Software Cost Estimation

Software Project Planning

The overall goal of project planning is to establish a pragmatic strategy for controlling, tracking, and monitoring a complex technical project.

Why?

So the end result gets done on time, with quality!

The Steps

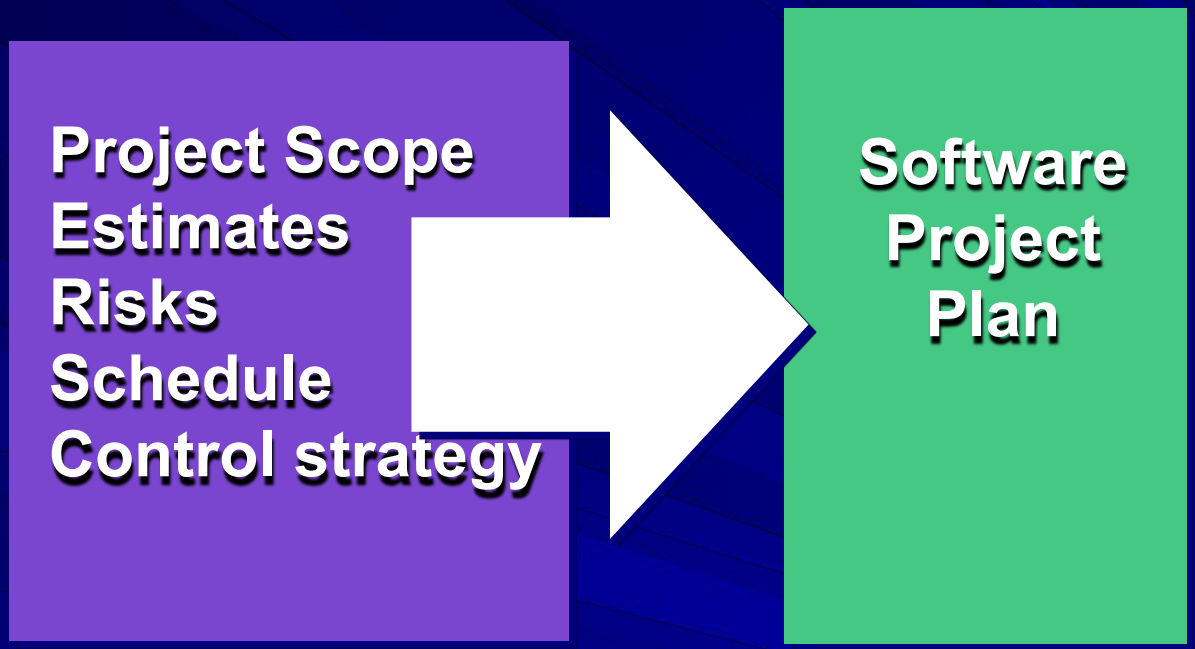
- Scoping—understand the problem and the work that must be done
- Estimation—how much effort? how much time?
- Risk—what can go wrong? how can we avoid it? what can we do about it?
- Schedule—how do we allocate resources along the timeline? what are the milestones?
- Control strategy—how do we control quality? how do we control change?

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!

Write it Down!



Defect Removal Efficiency

$$DRE = E / (E + D)$$

where:

E is the number of errors found before delivery of the software to the end-user

D is the number of defects found after delivery.

