



Systems Cost Modeling

CIF 15 Workshop



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Basic Source Information

GT Position Paper

NASA Systems Eng'g Guidebook

PSP Size Estimating

Mil Std 881b: WBS

Sw Cost Estimation with COCOMO II

DOD 5000.1, 5000.2, 5000.2R

**EIA 632 & IEEE 1220 (SE process);
and EIA 731 (assessment)**

ISO 12207

CMMI

Pages 48 to 58 of Barry's COCOMO II & MBASE

**Approach for estimating system engineering cost (by
Katherine J Tilton, Virginia Tech 1992**



The Issues

Scope: All the SE actiities

Goals: Size? Effort? Schedule?

Educated SysEs about Sw cost estimating?

Better integration with SwEng'g plans & estimates?

[Need early success]

[Maintain mapping to DOD terminology]

Scope

All the activities encompassed/called systems engineering: breaking system down functionally, physically distributing, ...

If the system is an Aircraft (flow-down of requirements):

- Level 1 = aircraft (take-off, land, carry, launch, ...)
- Level 2 = avionics (sense, detect, control, ...)
- Level 3 = radar (sense, detect, track, ...)
- Level 4 = antenna, signal processor, display,

Scope is at Level 4, maybe Level 3, but not Level 2.

Full life cycle: idea to production

MBASE Project Start (PS) to Product Release (PR)

System engineering activities

Development Cost



University of Southern California
Center for Software Engineering

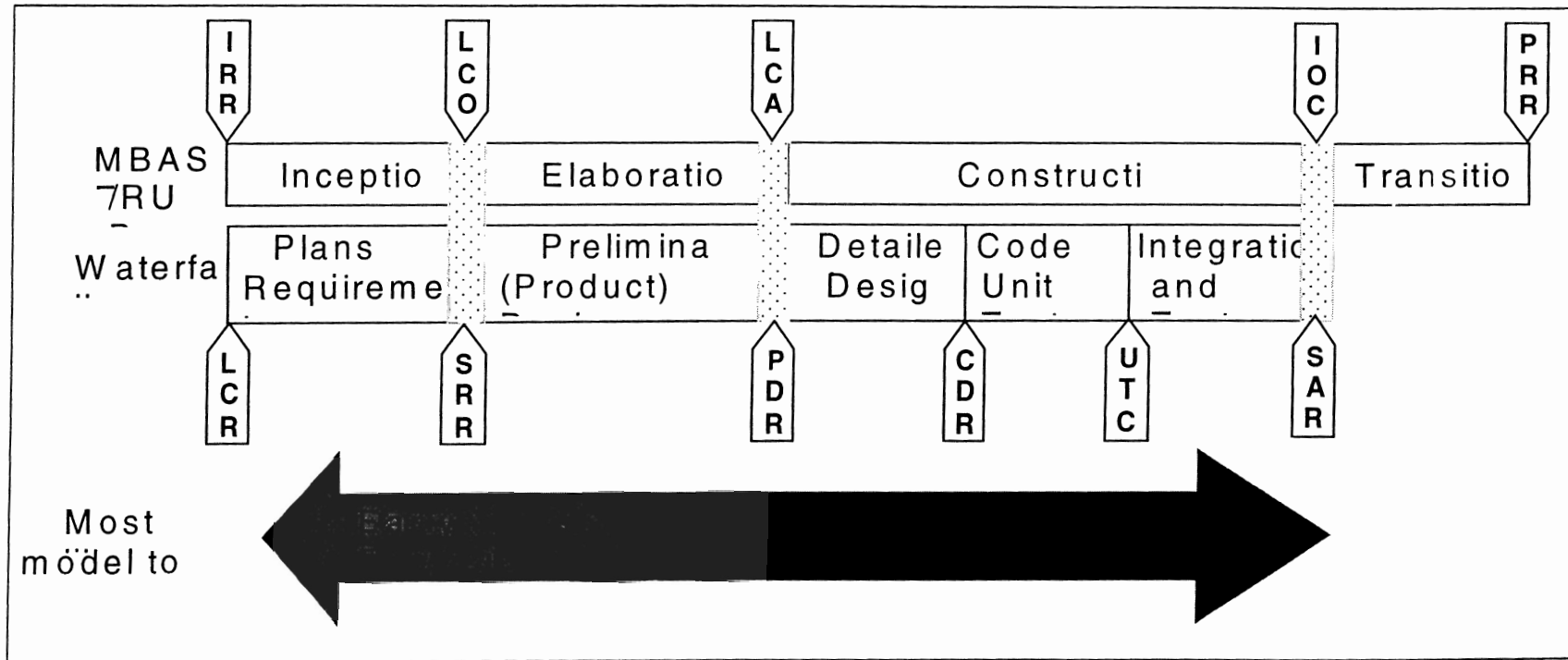
Systems Eng'g Cost Modeling – CIF 15 Worksnop

