TOPICS

Overview

Metrics

Estimation

Planning

SOFTWARE PROJECT ESTIMATION

- Overview
- Resources
- Decomposition Techniques
- Using LOC or FP to Estimate Effort
- Effort Estimation by Function
- Effort Estimation by Task
- Empirical Estimation Models
- COCOMO
- Putman Estimation Model

Overview

Estimation of:

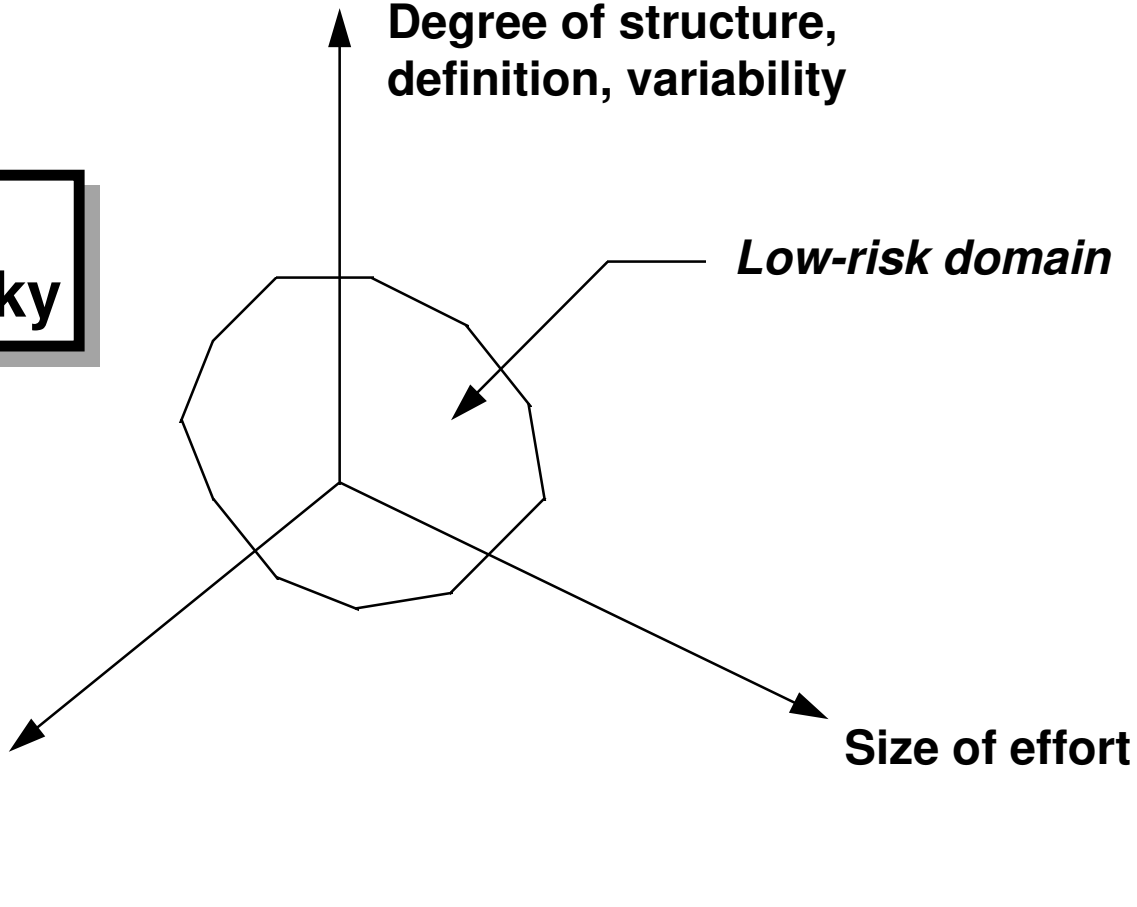
- **resources**
- **costs**
- **schedules**

Requires:

- **experience**
- **historical information**
- **quantitative measures of qualitative data**

Overview, Continued

Estimation can be Risky



Resources

Planning Task 1: Software Scope

1. Statement of software scope must be bounded
2. Software scope describes:
   - function
   - performance
   - constraints
   - interfaces
   - reliability

