



Software Cost Estimation



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Introduction to Costing

Presented by:
Jairus M. Hihn

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Agenda



Lecture 1: INTRODUCTION	08:30
Lecture 2: ENGINEERING COST ESTIMATE	09:15
Case Study Part A (Engineering Estimate)	10:15
Break	10:30
Lecture 3: SIZING THE SYSTEM	10:40
LUNCH	11:40
Case Study Part B (Sizing)	12:40
Lecture 4: MODEL BASED ESTIMATE	13:20
Case Study Part C (Model-based Estimate)	14:15
Lecture 5: INCORPORATING RISK	15:00
Lecture 6: VALIDATE & RECONCILE	16:00
Lecture 7: FOLLOW THROUGH	16:15



Topics



- Introduction & Background
- Purpose/Objective of Class
- Scope of Material
- Estimation Basics
- Overview Of Software Estimation Steps



Class Purpose/Objective



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- Purpose is to provide a structured tutorial in using a proven software cost estimation process as documented in the
 - *Software Cost Estimation Handbook*
 - Class does not provide cook book approach but will provide you with the tools/methods that you can modify to meet different estimation problems as they arise
 - External Released Version on NASA SW PAL
- Objective is that by the end of day you should be able to make an estimate using the described process and methods, and available tools



Scope (1)



- Should be used by anyone who has to make a software cost estimate for NASA-developed software
- While primarily intended for mission software, the process can be tailored for all software we develop even research software
- Process includes all the activities and support required to produce estimates from the requirements analysis phase through completion of the system test phase of the software life-cycle
 - Adjustments need to be made to current data and model estimates do cover all necessary cost elements
- Current focus is on software developed in-house, not software acquisition or maintenance



Scope (2)



- Software development cost for new, reused and modified code
- Life cycle phases primarily cover Software:
 - software requirements analysis
 - software design
 - software implementation
 - software integration and test
- Activities primarily include:
 - software management
 - software engineering
 - programming
 - software test engineering



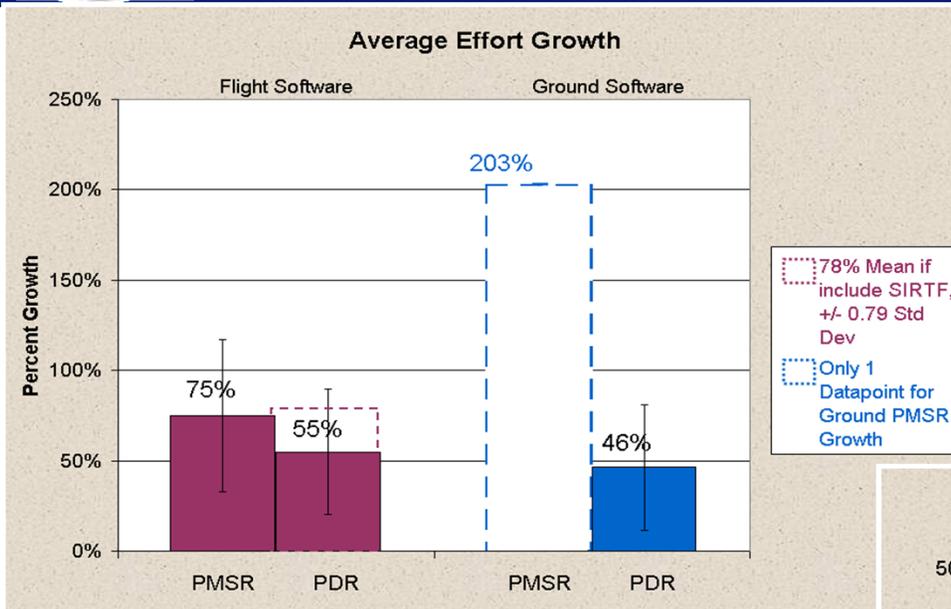
Estimation Methods



- All estimates are made using some combination of the basic estimation methods
 - Analogy
 - formal analogy
 - expert judgment
 - Cost estimating Relationship (CER)
 - models
 - “rules-of-thumb.”
- Whatever method is used, it is most important that the assumptions and formulas used be documented to enable more thorough reviews, and to make it easier to revise estimates at future dates when assumptions may need to be revised. Documented estimate is first line of defense against arbitrary budget cuts.



