Software Project Estimation

Cost Estimation

- project scope must be defined
- task and/or functional decomposition is necessary
- historical measures (metrics) are very helpful
- at least two different techniques should be used
- remember that uncertainty is inherent

To Understand Scope …

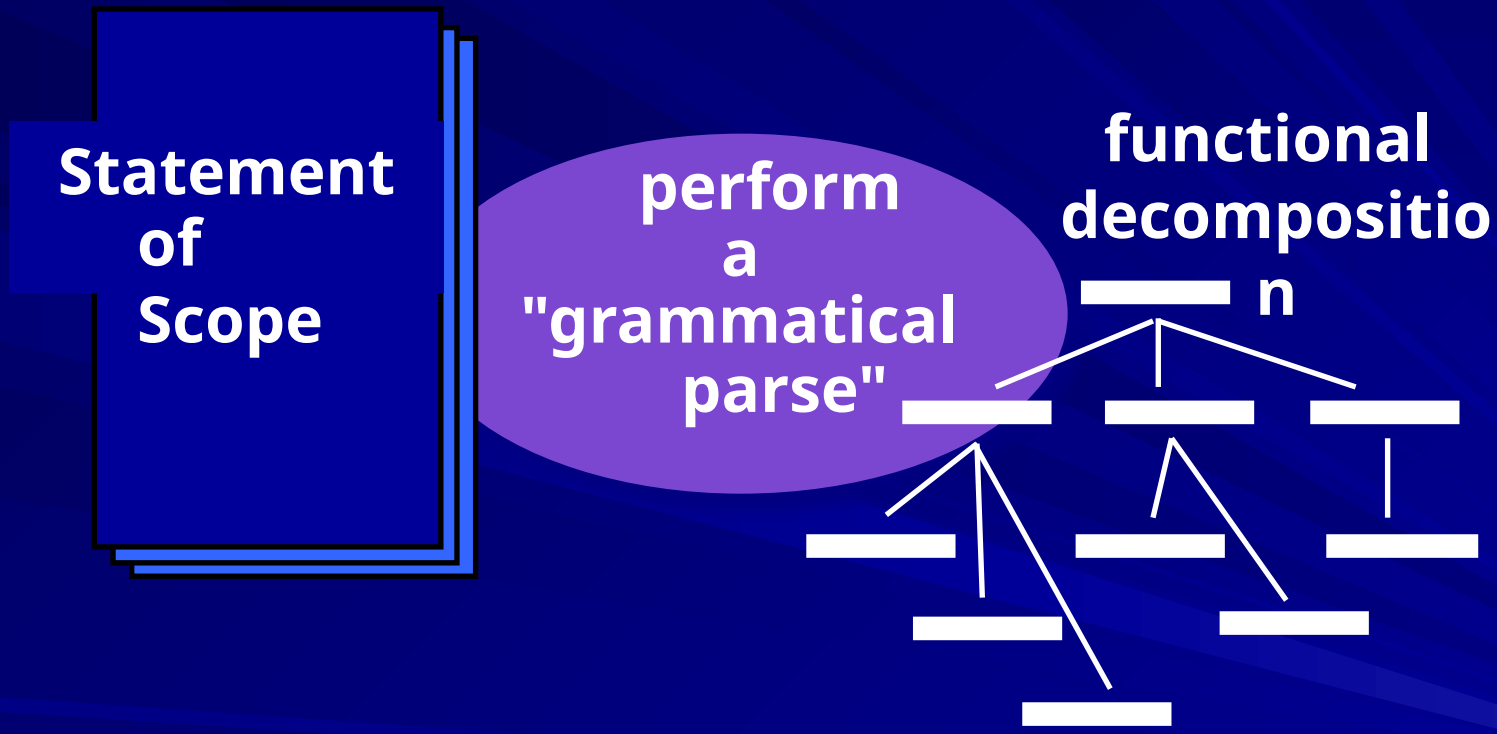
- Understand the customers needs
- understand the business context
- understand the project boundaries
- understand the customer's motivation
- understand the likely paths for change
- understand that ...

