Tooling
  - 1.1 unit multiplier

Cost Analysis

- Fixed Costs
  - Capital Cost
  - Insurance and taxation
  - Depreciation
  - Interest (borrowed capital)
- Variable Costs
  - Operating Costs
  - Energy Cost
  - Maintenance Cost
- Salvage Value

Future Value from Present Worth

- Knowing the growth rate (interest rate) of a fund, \( i \), and the initial value sunk into an investment, \( V_0 \), the value after accrual of one interest period, \( V_1 \), can be calculated from
  \[ V_1 = V_0 (1+i) \]  

Future Value from Present Worth

- Likewise the value after accrual from two interest periods is given from \( V_2 = V_0 (1+i)^2 \) and so forth.

Future Value from Present Worth

- If the initial investment value is defined as the present worth, \( P \) (i.e. \( P = V_0 \)), and the future value, \( F \), is defined as the value after accrual from \( n \) number of interest periods, (i.e. \( F = V_n \)), then the future value is
  \[ F = P(1+i)^n \]  

Annual Interest Rates

- The problem of determining the future value of the present worth is representative of determining the future worth of capital costs. Typical interest rates over the last 20 years have averaged around 6.2%. From 1988 to 2007, the peak value was 8.8% in 1988 and the minimum value was 4.1% in 2003. In 2007 was 4.7%, a decrease of 0.1% from 2006.
The inflation rate has been maintained just around 3.1% per annum over the last 20 years. Between 1988 and 2007, the average inflation matched actual inflation over the same time frame, though there was a maximum inflation rate of 5.4% in 1989 and a minimum rate of 1.6% in 1997. For 2007 the inflation rate was 4.5%, an increase of 1.6% from 2006.

\[
F = P(1 + r)^n
\]  
(3)

**This formula does not calculate the actual future dollars, it calculates the time equivalent future worth!!!**

The future value from an annuity fund (annual payments of more or less equal payments) can be found from the following general equation:

\[
F = \sum_{j=1}^{n} A_j (1 + i)^{-j}
\]
(4)
Eq. 5 represents the future value of an annuity (where each payment is of equal size) over a period of payments, and is representative annual fixed costs.

The future value from a gradient fund (annual payments of incremental size) can be found from the following general equation:

$$ F = \sum_{i=1}^{n} G_i (1+i)^{-j} $$

(6)

Where \( G_j = G(j-1) \) and \( G \) is a constant for all values of \( j \), for \( j=1,2,3,\ldots,n \) it can be shown through expansion that

$$ F = G \left[ \frac{(1+i)^{-1} - (1+i)^{-n}}{i} \right] $$

(7)

Eq. 7 represents the future value of a gradient (where each payment is one increment larger than the last) over a period of payments, and is representative annual cost increases.

All cost must be compared on the same relative time scales, whether on the present, future or even annual scales.

Depreciation is a method to spread asset costs over the span of a few years.

Benefit-Cost Analysis.