



CSSE 372 Software Project Management: Software Estimation Fundamentals

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Recall: Cleanroom Software Engineering

From

- Individual craftsmanship
- Sequential development
- Individual unit testing
- Informal coverage testing
- Unknown reliability
- Informal design

To

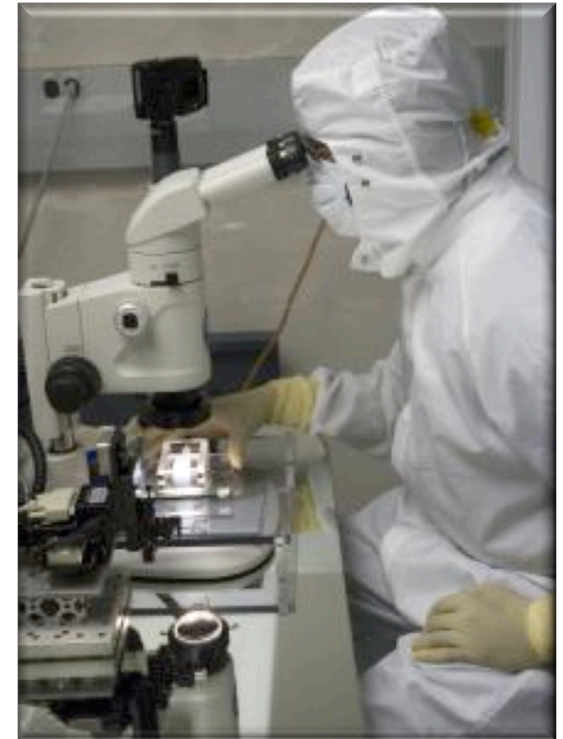
- Peer reviewed engineering
- Incremental development
- Team correctness verification
- Statistical usage testing
- Measured reliability
- Disciplined engineering specification and design

Focuses on defect avoidance

...rather than defect removal

Recall: Cleanroom Process Teams

- **Specification team**
 - Develops and maintains the system specification
- **Development team**
 - Develops and verifies software
 - Software is not compiled or executes during verification
- **Certification team**
 - Develops set of statistical tests to exercise software after development
 - Reliability growth models used to assess reliability



Learning Outcomes: Estimation

Estimate software project effort, cost, and schedule for an intermediate size project.

- **Compare contemporary estimation approaches**
- **Determine appropriate estimation approach for an estimate**



What are examples of things we estimate? How are these done?

- Think for 14.888 seconds...
- Turn to a neighbor and discuss it for a minute
- Can we talk!?



THE AUTHOR OF THE WINDOWS FILE COPY DIALOG VISITS SOME FRIENDS.