Even when you understand, nothing is guaranteed!

Estimation Techniques

- past (similar) project experience
- conventional estimation techniques
  - task breakdown and effort estimates
  - size (e.g., FP) estimates
- tools

Functional Decomposition



Conventional Methods: LOC/FP Approach

- compute LOC/FP using estimates of information domain values
- use historical effort for the project

Example: LOC Approach

Functions	estimated LOC	LOC/pm	$/LOC	Cost	Effort (months)
UICF	2340	315	14	32,000	7.4
2DGA	5380	220	20	107,000	24.4
3DGA	6800	220	20	136,000	30.9
DSM	3350	240	18	60,000	13.9
CGDF	4950	200	22	109,000	24.7
PCF	2140	140	28	60,000	15.2
DAM	8400	300	18	151,000	28.0
Totals	33,360			655,000	145.0

Example: FP Approach

measurement parameter	count		weight		
number of user inputs	40	x	4	=	160
number of user outputs	25	x	5	=	125
number of user inquiries	12	x	4	=	48
number of files	4	x	7	=	28
number of ext.interfaces	4	x	7	=	28
algorithms	60	x	3	=	180

count-total → 569

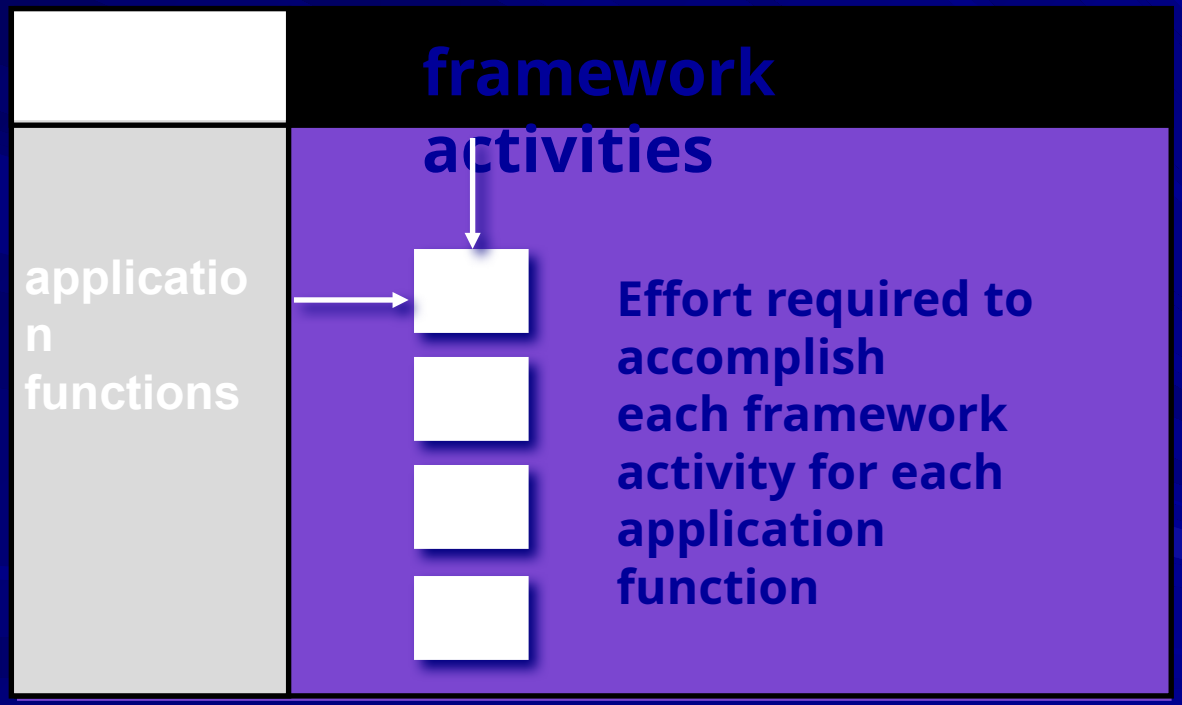
complexity multiplier .84

feature points → 478

× 0.25 p-m / FP = 120 p-m

Creating a Task Matrix

Obtained from "process framework"