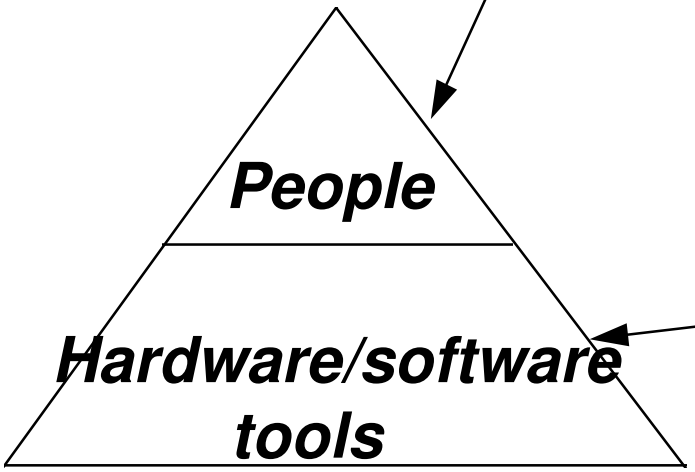
evaluated together

Resources, Continued

Planning Task 2: Estimation of Needed Resources

Specify:

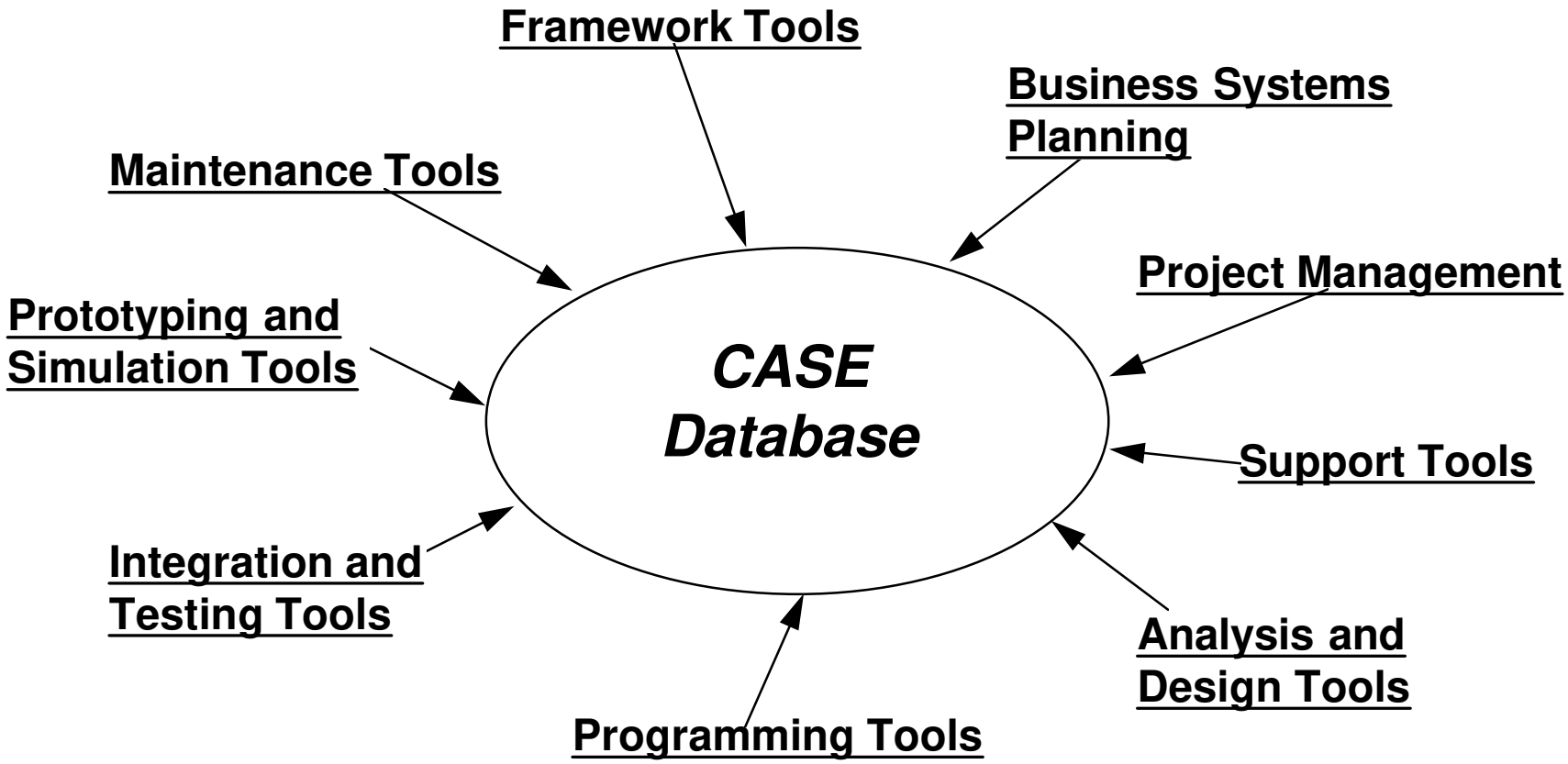
- **Required skills**
- **Availability**
- **Duration of tasks**
- **Start date**



