Measuring Internal Product Attributes: Software Size (Continued)

COCOMO Model

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COCOMO

- The COCOMO (Constructive Cost Model) is one of the most popularly used software cost estimation models i.e. it estimates or predicts the
  - effort required for the project,
  - total project cost and
  - scheduled time for the project.
- The model is proposed by Barry Boehm in 1981
- The model depends on the number of lines of code for software product development.

COCOMO

- According to COCOMO, there are three modes of software development projects that depend on complexity.
    - Organic Project: It belongs to small & simple software projects which are handled by a small team with good domain knowledge and few rigid requirements.
    - Example: simple business systems, simple inventory management systems, and data processing systems.
    - Semidetached Project: It is an intermediate (in terms of size and complexity) project, where the team having mixed experience (both experience & inexperience resources) to deals with rigid/nonrigid requirements.
    - Example: Database design or OS development
    - Embedded Project: This project having a high level of complexity with a large team size by considering all sets of parameters (software, hardware and operational).
    - Example: Air Traffic control or Traffic light control software.

COCOMO

- Depending upon the complexity of the project the COCOMO has three types. Such as:
  - Basic COCOMO: It is the one type of static model to estimates software development effort quickly and roughly. The level of estimation accuracy is less as we don't consider the all parameters belongs to the project.
  - Intermediate COCOMO: The intermediate model estimates software development effort in terms of size of the program and other related cost drivers parameters (product parameter, hardware parameter, resource parameter, and project parameter) of the project.
  - Detailed COCOMO: It is the advanced model that estimates the software development effort. The whole software is differentiated into multiple modules, and then we apply COCOMO in various modules to estimate effort and then sum the effort.

COCOMO

- <mark>**Classification of Cost Drivers and their attributes:**</mark>

(i) Product attributes -

- Required software reliability extent
- Size of the application database
- The complexity of the product

(ii) Hardware attributes -

- Run-time performance constraints
- Memory constraints
- The volatility of the virtual machine environment
- Required turnabout time

(iii) Personnel attributes -

- Analyst capability
- Software engineering capability
- Applications experience
- Virtual machine experience
- Programming language experience

(iv)

- **Project attributes -**
- Use of software tools
- Application of software engineering methods
- Required development schedule

Basic COCOMO

- Effort (E) = $a*(KLOC)^b$ Person-Months
- Development Time (D) = $c*(Effort)^d$ Months
- Average Staff Size = Effort/Development Time   Persons
- Productivity = KLOC/Effort   KLOC/Person-Month

- Where,
- **E =** Total effort required for the project in Person-Months (PM).
- **D =** Total time required for project development in Months (M).
- **KLOC =** the size of the code for the project in Kilo lines of code.
- **a, b, c, d =** The constant parameters for a software project.

PROJECT TYPE	a	b	c	d
Organic	2.4	1.05	2.5	0.38
Semidetached	3	1.12	2.5	0.35
Embedded	3.6	1.2	2.5	0.32

Basic COCOMO

- **Example:** Calculate the Effort, Scheduled time for development for estimated size of 300 KLOC

- **Answer:** Given estimated size of project is: 300 KLOC

- **For Organic**
  - Effort (E) = **a*(KLOC)^b** = 2.4*(300)$^{1.05}$ = 957.61 MM
  - Scheduled Time (D) = **c*(E)^d** = 2.5*(957.61)$^{0.38}$ = 33.95 Months(M)
  - Avg. Resource Size = **E/D** = 957.61/33.95 = 28.21 Mans
  - Productivity of Software = **KLOC/E** = 300/957.61 = 0.3132 KLOC/MM = 313 LOC/MM

- **For Semidetached**
  - Effort (E) = **a*(KLOC)^b** = 3.0*(300)$^{1.12}$ = 1784.42 MM
  - Scheduled Time (D) = **c*(E)^d** = 2.5*(1784.42)$^{0.35}$ = 34.35 Months(M)

- **For Embedded**
  - Effort (E) = **a*(KLOC)^b** = 3.6*(300)$^{1.2}$ = 3379.46 MM
  - Scheduled Time (D) = **c*(E)^d** = 2.5*(3379.46)$^{0.32}$ = 33.66 Months(M)