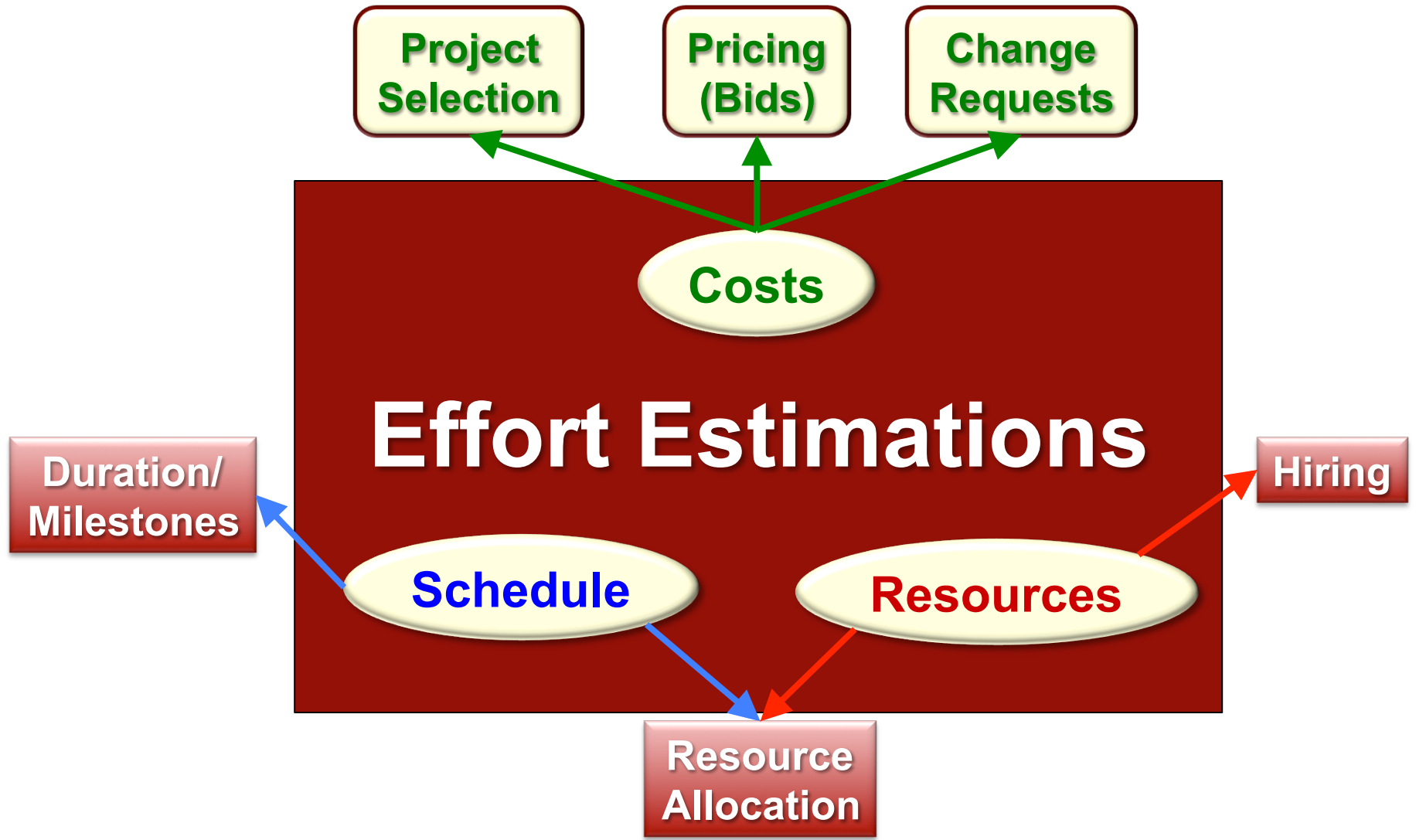
Estimating a Trip to Washington DC

- **10 Independence Ave SW, Washington, DC**
- **Time Estimate: 11 hours 2 minutes**
- **Distance Estimate: 669.37 miles**
- **Fuel Cost: \$60.50**
- **And a list of instructions/tasks...**

How do we know you will get there in the estimated time, cost, and miles?

What are the assumptions?

Why do Software Project Estimates?





THE CREDIBLE HULK

"You won't like me when I'm angry. Because I always back up my rage with facts and documented sources."



Software Cost Estimation Methods

- Estimation by Analogy
- Delphi – Expert Judgment
- Price-to-Win – Time/Cost Box
- Bottom-Up – Grassroots
- Parametric

Best approach is use of multiple methods, comparing and iterating results to clarify differences

Estimating by Analogy 1/2

- **Relates cost of system to cost of a known similar system through comparisons of key technical and management characteristics**
- **Uses**
 - When little data available, but previous systems can serve as basis
 - Quick, rough order of magnitude estimate needed
 - Check on other techniques



Estimating by Analogy 2/2

■ Advantages

- Estimates when little data available
- Requires limited data collection
- Based on “actual” costs (depending on adjustments)

■ Disadvantages

- Based on *limited data*
- *Subjective* adjustments may be difficult to validate
- *Accuracy* highly dependent on similarity between items
- Does not identify cost *drivers*



Delphi Estimating - Expert Judgment

- One or more software and/or application domain experts use their experience to predict software resource needs.
 - Consensus process iterates until estimate reached
- **Advantages**
 - Relatively cheap estimation method
 - Accurate to the degree that experts have direct experience with similar systems
- **Disadvantages**
 - Low experience or no experts results in inaccurate estimates



Pricing to Win Estimating



- The project costs what the customer has to spend on it
 - Timebox or fit into the budget
(How much can you do for this amount?)