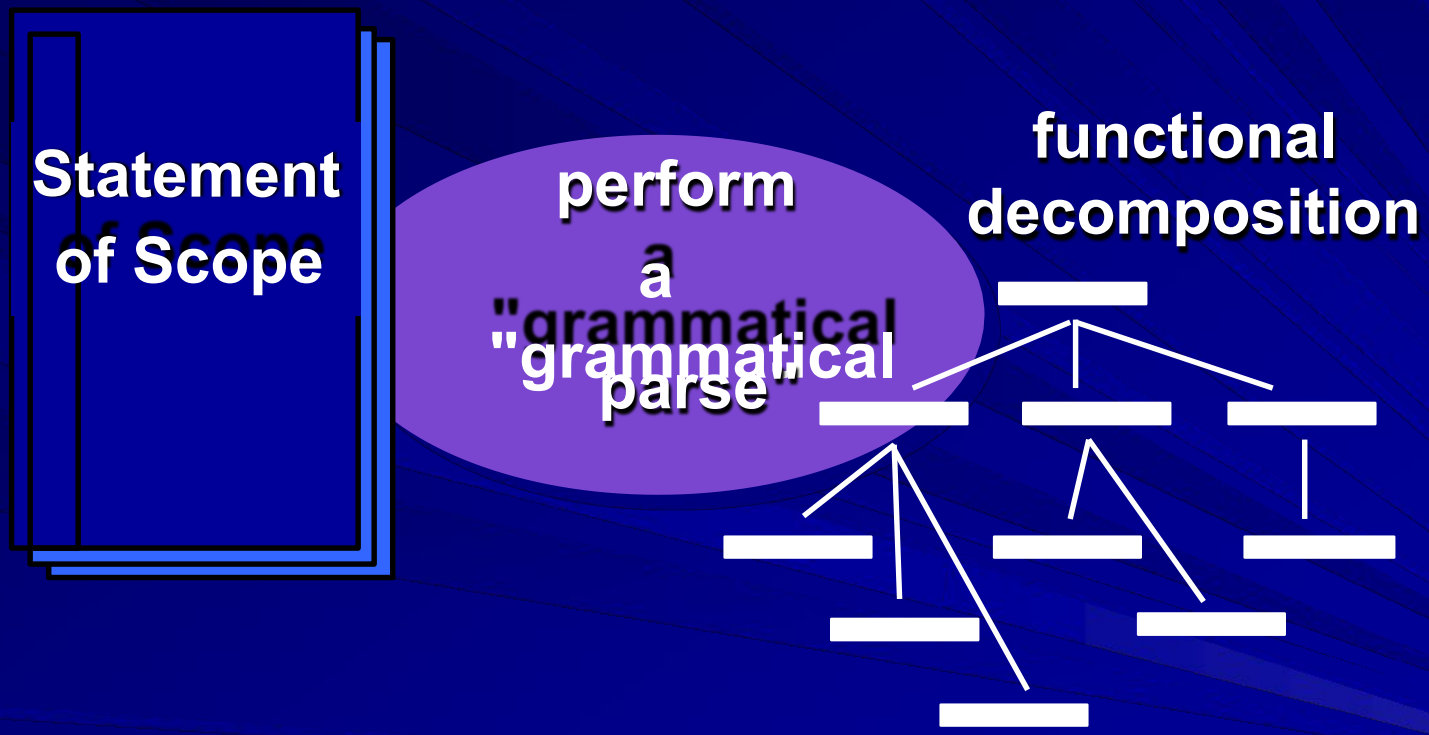
Cost Estimation

- project scope must be explicitly 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

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

Comparing LOC and FP

Programming Language	LOC per Function point avg.	median	low	high
Ada	154	-	104	205
Assembler	337	315	91	694
C	162	109	33	704
C++	66	53	29	178
COBOL	77	77	14	400
Java	63	53	77	-
JavaScript	58	63	42	75
Perl	60	-	-	-
PL/1	78	67	22	263
Powerbuilder	32	31	11	105
SAS	40	41	33	49
Smalltalk	26	19	10	55
SQL	40	37	7	110
Visual Basic	47	42	16	158