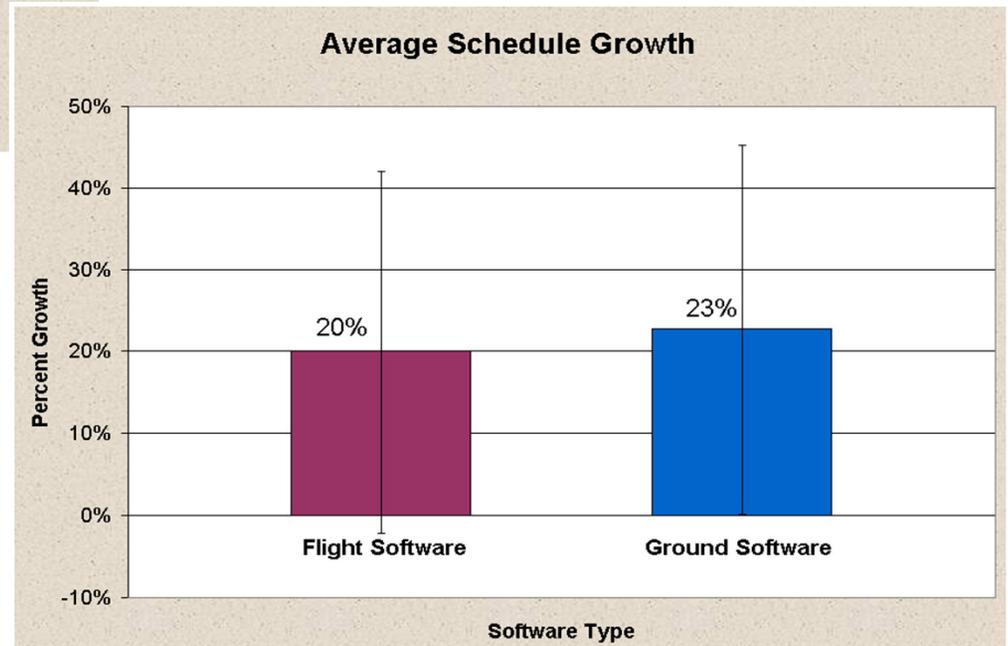
The 1990's Environment Effort and Schedule Growth



- The basic rule of thumb for effort growth has not changed over the years

50% from PDR!

- But this is 50% from the budget which is not necessarily your estimate
- Many have claimed over the years that the budget has little relationship to their estimates.
- So why does this happen?**





The 2000 – 2010 Environment Effort Growth



Projects that are following a disciplined process exhibit below average budget growth

