Estimating Capital Costs

➤ Order of magnitude (+40% to -20%)
➤ Study equipment (+30% to -20%)
➤ Preliminary design (+25% to -15%)
➤ Definitive (+15% to -7%)
➤ Detailed (+6% to -4%)

(see Tables 5.1 and 5.2 for details)
Purchased Equipment Costs

- Vendor quote
- Cost data from previous purchases
- Cost graphs (e.g. Figure 5.1)
- Scale-up factor

\[
\frac{C_a}{C_b} = \left(\frac{A_a}{A_b}\right)^n
\]
Cost Inflation

- Chemical engineering plant cost index
- Marshall and Swift process industry index
- Nelson refinery construction index

\[
\frac{C_2}{C_1} = \left( \frac{I_2}{I_1} \right)
\]
Plant Total Capital Cost

- Direct project expenses
- Indirect project expenses
- Contingency and fees
- Auxiliary facilities

(see Table 5.6 for details)
Simple method to estimate cost of expanding existing plant using factors listed in Table 5.7

\[ C_{TM} = F_{Lang} \sum_{i=1}^{n} C_{p,i} \]
Bare Module method (1)

- Estimate cost of each piece of equipment
  - specific equipment type
  - materials of construction
  - operating pressure

- Bare module cost \( (C_{BM}) \) accounts for direct and indirect costs for each piece of equipment
Bare module method (2)

Bare module cost factor ($F_{BM}$) accounts for direct and indirect costs associated with purchased equipment cost ($C_p$)

\[ C_{BM} = C_p \cdot F_{BM} \]

(see Table 5.8 for details)
Bare module method (3)

- Cost can be adjusted using pressure ($F_p$) and materials of construction ($F_m$) factors.

Bare module method (4)

Calculation algorithm for each piece of equipment:

- obtain $C_p$ (appendix A)
- obtain $F_p$ and $F_m$ (appendix A)
- obtain $F_{BM}$ (appendix A)
- calculate $C_{BM}$
- update cost from Sept. 2001 (CEPCI=397)
Bare module method (5)

- Contingency and fees = 18% of $C_{BM}$
- Auxiliary facilities = 50% of $C_{BM}$
- Total plant cost computed as:
Example

Compute the bare module cost ($C_{BM}$) for a floating head shell and tube heat exchanger:

- heat transfer area = 100 m²
- working pressure = 100 bar
- stainless steel construction
Estimating Operating Costs

- Direct manufacturing costs
- Fixed manufacturing costs
- General expenses

(see Tables 6.1 & 6.2 for details)
Estimating Operating Costs

- $C_{\text{TM}}$ or $C_{\text{GR}}$
- Cost of operating labor ($C_{\text{OL}}$) [sec. 6.2]
- Cost of utilities ($C_{\text{UT}}$) [sec 6.3]
- Cost of waste treatment ($C_{\text{WT}}$) [sec 6.7]
- Cost of raw materials ($C_{\text{RM}}$) [sec 6.4]
Table 6.2 shows detailed estimates

Final result is:

\[
\text{COM} = 1.23(C_{UT} + C_{WT} + C_{RM}) + 2.73C_{OL} + 0.28\text{FCI}
\]

where FCI = \(C_{TM}\) or \(C_{GR}\)
Stream Factors

➤ Operating costs are reported as \$/yr

➤ Typical plants only operate for a fraction of the year (known as the stream factor)

\[
\text{stream factor} = \frac{\text{stream days per year}}{365}
\]