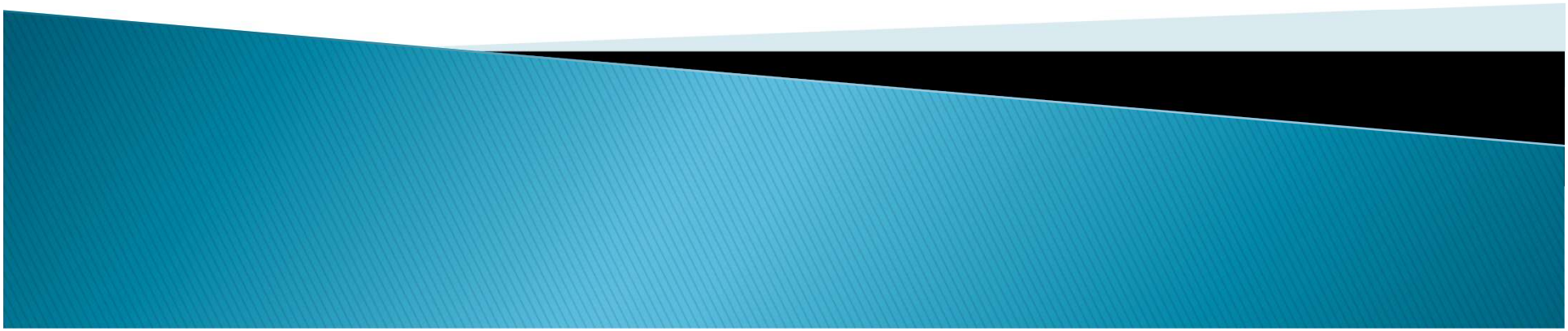
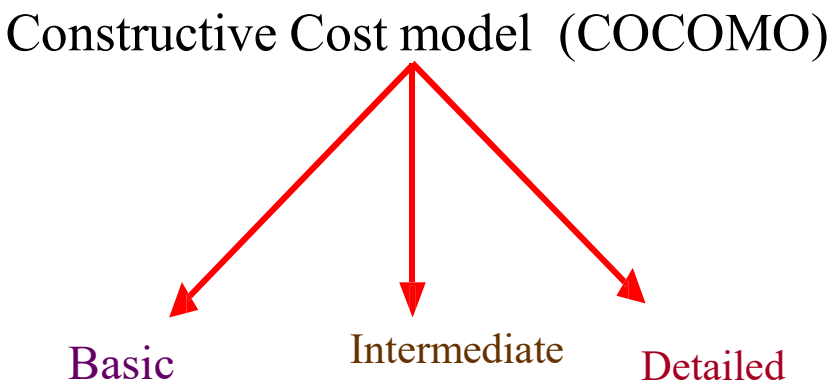
Cost Estimation



Cost Estimation

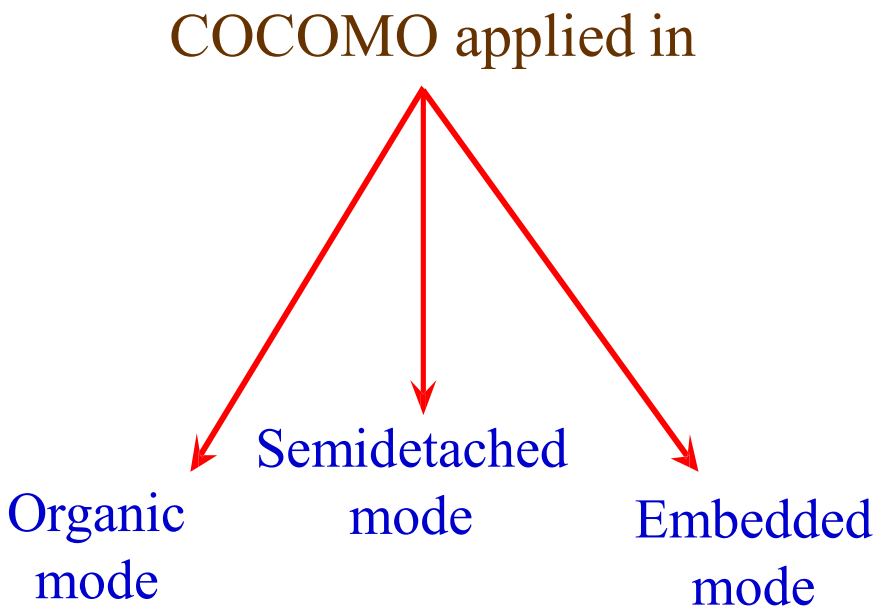
The Constructive Cost Model (COCOMO)