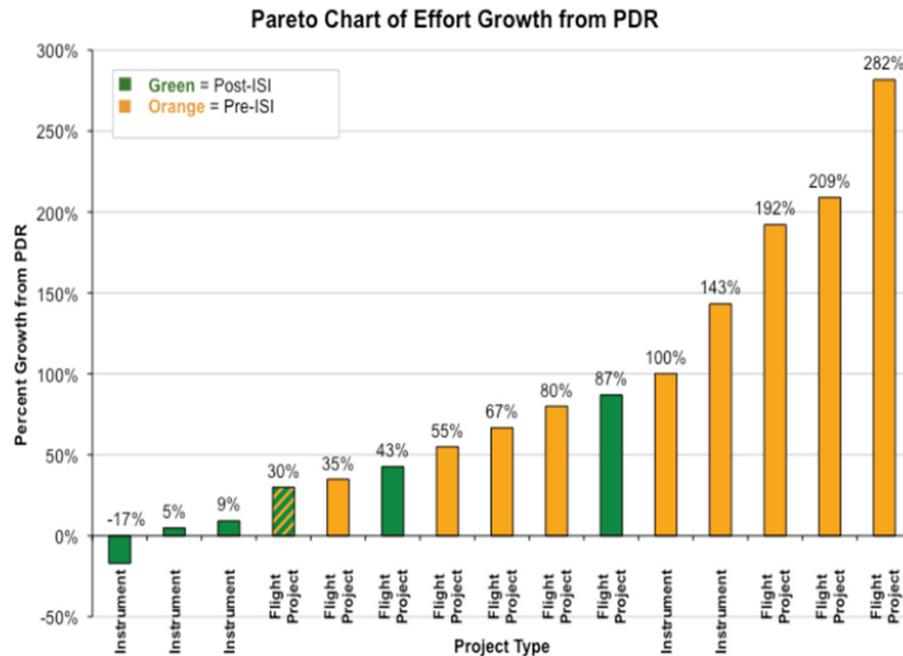


Figure 3- 24: Effort Growth from PDR by ISI status

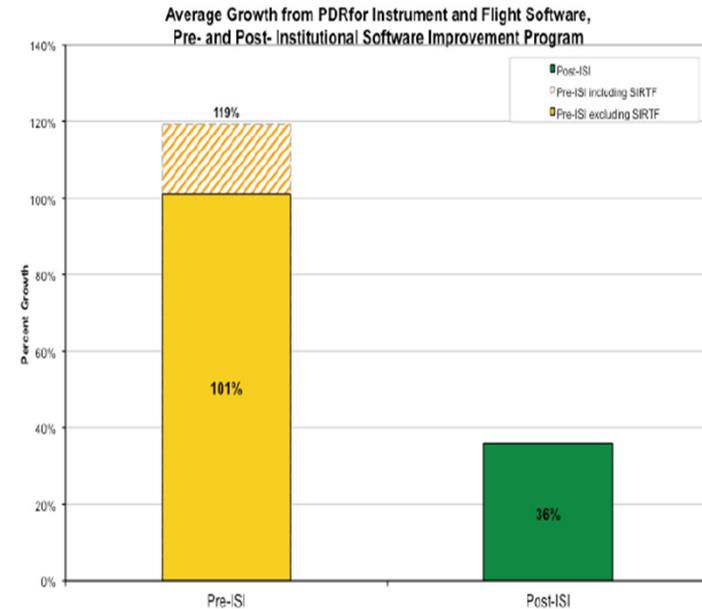
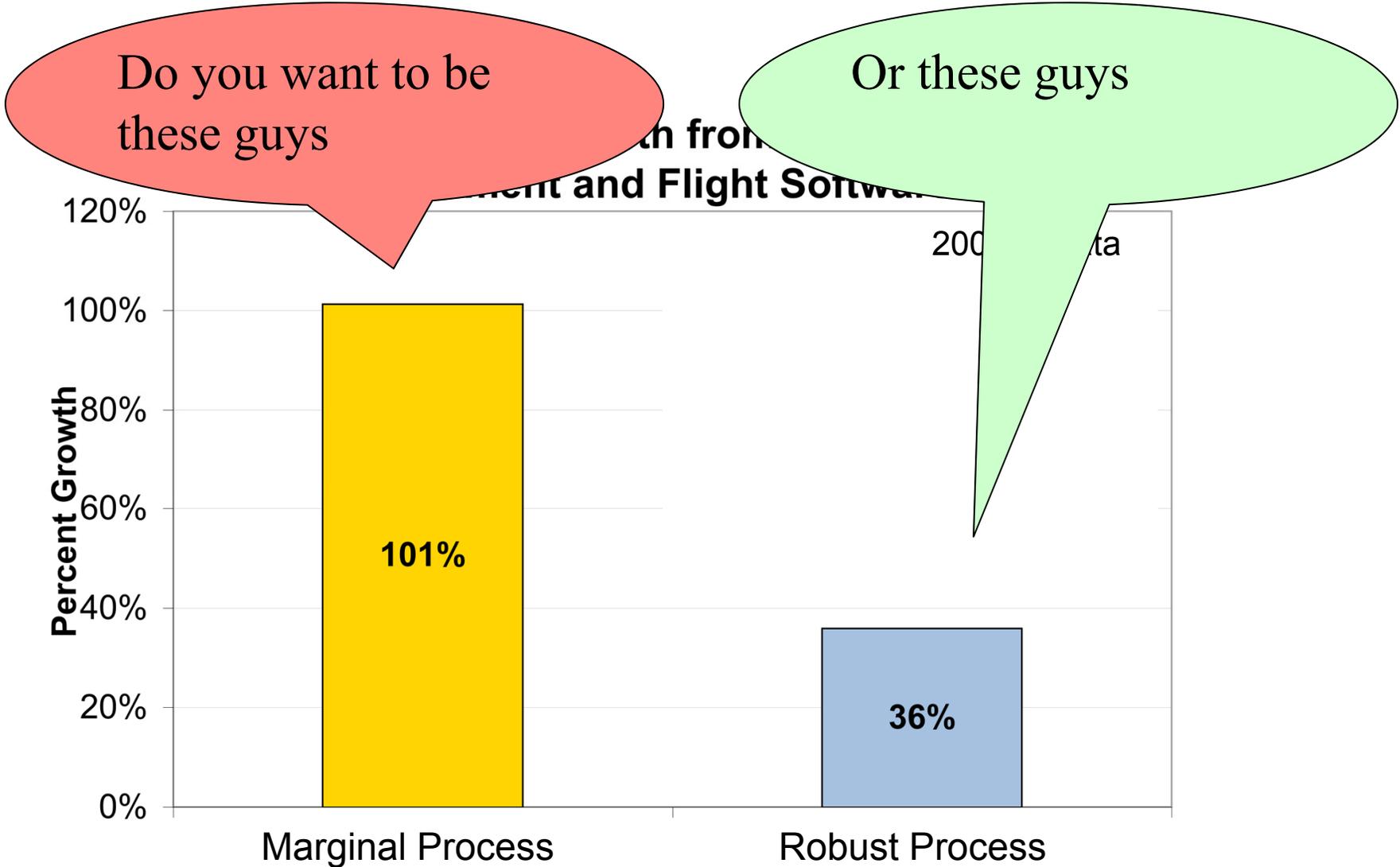