Empirical Estimation Models

General form:

effort = tuning coefficient * size exponent

usually derived as person-months of effort required

a number derived either a constant or based on complexity of project

usually LOC but may also be function point

empirically derived

Empirical Estimation Model

LOC-Oriented Estimation models

$E = 5.2 X(KLOC)^{.91}$	Waltson-Felix Model
$E = 5.5 + 0.73 X (KLOC)^{1.16}$	Bailey-Basili model
$E = 3.2 X (KLOC)^{1.05}$	Boehm Simplw Model

FP-Oriented Estimation models

E = -13.39 X .0545 FP	Albrecht and Gaffney Model
$E = 60.62 X 7.728 X 10\text{-}8 FP^3$	Kemerer model
E = 585.7 X 15.12 FP	Matson, Barnett, and Mellichamo Model

COCOMO Model

- Bery Boehm introduced a hierarchy of s/w estimation models bearing the name COCOMO, for COnstructive COst MOdel.
  - Empirical models for estimating effort and time

See : sunset.usc.edu/COCOMOII/cocomo.html

COCOMO II

COCOMO II is actually a hierarchy of estimation models that address the following areas:

- Application Composition model
- Early Design Stage Model
- Reuse Model
- Post-architecture stage model

Object Points Estimate

COCOMO II application composition model uses object points

Like Function Points, the Object Point is an indirect s/w measure that is computed using counts of number of:

1) Screens (UI)
2) Reports
3) Components

NOP = Object Points x [(100-%reuse)/100]

PORD is a parameter with unit NOP / person-month

Estimated effort = NOP / PROD

Early Design Model

Requirement Analysis done

You can estimate the size of code by LOC

$PM = A \times Size^{B} \times M$

Where

M= PERS x RCPX x RUSE x PDIF x PREX x FCIL x SCED

A =2.94, B = 1.1 to 1.24 depending n the novelty

PERS= Personnel Capability

RCPX= Product reliability and Complexity

RUSE= Reuse required

PDIF = Platform difficulty

PREX = Personnel Experience

SCED= Required Schedule

FCIL = Team support facility

Reuse Mode

Black Box Reuse: The component will be reused with necessary configuration

White Box Reuse: Code will be modified when reused

The number of new code will be estimated

For generated code

PM= (ASLOC * AT/100)/ ATPROD

ASLOC: Number of lines of Generated Code

AT: Percentage of Code Automatically Generated

ATPROD: Productivity of Engineers to generate code

When code is understood for integration

ESLOC= ASLOC * (1-AT/100) * AAM

AAM= adaptation adjustment multiplier

From the cost of changing the reused code

Post Architecture Stage Model

Same as early design model
17 rather than 7 multipliers
Code size will be estimated
    Number of new lines of codes
    Modified as there might be change of requirements
Exponent term depends on the following factors (ranked between 1 to 5, 1 for excellent, 5 for poor),
    Precedenteness
    Development flexibility
    Architecture/Risk Resolution
    Team Cohesion
    Process maturity
Sum/100 +1.01 is the exponent term

The Software Equation

- It is a dynamic multivariable model that assumes a specific distribution of effort over a life of s/w development of project. [from 4000 s/ projects]

$E = [LOC \times B^{0.333} / P]^3 \times (1/t^4)$

E = effort in person-months/person-years

t = project duration in months or years

B =special skill factors [B =.16 (5-15 KLOC)

B = .39 (70 kloc)]