Representative values developed by QSM

Example: LOC Approach

Functions	e stimate d 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

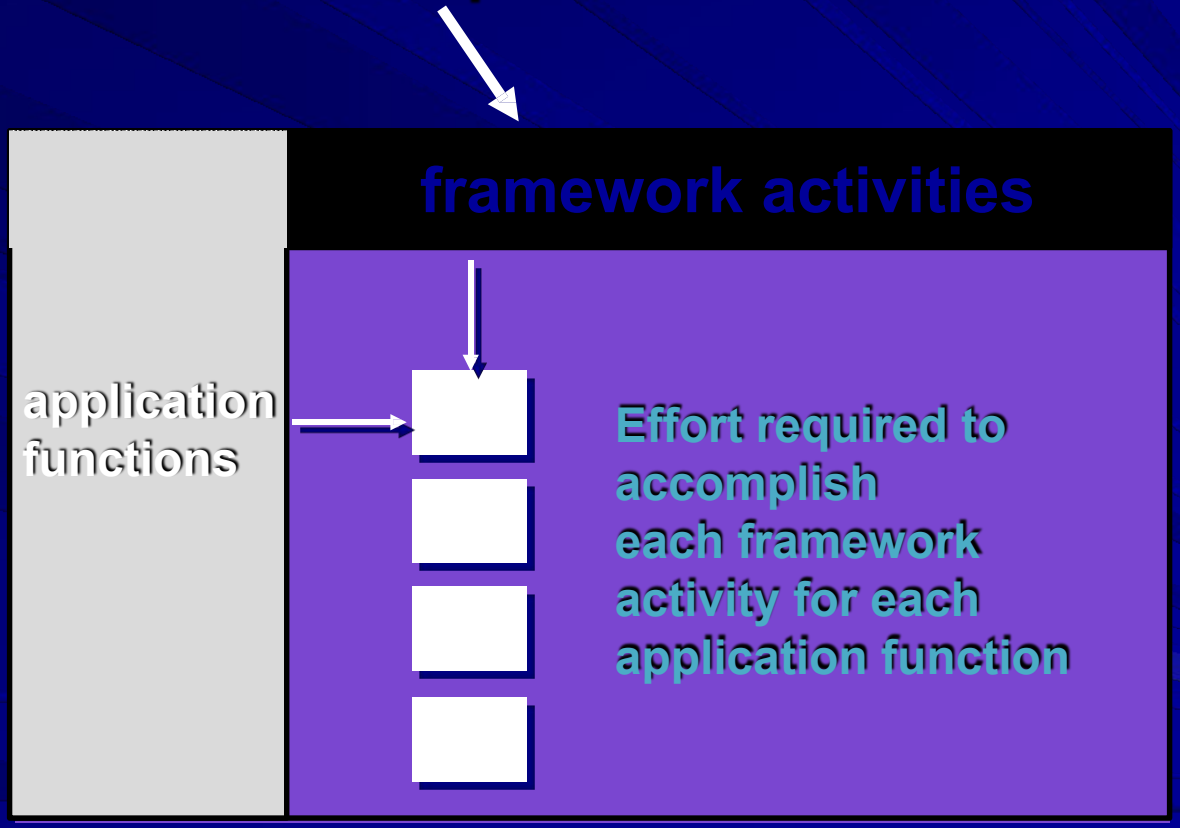
Example: FP Approach

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
complexity multiplier					.8
feature points					470

× 0.25 p-m / FP = 120 p-m

Creating a Task Matrix

Obtained from "process framework"



Process-Based Estimation Example

Activity →	CC	Planning	Risk Analysis	Engineering		Construction Release		CE	Totals
Task →				analysis	design	code	test		
Function ▼									
UICF				0.50	2.50	0.40	5.00	n/a	8.40
2DGA				0.75	4.00	0.60	2.00	n/a	7.35
3DGA				0.50	4.00	1.00	3.00	n/a	8.50
CGDF				0.50	3.00	1.00	1.50	n/a	6.00
DSM				0.50	3.00	0.75	1.50	n/a	5.75
PCF				0.25	2.00	0.50	1.50	n/a	4.25
DAM				0.50	2.00	0.50	2.00	n/a	5.00
Totals	0.25	0.25	0.25	3.50	20.50	4.50	16.50		46.00
% effort	1%	1%	1%	8%	45%	10%	36%		