Figure 3- 23: Average Percentage Effort Growth

* Source: ESD Mission Software -- State of Software Report 2008



You Decide ...





Cost Estimation Issues

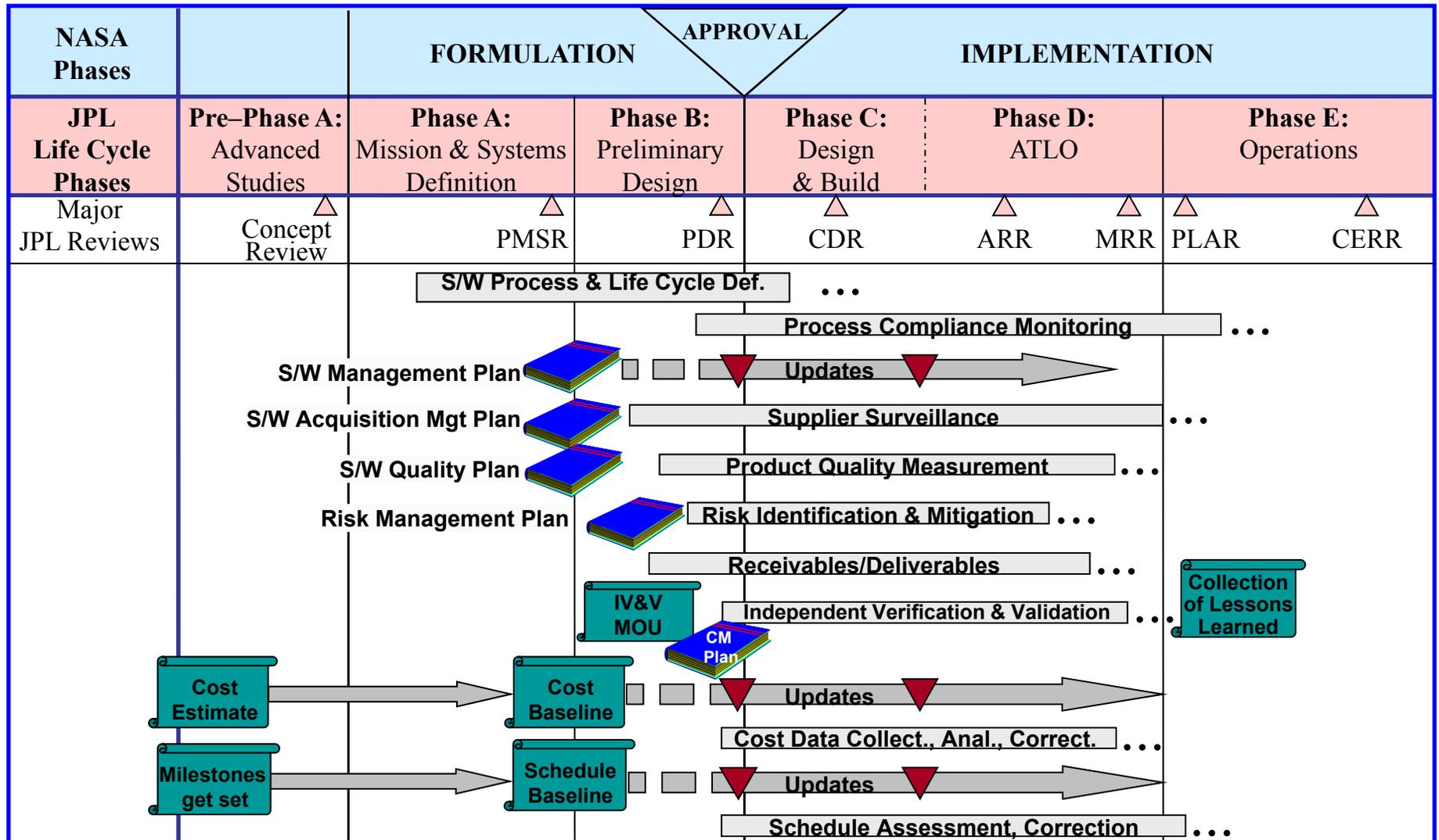


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- Budget 'bogies' get set very early in lifecycle. Sometimes based on casual conversations.