- **Advantages**
 - Ensures high potential of getting the contract

- **Disadvantages**
 - The customer gets the system but with less than s/he wants
 - Often simplistic

Bottom-Up Estimating 1/2

- (AKA Grass roots) estimating builds up an estimate of a system using detailed information about components

- Uses

- Production estimating
- Estimate of firm designs



Bottom-Up Estimating 2/2

■ Advantages

- Sensitive to changes in design
- Provides visibility into cost drivers
- Most precise cost estimation approach

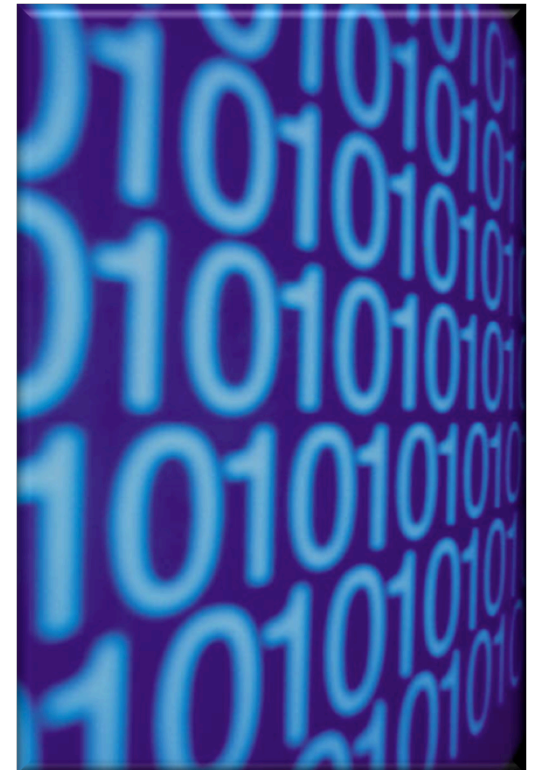


■ Disadvantages

- Requires detailed design information
- Time consuming
- Difficult to perform cost trade-offs
- Accuracy depends on stability of design, and skill of team

Parametric Estimating 1/2

- Relates the cost of a system to one or more parameters of the system such as physical or performance characteristics
- Uses
 - Cost estimates and trade-offs for systems in early development
 - Quick reaction estimates
 - Independent check on other estimates



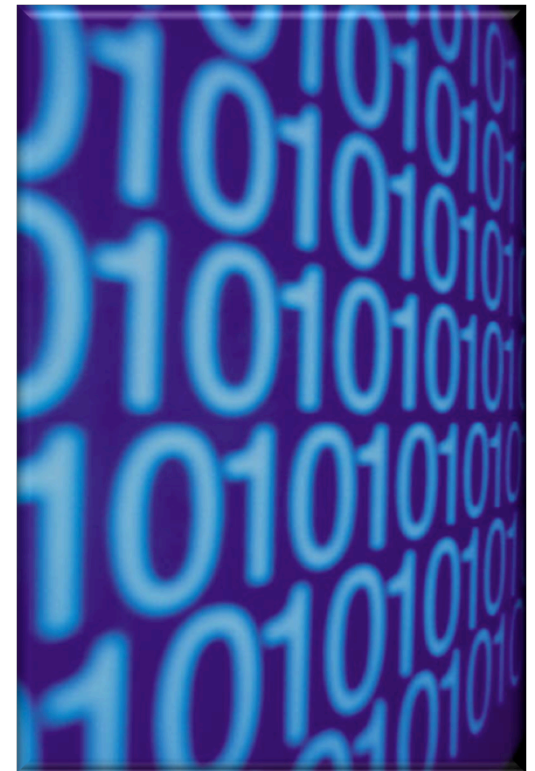
Parametric Estimating 2/2

■ Advantages

- Sensitive to significant design changes
- Quantifies effects of cost drivers
- Based on “real world” experience of many systems
- Gives quick, reproducible results

■ Disadvantages

- Inputs are subjective
- Results not as precise as bottom-up
- Requires skilled analyst to develop