CC = customer communication CE = customer evaluation

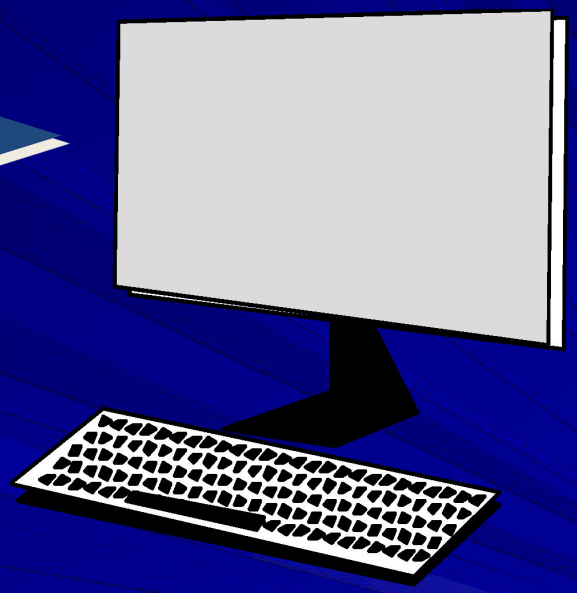
Based on an average burdened labor rate of $8,000 per month, the total estimated project cost is $368,000 and the estimated effort is 46 person-months.

Tool-Based Estimation

project characteristics

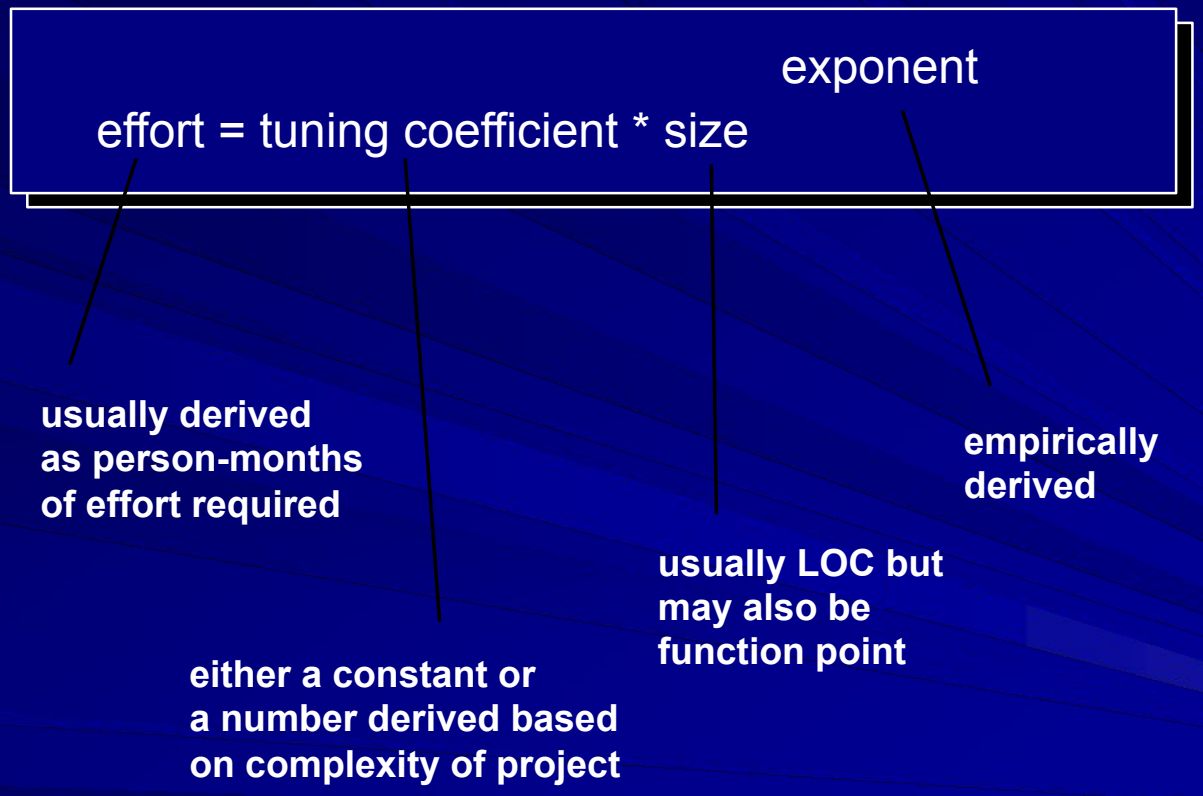
calibration factors

LOC/FP data



Empirical Estimation Models

General form:



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.