Specify:

- **Description**
- **Availability**
- **Duration of use**
- **Delivery date**

Resources, Continued



CASE - Computer-Aided Software Engineering

Resources, Continued

Reuse - A Resource

Two rules:

1. **If existing software meets requirements, then**

   acquire and use it!

2. **If existing software can meet requirements with some modification, then**

   be careful!

The cost of modification can exceed the cost of new development!

Decomposition Techniques

- LOC and FP Estimation
- Effort Estimation

Decomposition Techniques, Continued

LOC and FP Estimation

The idea is that the person planning the software project:

- **creates a bounded statement of the scope of the software**
- **decomposes the scope into smaller subfunctions**
- **estimates LOC or FP for each subfunction**
- **applies baseline productivity metrics (e.g., LOC/person-month) to LOC or FP estimates to produce a cost or effort estimate for each subfunction**
- **combines estimates for each subfunction to derive estimates for the entire project**

Decomposition Techniques, Continued

Differences Between LOC and FP

- FP estimation techniques require less detail than LOC
- LOC is estimate directly while FP is estimated indirectly

Using LOC or FP to Estimate Effort

1. Estimate LOC or FP values for each subfunction
   - Use historical data (or intuition, if necessary)
   - Three estimates: optimistic (o), most likely (m), and pessimistic (b)
2. Calculate expected value for each subfunction $E = \frac{a + 4m + b}{6}$
3. Apply productivity data to get effort to be expended; two ways:
   1. Total expected LOC or FP for all subfunctions and divide this by the expected LOC or FP completed per person-month (estimated from past projects); example:

Effort = 310 expected FP for project/5.5 expected FP per person-month

= 56 person-months

   2. Multiply each subfunction LOC or FP by the adjusted productivity value (based on the estimated complexity of the function) and sum the results for all subfunctions in the project

Effort Estimation by Function

CAD Program Example

Function	*Optimistic*	*Most Likely*	*Pessimistic*	*Expected*	*$/Line*	*Line/Month*	*Cost*	*Months*
User interface control	1800	2400	2650	2,340	$14	315	$ 32,760	7.4
2-D geometric analysis	4100	5200	7400	5,380	$20	220	$107,600	24.4
3-D geometric analysis	4600	6900	8600	6,800	$20	220	$136,000	30.9
Data structure mgmt	2950	3400	3600	3,350	$18	240	$ 60,300	13.9
Graphics display	4050	4900	6200	4,950	$22	200	$108,900	24.7
Peripheral control	2000	2100	2450	2,140	$28	140	$ 59,920	15.2
Design analysis	6600	8500	9800	8,400	$18	300	$151,200	28.0
Estimated Effort				33,360			$656,680	144.5

Estimated Cost: $ 656,680
Estimated Effort: 144.5 person-months

Effort Estimation by Task

CAD Program Example

Function	*RA*	*Design*	*Code*	*Test*	*Total*
User interface control	1.0	2.0	0.5	3.5	7.0
2-D geometric analysis	2.0	10.0	4.5	9.5	26.0
3-D geometric analysis	2.5	12.0	6.0	11.0	31.5
Data structure mgmt	2.0	6.0	3.0	4.0	15.0
Graphics display	1.5	11.0	4.0	10.5	27.0
Peripheral control	1.5	6.0	3.5	5.0	16.0
Design analysis	4.0	14.0	5.0	7.0	30.0
Total	14.5	61.0	26.5	50.5	152.5
Rate ($)	5200	4800	4250	4500	
Cost ($)	75,400	292,800	112,625	227,250	708,075

Estimated Cost: $ 708,075
Estimated Effort: 152.5 person-months

Empirical Estimation Models

- **Static single-variable model (example: COCOMO)**

$$\text{Resource} = cx^{d}$$

where

x is the estimated characteristic (LOC, FP, effort, etc.)