P = productivity parameter [2000 -> embedded s/w

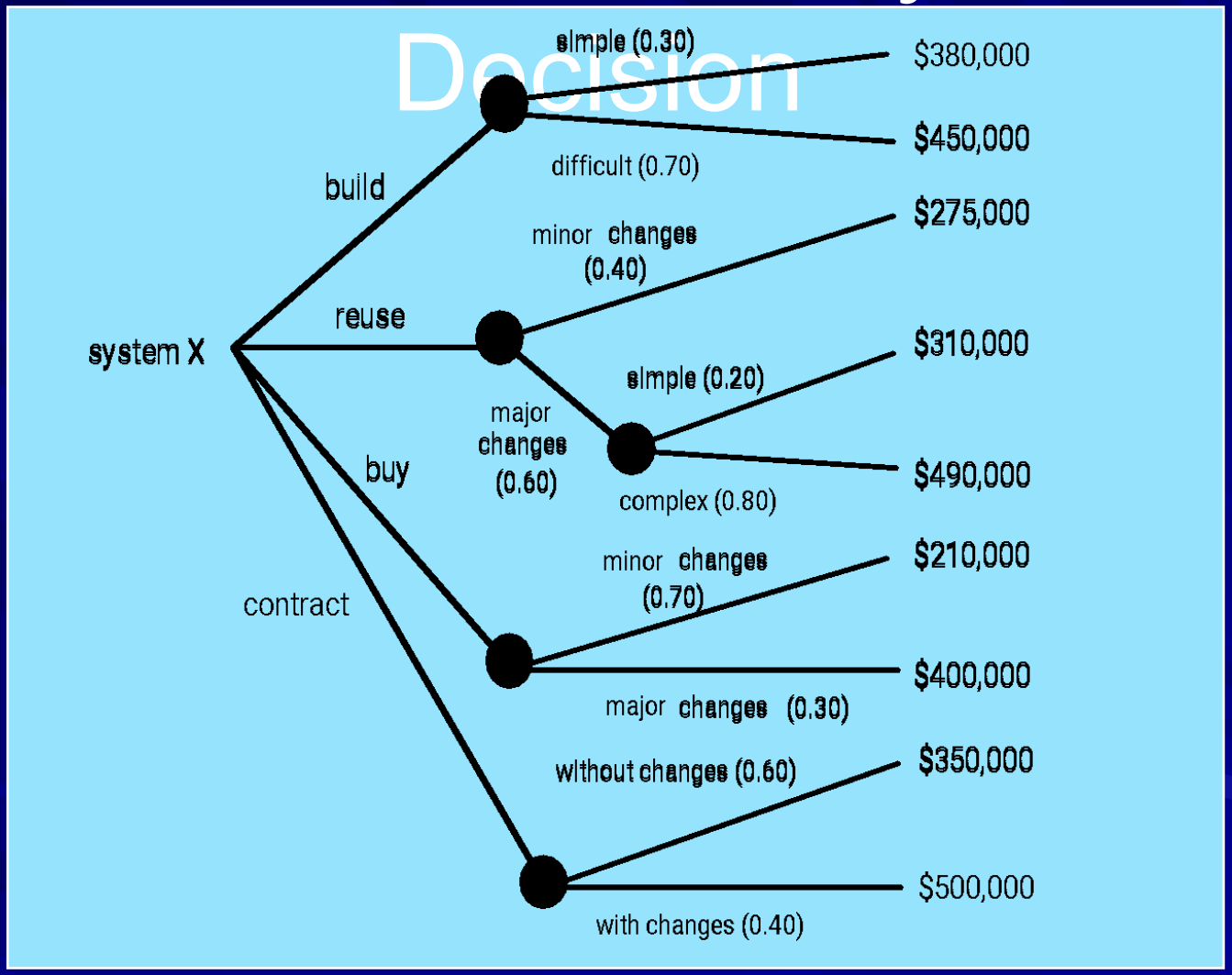
10,000 -> telecomm

20,000 -> business app]

Estimation Guidelines

- estimate using at least two techniques
- get estimates from independent sources
- avoid over-optimism, assume difficulties
- you've arrived at an estimate, sleep on it
- adjust for the people who'll be doing the job—they have the highest impact

The Make-Buy Decision



Computing Expected Cost

expected cost

= $\sum$(path probability) x (estimated path cost)

For example, the expected cost to build is:

$$\text{expected cost}_{build} = 0.30(\$380K)+0.70(\$450K)$$
$$= \$429\ K$$

similarly

expected cost$_{reuse}$ = $382K

expected cost$_{e\text{-}buy}$ = $267K

expected cost$_{contr}$ = $410K