Anchor points

May need to go beyond [modify] MBASE (IOC mis-
understanding; PRR; ...)

Look at ISO standard

Life Cycle Phases – MBASE vs WF





New Parameters

Modeling complexity

New algorithms

What Needs to be Added

To cover the "decomposition" of the system

To cover "integration" (the distinctly different) activities

Scope (Cont.) & A Plan of Attack

The total system engineering effort for the next larger, software-intensive system than the software-only system

- Increment 1: expand COCOMO II to software system engineering
 - including software systems engineering and software engineering activities covering the MBASE phases of Inception, Elaboration and Construction (but not including hardware integration in an embedded system during construction)
 - excluding system engineering related to the hardware system engineering; and software & Systems and Software Engineering in Transition

Plan of Attack (cont.)

- Increment 2, Alt. 1: expand to cover the hardware and software integration in both Construction (embedded hardware) and the Transition phase of the MBASE
- Increment 2, Alt. 2: expand to cover hardware developmental system engineering, hardware prototype construction, and hardware/software integration
- Increment 3 ...

Sizing

Requirements? (domain specific? Level of detail?)

- Countable? [system spec "shall"s]
 - Explicit? Implied?
 - Before Inception¹ (IRR)? At IOC (PR)?
Need Early Design & Post Architecture models?
- May need a complexity factor?
 - May need adaptation/reuse
 - May "equivalent shalls"
 - Clarity? Linkages or hidden dependencies?

Number of Subsystems

¹ MBASE

Sizing (cont.)

**Need requirements volatility & evolution (REVL)
[volatility or stability]; requirements maturity; Stability of
the "environment" [for the requirements volatility]**

Have estimation techniques:

- Analogy
- HCA

Other Suggested Parameters (5 years old)

of requirements

TBD, TBR (resolved)

of internal and external interfaces

of documents

Types of documents and relative difficulty factors

**Number of [customer attended formal] reviews
recommend for the program and relative complexity
regarding preparation**

Amount of customer oversight [help?] imposed [BUSB]

Schedule for the program

Cost of material to be delivered to customer

Other Suggested Parameters (5 years old; cont.)

Cost of the software development

Program type?

Design maturity [precedentedness? of host system]

Program staff experience



Tasks

1. Delphi to ID "top" parameters (cost drivers)
2. Map how to size to where you are in development cycle
3. Identify Industry (customer) needs: Propose user screens (input/output) and/or use-cases for operations
4. ID initial data sources [and get some]
5. Consider major Block Change treatment
6. Relationship of USC/CSE – INCOSE (find a "home" in INCOSE?)
7. Assesement Data Repository proposal and this SE estimation effort
8. Scope & Define the Model



Tasks

9. Software system of systems cost model(?) And tools (and/or what if games)

10. Compare & contrast MBASE (as is today) with MBASE extended to cover systems engineering tasks

11. Apply MBASE tools and techniques in Systems and Software Systems Engineering

- **OCD & "Inception"**
- **EasyWinWin (requirements elicitation/clarification)**
- **Results Chain**

Difficulty/Importance