Model proposed by B. W. Boehm's through his book Software Engineering Economics in 1981

Cost Estimation

COCOMO



Mode	Project size	Nature of Project	Innovation	Deadline of the project	Development Environment
Organic	Typically 2-50 KLOC	Small size project, experienced developers in the familiar environment. For example, pay roll, inventory projects etc.	Little	Not tight	Familiar & In house
Semi detached	Typically 50-300 KLOC	Medium size project, Medium size team, Average previous experience on similar project. For example: Utility systems like compilers, database systems, editors etc.	Medium	Medium	Medium
Embedded	Typically over 300 KLOC	Large project, Real time systems, Complex interfaces, Very little previous experience. For example: ATMs, Air Traffic Control etc.	Significant	Tight	Complex Hardware/ customer Interfaces required

The comparison of three COCOMO modes

Cost Estimation

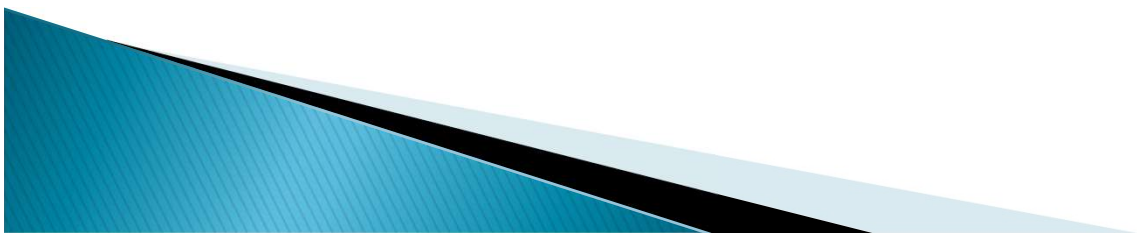
Basic Model

Basic COCOMO model takes the form

$$E = a_b (KLOC)^{b_b}$$

$$D = c_b (E)^{d_b}$$

where E is effort applied in Person-Months, and D is the development time in months. The coefficients a_b, b_b, c_b and d_b are given in table 4.



Cost Estimation

Software Project	a_b	b_b	c_b	d_b
Organic	2.4	1.05	2.5	0.38
Semidetached	3.0	1.12	2.5	0.35
Embedded	3.6	1.20	2.5	0.32

Table 4: Basic COCOMO coefficients

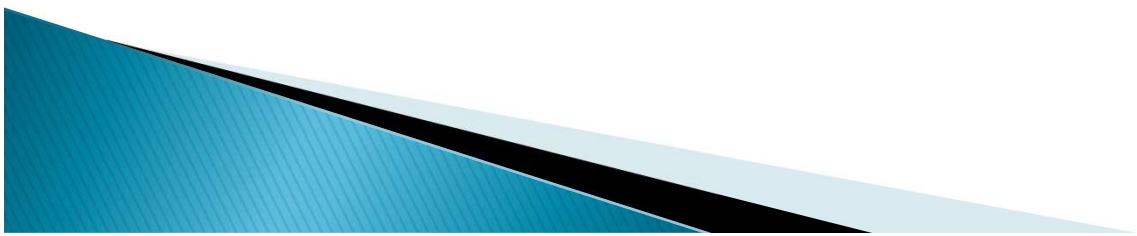
Cost Estimation

When effort and development time are known, the average staff size to complete the project may be calculated as:

$$\text{Average staff size } (SS) = \frac{E}{D} Persons$$

When project size is known, the productivity level may be calculated as:

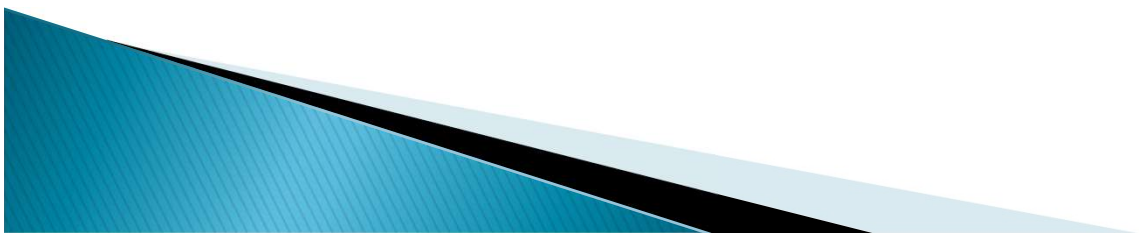
$$\text{Productivity } (P) = \frac{KLOC}{E} KLOC / PM$$



Cost Estimation

Example

Suppose that a project was estimated to be 400 KLOC. Calculate the effort and development time for each of the three modes i.e., organic, semidetached and embedded.



Cost Estimation

Solution

The basic COCOMO equation take the form:

$$E = a_b(KLOC)^{b_b}$$

$$D = c_b(KLOC)^{d_b}$$

Estimated size of the project = 400 KLOC

(i) Organic mode

$$E = 2.4(400)^{1.05} = 1295.31 \text{ PM}$$

$$D = 2.5(1295.31)^{0.38} = 38.07 \text{ M}$$

Cost Estimation

(ii) Semidetached mode

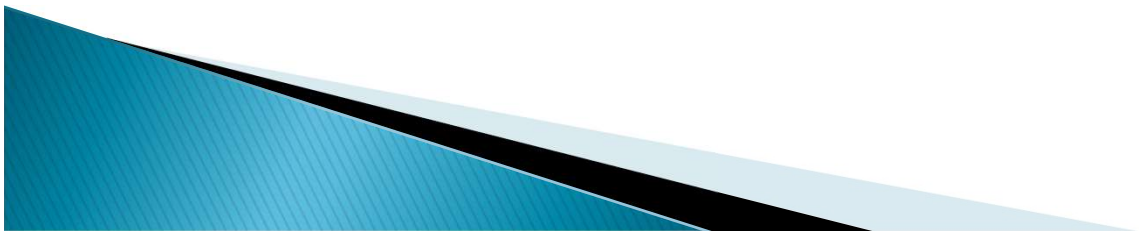
$$E = 3.0(400)^{1.12} = 2462.79 \text{ PM}$$

$$D = 2.5(2462.79)^{0.35} = 38.45 \text{ M}$$

(iii) Embedded mode

$$E = 3.6(400)^{1.20} = 4772.81 \text{ PM}$$

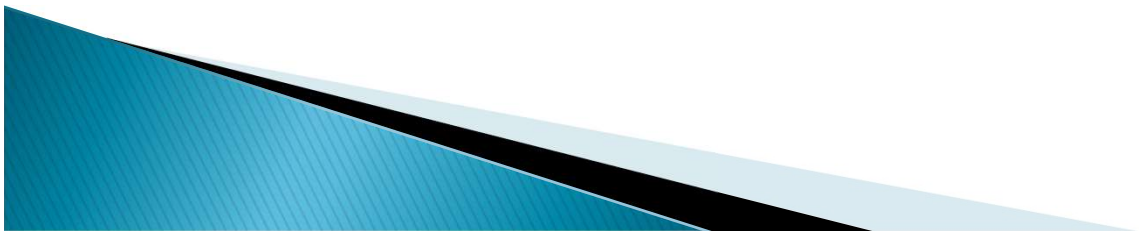
$$D = 2.5(4772.8)^{0.32} = 38 \text{ M}$$



Cost Estimation

Example:

A project size of 200 KLOC is to be developed. Software development team has average experience on similar type of projects. The project schedule is not very tight. Calculate the effort, development time, average staff size and productivity of the project.