 - You will typically get held to this number!!
- Current proposal and planning process encourages/ demands under-estimating in early stages of lifecycle
- Software estimation is fundamentally an uncertain business under the best of conditions



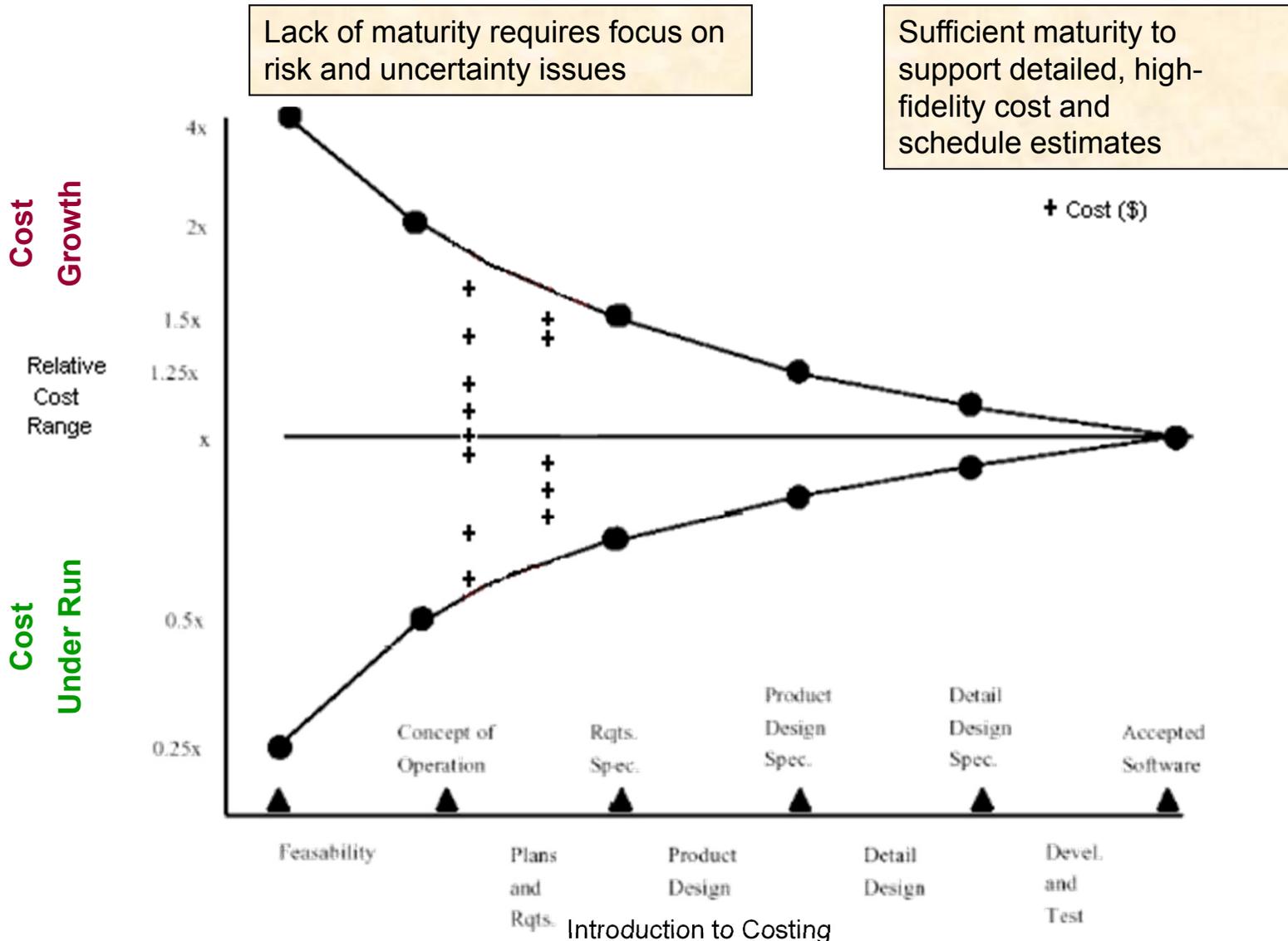
Software Cost Estimation & Planning Over the Life-Cycle





