

Systems Cost Modeling

**Affiliate Breakout Group Topic
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Problem Statement & Approach

Problem Statement: As the government contracting community moves from traditional, sole source/cost plus contract vehicles to competitive, fixed price ones there is an ever increasing need for a credible, supportable, fact-based **System Engineering (SE) estimation model.**

An Approach: I submit that

- USC/CSE has the research knowledge and tools based upon the COCOMO II development effort to lead such a task,
 - with the USC Industrial Affiliates help, including data, peer review, and WB Delphi team membership).
 - Another valued resource could be INCOSE for insight and data.
- The resultant model could eventually be a candidate as an emerging extension to COCOMO II.

System ~~SE~~ Estimation Model Building Blocks

System ~~SE~~ Cost Drivers

Conceptually, the current COCOMO II cost drivers apply to system ~~SE~~ as well, but not necessarily the current productivity range/values:

- Current Scale Factors have a strong SE focus
 - FLEX - Development Flexibility
 - TEAM - Team Cohesion
 - PREC - Precedentedness
 - RESL - Architecture and Risk Resolution
 - PMAT - Process Maturity (EIA, CMMI, etc.)
- Most Effort Multipliers (EMs)
Apply well to systems ~~SE~~ (except maybe DATA, RUSE, and LTEX)
- Early Design composite multipliers would be most appropriate initially, however for the Post-Architecture EM set ...



Post-Architecture EM set...

- ACAP/PCAP - Personnel/Team Capability
(some ACAPs are actually SE types)
- CPLX - Product Complexity (design)
- TIME - Time Constraints (performance requirements issues)
- RELY - Required Reliability (testing rigor)
- STOR - Storage Constraints (performance requirements issues)
- APEX - Application Experience
- TOOL - Use of SW Tools (instead, ~~SE~~ tools like DOORS, etc.)
- SITE - Multi-Site Development
- DOCU - Documentation to Match Life-Cycle Needs
- PVOL - Platform Volatility
- PLEX - Platform Experience
- SCED - Required Development Schedule
- PCON - Personnel Continuity



REVL and Others

**REVL - Requirements Volatility and Evolution applies
(except you are not adjusting SW SLOC but some other
measure of system-~~SE~~ size)**

Other Cost Drivers?

System-SE Sizing

We need an Early Design Model measure of system-SE size derivable from RFP and preliminary Interface docs / system Specs for the proposal, plus more definitive data process and artifact data from system architectural and design work later in development (Post Architectural Model)

An Early Design System-SE Sizing Candidate: Requirements

- Some requirement attributes that may drive system-SE cost
- Clarity
- Completeness
- Stability
- Maturity (TBDs, TBRs)

- Complexity
- Other Attributes?

Requirements-based sizing has the advantage of applying to both COTS/Component based and custom developed systems

Other system-~~SE~~ Sizing Candidates: Either Early Design or Post-Architectural

- Number/Complexity/Maturity/Stability of External Interfaces
- Number/Complexity/Maturity/Stability of Internal Interfaces
- Function Points/Feature Points
- Use Cases (or elements of)
- OO Design Artifacts and Complexity
- Number/Complexity/Page Counts/Planned Releases of SE-Generated Documents
- Other Candidates?



System-SE- Effort Scope & Distribution

- We need a high-level SE Task list (analogous to the COCOMO II SW activities performed) for better definition of what constitutes SE effort (may need to combine or descope for simplicity):
 - System Requirements Management
 - Project Office Support (including customer change requests *)
 - Detailed Project Planning
 - Simulation and Modeling
 - Concept of Operations Development
 - System Arch. and Design
 - Technical Performance Monitoring
 - Verification and Validation Activities
 - Project Office Support (both contractor and customer)
 - Specialty Engineering (e.g., "ilities")
 - Other Tasks?



SE EC Efforts

For anticipated changes to a program

Reviewing and responding to Request For Changes (RFCs).

Write the draft RFC

Writing/coordinating the response to the RFC via the Engineering Change Proposal (ECP) mechanism

Possible bottoms-up drivers for estimating this task are:

- Proposal requirement maturity TBDs/TBRs provides some indication
- Customer change request history is an indicator (number of RFCs per month) along with...
- Anticipated length of the program

MBASE distribution of the SE effort

**start in the Inception (PS to LCO) phase,
peak during the Elaboration (LCO to LCA) phase,
would require sustaining ("minding the store" effort)
during Construction (LCA to IOC),
and then pick back up in the latter part of Construction
and continue through much of the Transition phase (IOC
to PR)**

Miscellaneous Comments

If building a useful System SE estimation model was a simple task it would have been done long ago.

In fact, there have been many barriers:

- Lack of reliable System-SE "sizing" data,
- Ill-defined SE tasks and roles, and thus fuzzy SE effort data,
- Complexities related to estimating IPT efforts (also a SW estimation issue)

Miscellaneous Comments (cont.)

Choice of development method

- Waterfall,
- Spiral,
- Incremental,
- etc.

would seem to be a driver.

Is the systems engineering effort for the first few spirals relatively more than later spirals?

Typical systems engineering staffing profiles per method as development proceeds would be useful.

MBASE anchor points would seem to provide a good starting point.



Miscellaneous Comments (cont.)

Need to define relationship to USC COCOTS and other such COTS based estimation models

For simplicity, may need to initially limit a system SE estimation model to software intensive systems

Recent movement of DoD standards towards best commercial practices, including less formal documentation, might make historical system-SE effort expenditures for 2167A-like projects suspect for use in future systems.