Continuing with Software Estimation

- Parametric Estimation is the most common among estimation techniques
- A simple formula for estimating FTE's parametrically might be:

$$\# \text{ of FTEs} = \text{EquivalentLOC} / \text{ProductivityRate}$$

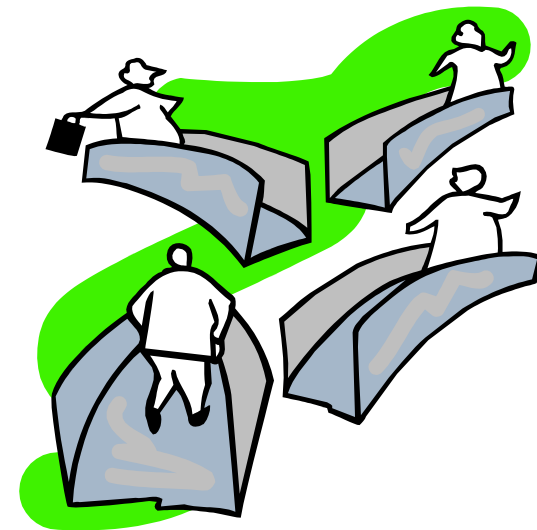
where:

- $\text{EquivalentLOC} = \text{LOC} * f(\text{Complexity})$
- $\text{ProductivityRate} = (\text{AvgLOC} (f(\text{Skill}) * f(\text{Language}))) / \text{StaffYear}$
- Since all code and staff are not created equal, we need to clarify some parameters

Example: Complexity Parameter

$$f(\text{Complexity}) = \begin{aligned} & ((\% \text{simple} * \text{SimpleWeight}) && + \\ & (\% \text{moderate} * \text{ModerateWeight}) && + \\ & (\% \text{complex} * \text{ComplexWeight})) / 100 \end{aligned}$$

- SimpleWeight => .5
- ModerateWeight => 1
- ComplexWeight => 1.5



Another good reason to
have good **estimates**...
and **emergency rooms**!



At the beginning of a project where you don't have lines of code to count for a sizing estimate, what would be a reasonable sizing element?

- Think for 16.1111 seconds...
- Turn to a neighbor and discuss it for a minute
- Now can we talk!?