Cost Uncertainty: Accuracy in Estimating

Estimates Cannot be More Accurate than Requirements/Design Maturity



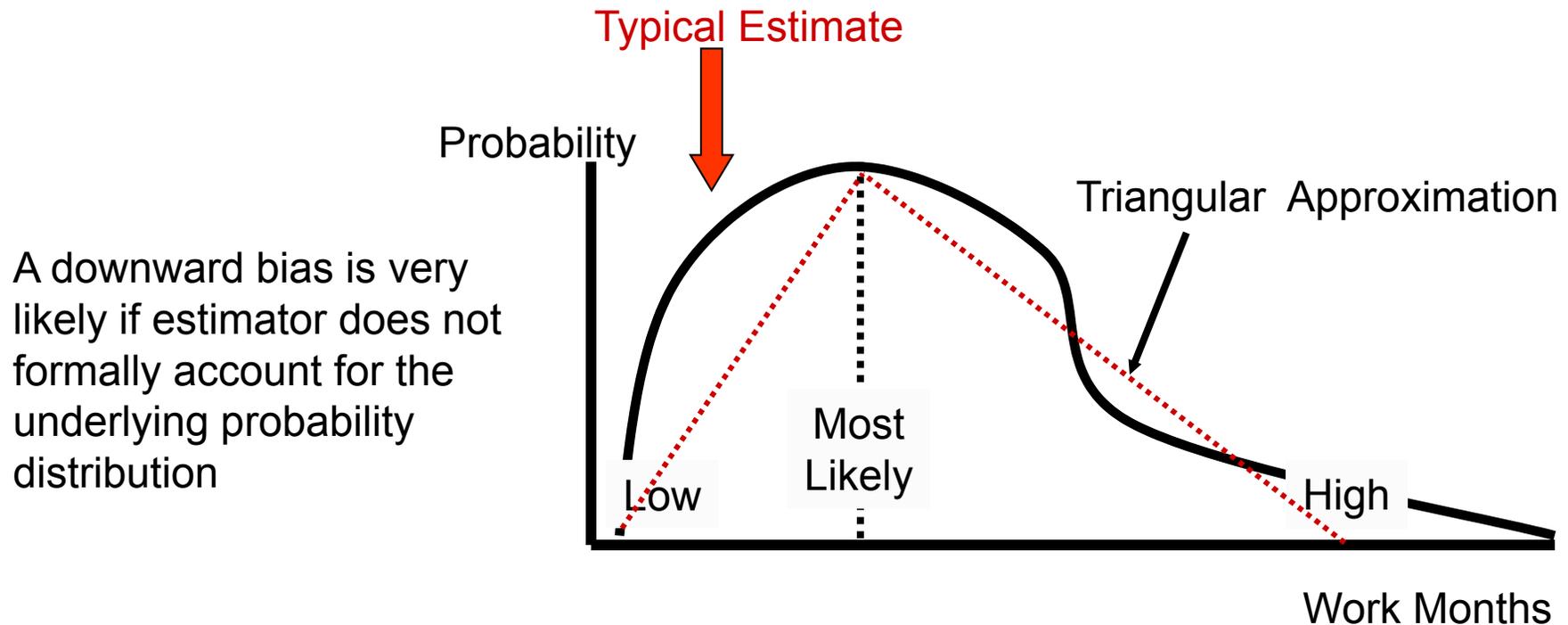
Introduction to Costing



Cost Uncertainty: Fundamental Reason for Underestimation



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A downward bias is very likely if estimator does not formally account for the underlying probability distribution

- Typically cost, effort, SLOC distributions are highly skewed to the left
- We can capture all this with just three parameters
 - Low, Most Likely, and High
- Point estimates tend to fall between the low and most likely distribution parameters and Most Likely is typically less than 50th percentile



So What Should You Do?