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
- 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

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/w 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 =0.16 (5-15 KLOC)

B = 0.39 (70 kloc)]

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

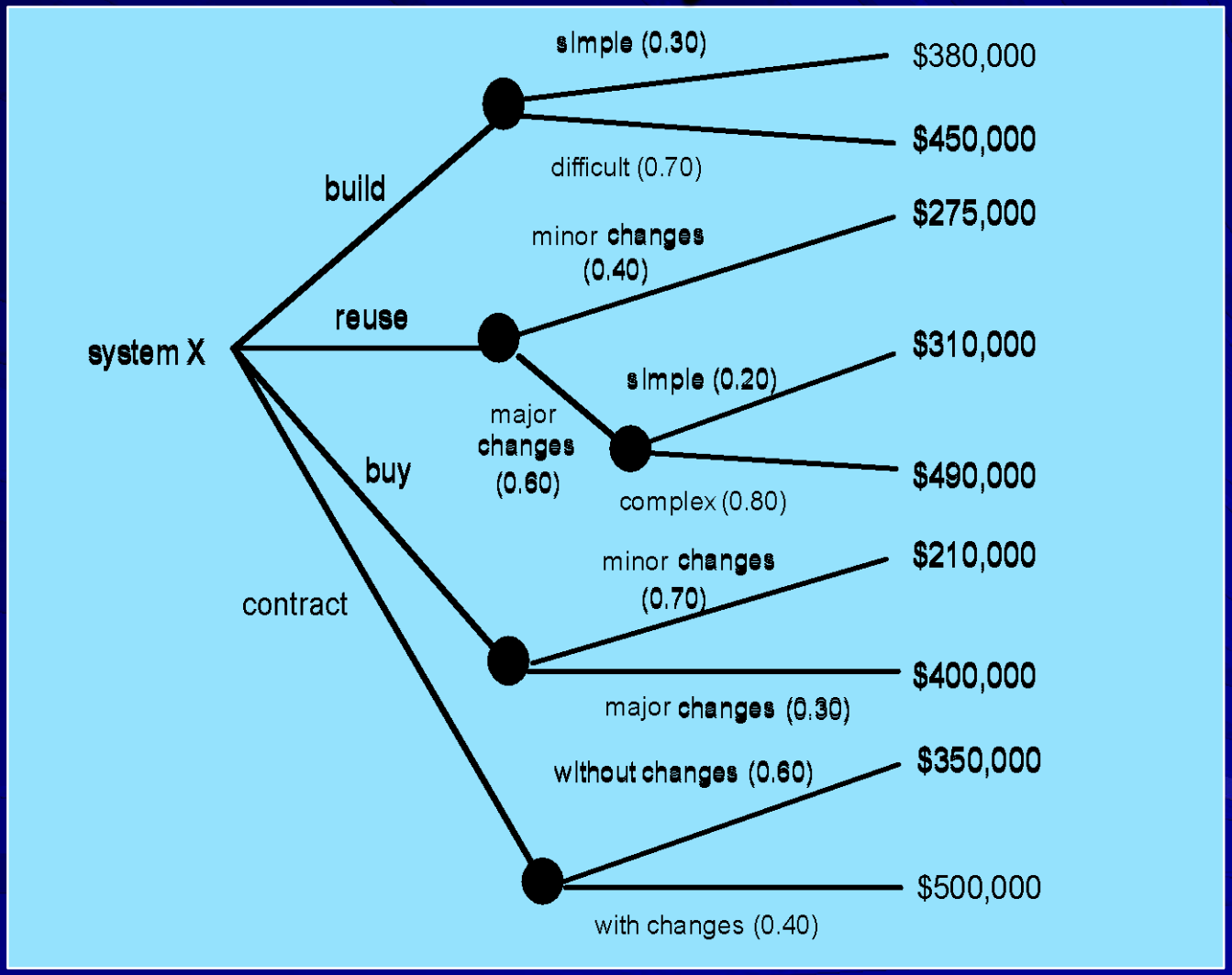
10,000 -> telecomm

20,000 -> business app]

Estimation Guidelines

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

The Make-Buy Decision



Computing Expected Cost

expected cost =

$$\sum \text{(path probability)}_i \times \text{(estimated path cost)}_i$$

For example, the expected cost to build is:

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

similarly,

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

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

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