Estimating Size with Function Points

Originally based on work at IBM from 1979

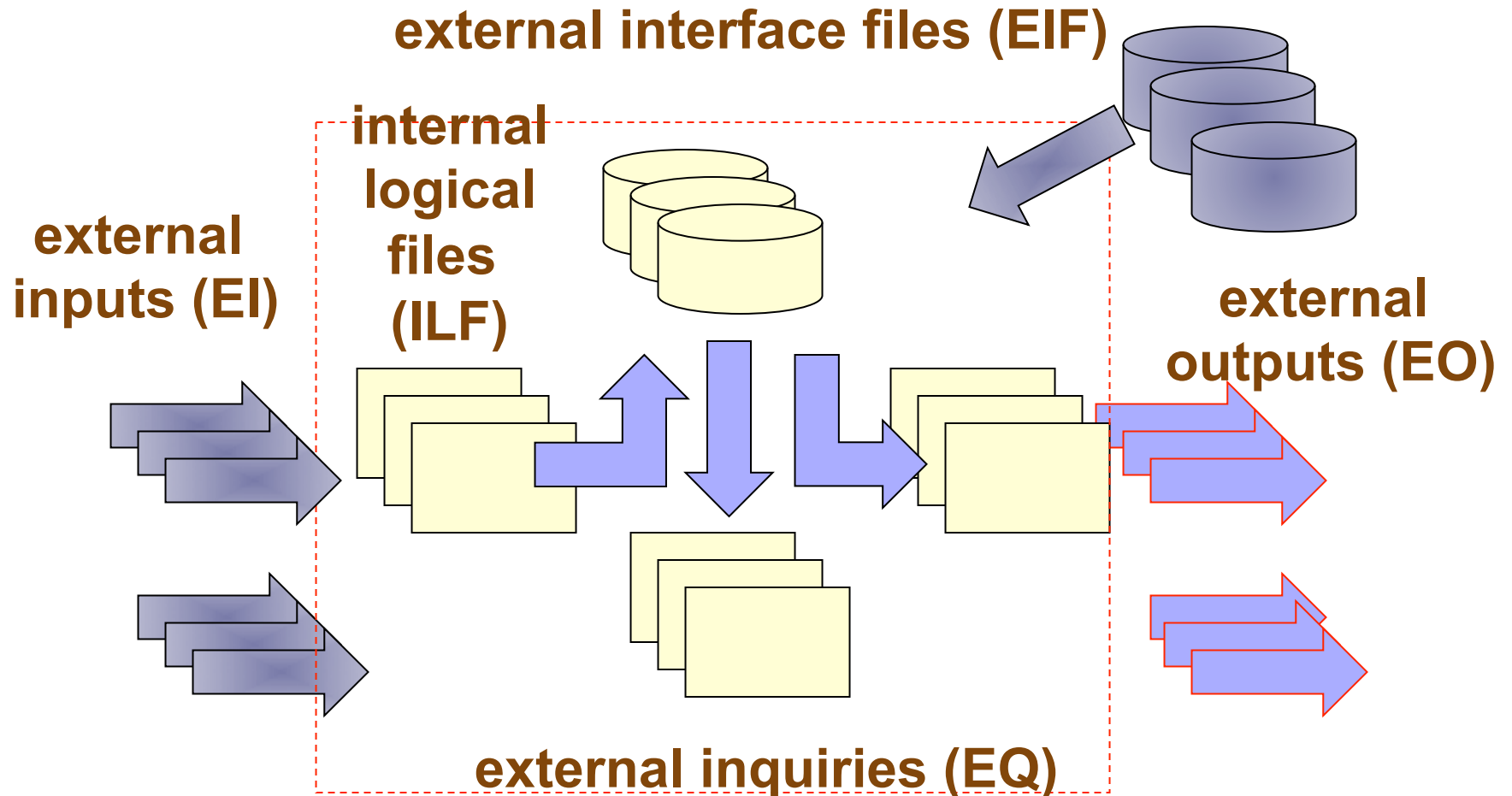
- Allan Albrecht and John Gaffney wanted to measure the productivity independently of lines of code
- Now developed by the International FP User Group (IFPUG - US based)
- Also Mark V and others...





Estimating Size with Function Points

(Albrecht & Gaffney)





Albrecht FP Weightings

type	simple	average	complex
ILF	7	10	15
EIF	5	7	10
EI	3	4	6
EO	4	5	7
EQ	3	4	6

Disadvantage: The weights are assigned subjectively.



Function Point Example

- A program extracting **yearly salaries** from the *payroll file*, and the *details of courses* and *hours taught* on each course by each staff from *two files* maintained by the *time-tabling system*. The program will **calculate the staff costs** for each course and put the results into *a file* that will then be read by the *main accounting system*. The program will also produce a *report* showing for each course the *hours taught* by each staff and the *cost of those hours*.
- Using the FP method, calculate the Albrecht function points for this subsystem, assuming that the report is high complexity, but that all the other elements are average complexity.



Function Point Example (continued)

type	simple	average	complex
ILF	7	9	15
EIF	5	8	10
EI	3	4	6
EO	4	6	8
EQ	3	4	6



Problem with Over/Under-Estimating

- **Parkinson's Law: Work expands to fill the time available**
 - An over-estimate is likely to cause project to take longer than it would otherwise
- **Murphy's Law: Anything that can go wrong will go wrong**
 - Under-estimation may lead to quality problem
- **Brooks' Law: Putting more people on a late job makes it later**

Cost Estimation

- Project scope must be explicitly defined
- Task, functional, or component decomposition is necessary
- Historical measures (metrics) are very helpful
- To assure fit, use two or more estimation techniques
- Uncertainty is inherent in most estimation endeavors – plan on it!





Homework and Reading Reminders

- **Read Chapter 3 of text**

- **Complete Homework 2 – Play SimSE Game and report results according to assignment**
 - **Due by 5pm, Tuesday, September 18th, 2012**

- **Get a Head Start on COCOMO**
 - **Look over COCOMO-II User Manual and Model Manual**
 - **Download COCOMO-II Software (from Angel) or get Evaluation Copy of Costar**