- The estimation method described in the class and in the handbook emphasizes development of cost estimates based upon:
 - Data-driven estimates
 - from NASA historical experience
 - Multiple estimates
 - models, analogies, rules of thumb
 - Incorporate risk and uncertainty

When budget is cut, descope we must!



Software Estimation Steps



- The cost estimation process is highly iterative
- The reason for the iteration over the different steps is that cost estimation is part of the larger planning and design process, in which the system is designed to fit performance, cost, and schedule constraints along with reconciliation and review of the different estimates
- Although the steps may be performed in a different order, these steps will be discussed in the order that the steps are numbered, which represents the canonical form

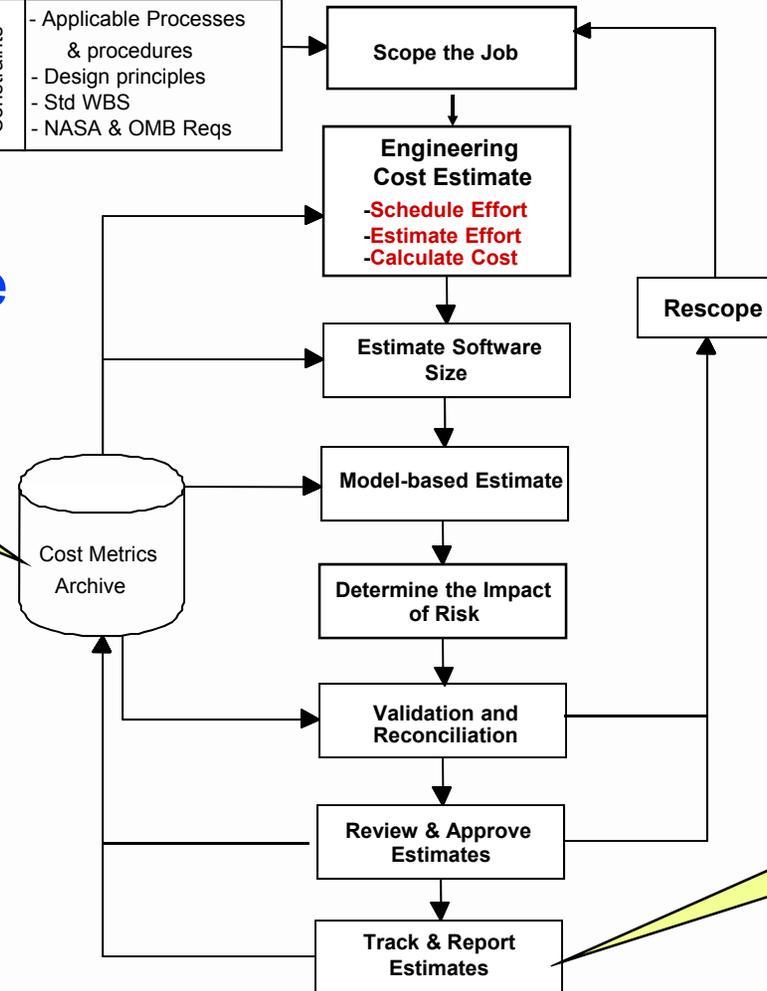


SW Cost Inputs	<ul style="list-style-type: none"> - Requirements - Architectural Design - Mission/Project Sched. - Implementation Appr. - Mission/Project WBS - SW Implementation and Design Approach
Constraints	<ul style="list-style-type: none"> - Applicable Processes & procedures - Design principles - Std WBS - NASA & OMB Reqs

Go to
> <http://software>

Save History

Software Estimation Steps



When budget is too low
"Do not look for a silver bullet"
- DESCOPE

Follow Through



Key Points



- **Use at least two estimates**
- **Document the basis of estimate (BOE)**
- **Update estimate at significant milestones**
- **Keep your history**
- **Incorporate Uncertainty**



What's Coming Next



- The software estimation process discussed in the following lectures and exercises describes the steps for developing software estimates and subsequently tracking and refining those estimates throughout the life of the project
- Class does not follow the handbook exactly but is consistent with handbook contents
 - Class discusses more variations in how to estimate
 - Covers some additional more complex material