What is estimated?

- TIME = MONEY
- TIME:
  - unit is typically month (year)
  - duration, chronological month
  - effort, person-month (man-month)

Basic Relation

- person-month / nbr-of-people = duration
- example:
  - 36 person-month, 1 developer, 36 month
  - 36 person-month, 2 people, 18 month
  - 36 person-month, 12 people, 3 month
- Beware of the "million monkey" syndrome [Brooks]

Basic Principles - Decomposition

- It is easier to estimate time & cost for a smaller unit than to estimate time & cost for the complete system.
- Estimation by decomposition:
  - Decompose your system or development process, estimate time & cost for the parts and summarize.

Basic Principles - Empirical Knowledge

- Find parameters which characterise your system and derive time & cost based on a documented case history.
- Empirical model:
  - time = function (parameters)
- You rely on a correlation between time & cost and the set of independent parameters

Typical Parameters

- number and complexity of functions
- number and complexity of modules
- number of lines of code (LOCs)
- number and duration of steps in your development process
- skills and technologies involved
When to do your estimate

- the later the more accurate your parameters
- early estimate:
  - you need to estimate your parameters
  - divide an conquer strategy
  - garbage in => garbage out
- keep your estimate up-to-date

COCOMO [B. Boehm]

- CONstructive COst MOdel
- empirical method
- hierarchy of COCOMO models (parameters)
  - basic: prg size
  - intermediate: prg size + cost drivers
  - advanced: prg size + cost drivers per phase
- for each project type

COCOMO - Parameters

- prg size: LOCS (lines of code)
- "cost drivers"
  - evaluate:
    - product, hardware, personnel, project
  - measured on a 6 point scale
  - allow for derivation of an EAF
    (Effort Adjustment Factor)

COCOMO - Project Types

- organic mode:
  - relatively small and simple
  - small team of skilled developers
- semi-detached:
  - intermediate in size and complexity
  - mixed skill levels on the team
- embedded:
  - hard constraints for HW, SW, operation

Basic COCOMO - The Functions

\[ \text{person-month} = a^* (KLOC)^b \]
\[ \text{duration-in-month} = c^* (\text{person-month})^d \]

KLOC ... kilo lines of code
a, b, c, d depend on the project type

Basic COCOMO - Tables

<table>
<thead>
<tr>
<th>project type</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>organic</td>
<td>2.4</td>
<td>1.05</td>
<td>2.5</td>
<td>0.38</td>
</tr>
<tr>
<td>semi-detached</td>
<td>3.0</td>
<td>1.12</td>
<td>2.5</td>
<td>0.35</td>
</tr>
<tr>
<td>embedded</td>
<td>3.6</td>
<td>1.20</td>
<td>2.5</td>
<td>0.32</td>
</tr>
</tbody>
</table>
Basic Cocomo - Example

• You must decide on:
  – LOCS: 50,000 lines of code
  – project type: semi-detached
• person-month: $3.0 \times (50)^{1.12} \approx 240$
• duration-in-month: $2.5 \times (240)^{0.35} \approx 17$
• number of people: $240 / 17 \approx 14$