c and d are constants derived from data collected from past projects

- **Static multivariable model**

$$\text{Resource} = cx + dy + \ldots$$

where

x, y, ... and c, d, ... are as above

- **Dynamic multivariable model**

  Project resource requirements are determined over a series of time steps

- **Theoretical (example: Putman Estimation Model)**

  Uses equations derived from hypothesized expenditure curves

COCOMO

- Involves basic, intermediate, and advanced models
- Basic model:

$$\text{Effort} = a(b)\,KLOC^{\,b(b)}\,\text{person} - \text{months}$$

$$\text{Development_Time} = c(b)\,Effort^{\,d(b)}\,\text{months}$$

a(b), b(b), c(b), and d(b) are determined from the table:

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

COCOMO, Continued

Example of COCOMO basic model on the CAD program:

Effort = 3.0 (LOC) ^ 1.12

= 3.0 (33.3) ^ 1.12

= 152 person-months

Development Time = 2.5 (Effort) ^ 0.35

= 2.5 (152) ^ 0.35

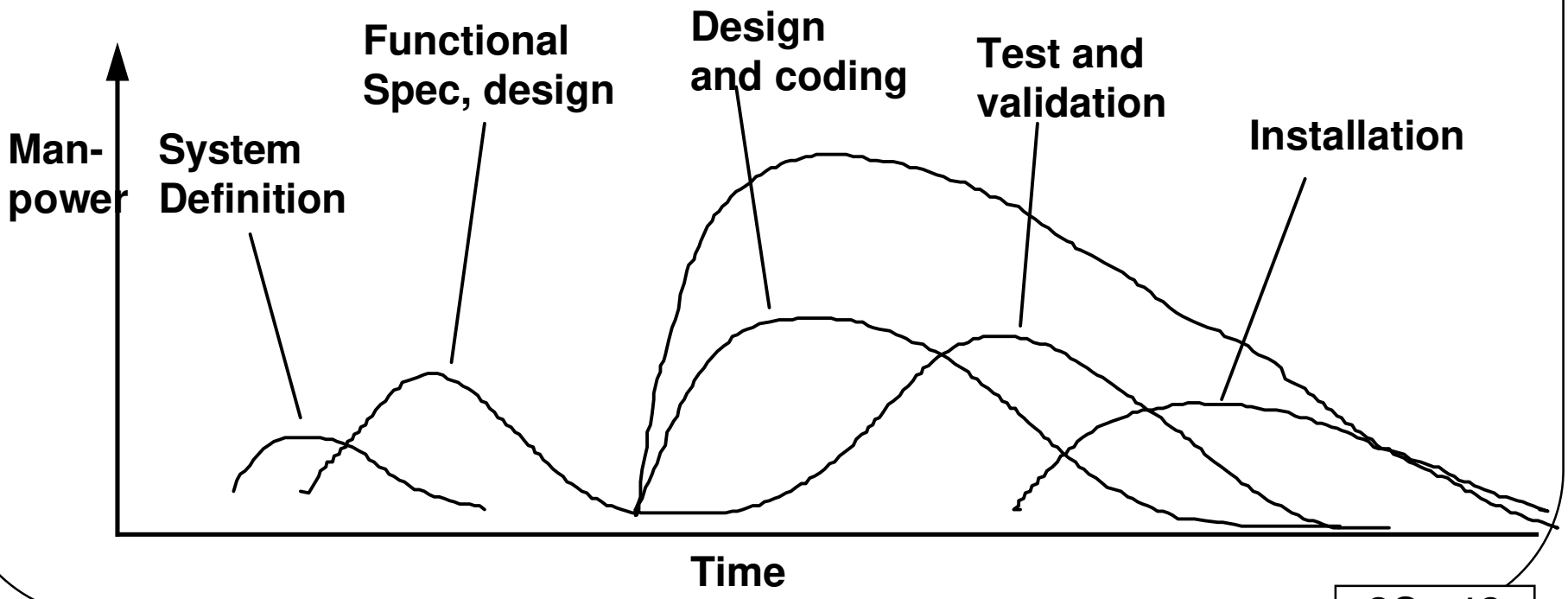
= 14.5 months

Thus, estimated number of people N is:

N = Effort / Development Time

= 152 / 14.5

= 11 people

Putman Estimation Model

- Data is derived from large projects
- Model is applicable to smaller projects as well
- The distribution of effort is described by the Rayleigh-Norden curve