Cost Estimation

The semi-detached mode is the most appropriate mode; keeping in view the size, schedule and experience of the development team.

$$E = 3.0(200)^{1.12} = 1133.12 \text{ PM}$$

$$D = 2.5(1133.12)^{0.35} = 29.3 \text{ PM}$$

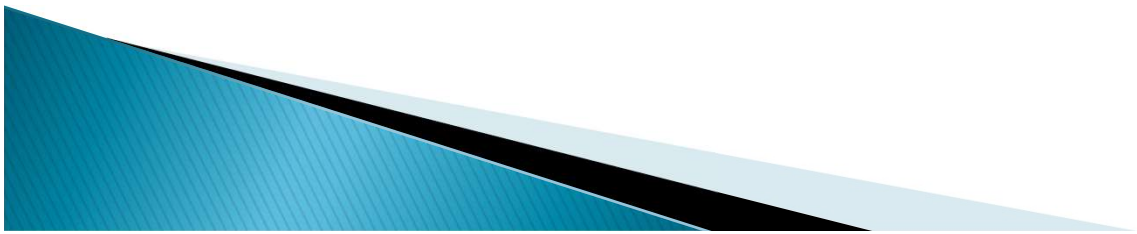
$$\text{Average staff size } (SS) = \frac{E}{D} Persons$$

$$= \frac{1133.12}{29.3} = 38.67 Persons$$

Cost Estimation

$$\text{Average staff size } (SS) = \frac{E}{D} Persons$$

$$= \frac{1133.12}{29.3} = 38.67 Persons$$



Cost Estimation

Intermediate Model

Cost drivers

(i) Product Attributes

- ➢Required s/w reliability (RELY)
- ➢Size of application database (DATA)
- ➢Complexity of the product (CPLX)

(ii) Hardware Attributes

- ➢Run time performance constraints (TIME)
- ➢Memory constraints (STORE)
- ➢Virtual machine volatility (VIRT)
- ➢Turnaround time (TURN)

Cost Estimation

(iii)Personal Attributes

- ➢Analyst capability
- ➢Programmer capability
- ➢Application experience
- ➢Virtual m/c experience
- ➢Programming language experience

(iv)Project Attributes

- ➢Modern programming practices
- ➢Use of software tools
- ➢Required development Schedule

Cost Estimation

Multipliers of different cost drivers

Cost Drivers	RATINGS					
	Very low	Low	Nominal	High	Very high	Extra high
Product Attributes						
RELY	0.75	0.88	1.00	1.15	1.40	--
DATA	--	0.94	1.00	1.08	1.16	--
CPLX	0.70	0.85	1.00	1.15	1.30	1.65
Computer Attributes						
TIME	--	--	1.00	1.11	1.30	1.66
STOR	--	--	1.00	1.06	1.21	1.56
VIRT	--	0.87	1.00	1.15	1.30	--
TURN	--	0.87	1.00	1.07	1.15	--

Cost Estimation

Multipliers of different cost drivers

Cost Drivers	RATINGS					
	Very low	Low	Nominal	High	Very high	Extra high
Personnel Attributes						
ACAP	1.46	1.19	1.00	0.86	0.71	--
AEXP	1.29	1.13	1.00	0.91	0.82	--
PCAP	1.42	1.17	1.00	0.86	0.70	--
VEXP	1.21	1.10	1.00	0.90	--	--
LEXP	1.14	1.07	1.00	0.95	--	--
Project Attributes						
MODP	1.24	1.10	1.00	0.91	0.82	--
TOOL	1.24	1.10	1.00	0.91	0.83	--
SCED	1.23	1.08	1.00	1.04	1.10	--

Cost Estimation

The multiplying factors for all 15 cost drivers are multiplied to get the **effort adjustment factor (EAF)**

Intermediate COCOMO equations

$$E = a_i(KLOC)^{b_i} * EAF$$

$$D = c_i(E)^{d_i}$$

Project	a_i	b_i	c_i	d_i
Organic	3.2	1.05	2.5	0.38
Semidetached	3.0	1.12	2.5	0.35
Embedded	2.8	1.20	2.5	0.32

Coefficients for intermediate COCOMO