

Notes on System Engineering Cost Workshop – Workshop Lead: Barry Boehm

Workshop Objectives -

- (1) Baseline current state of the art -
 - appears to be activity based costing and % of total system costs
- (2) Review current initiatives
- (3) Identify critical issues
- (4) Recommend PSM roles, initiatives

Barry gave a review of USC's COSYSMO Project:

- **Discussion of scope:** Decided that trying to estimate the whole spectrum of system engineering is too big. SE activities like SETA support and aircraft are bigger than COSYSMO can tackle at once. The COSYSMO effort decided to go in increments starting with front-end costs of information systems engineering focusing on software intensive, computer-based systems or subsystems where H/W consists of defined networks, HCI devices, data storage devices. Thus deferring to later increments SETA projects, physical structures, ships, etc. Additionally, defer post-deployment activities - focus in first increment on system definition, integration & test. Therefore they are defining systems engineering as:

- System engineering effort = sum of System Engineering WBS elements - *those elements have not been nailed down yet.*

Barry went over list of current COSYSMO project participants composed of USC and industry personnel. Discussed their overall approach to modeling (i.e., Start with early estimation capability and avoid parameters not well known and work with large grain breakdowns - phases, activities, product elements. The following outlines his presentation:

Proposed COSYSMO approach (see workshop slides)

- Start with "system size" and effort drivers
- Draw on current sizing and cost driver approaches
- Will consider but defer activity-based and product-WBS based approaches

Strawman COSYSMO (see workshop slides)

- Sizing model determined nominal effort and schedule (as in COCOMO II)
- Several sizing approached under consideration
- Factor in requirements volatility, reuse, complexity
- Begin with linear equation relating size and effort
- Multiplicative cost driver adjust effort and schedule (as with COCOMO II)

Some candidate sizing/Complexity models

- Number of requirements
- **Issue identified:** Granularity of the requirement
- **Issue identified:** Complexity of the requirement
- Function-point metrics
- Operational threads or Use cases
- Requirements volatility factor
- Reuse factor
- Combination of sizing elements and cost-driver attributes

- E.g., system function requirements - #, complexity, understanding, stability
 - system performance & service requirements (TPMs) - #, complexity...
 - (a list of these - see Barry's handout)

Next Steps for finalizing sizing measures

- Pairwise comparison approach for sizing
 - Compare with known systems
- COCOMO II complexity factors
 - E.g., control, device- dependence
- Evolving Rational Sizing model
 - "software mass" = number of classes of data, number of use cases, distribution and algorithm complexity

Cost and Schedule Drivers - Application Factors *(see workshop slides)*

- Requirements understanding
- Architecture understanding
- Plus others...

Cost and Schedule Drivers - Team Factors *(see workshop slides)*

- Number and diversity of stakeholder communities
- Stakeholder team cohesion
- Plus others...

COSYSMO group felt that these were biggest drivers for Application factors:

- Requirements Understanding
- Architecture Understanding

Biggest drivers for Team Factors

- Personnel capability and continuity
- Number and diversity of stakeholder communities

Issues COSYSMO encountered

- What's systems vs software engineering *(see workshop slides 'Scope of SE and SWE')*
- Special sources of effort - modeling, COTS integration

BREAK

Barry posed the question to the attendees, "What are the most important issues to discuss?"

(1) technical issues - scope of SE, alternative costing estimation methods and models... *(see workshop slides)*

(2) PSM - what role can PSM play?

Discussion on the definition of 'Systems Engineering'

- Suggested that COSYSMO should review EIA 731 to possibly help their effort *(Barry will identify action items for COSYSMO group to review EIA 731 as a definition of system engineering.)*
 - Can anyone make terminology in MIL-Handbook 881 consistent with what's in EIA 731?
- Additionally collaborate with INCOSE, GMU, & USC integration

Discussion of system size measures - *(see workshop slide 19)*

- System Functional Requirements
- System Performance and Service Requirements (TPMs)
- System Scenarios and Ops Concept (operational threads, use cases)
- System External and Internal Interfaces
- System I&T (# test cases, # procedures, special test equipment...(see handout)
- System Architecture & Platforms including security requirements (see handout for specific measures)

Additions suggested to chart 19:

- models and simulations
- mission needs as early size measure (before we have functional requirements)

Issues identified with size measures:

- Orthogonality of functions and use cases
- Granularity guidelines
- Complexity weights
- How to avoid double counting with different cost models
 - Models for software
 - Models for COTS integration
 - Models for System integration
- Attendee Observation: There is a utility for early system costing (not just system engineering but full costs - software, hardware and system engineering)

Discussion on Cost drivers - (see workshop slide 14):

- Team Factors
- Application Factors

Issues remaining for COSYSMO project to handle:

- Ratings scales for cost drivers - e.g., how to measure Requirements Understanding?
- Discussion about management capability - hidden under personnel capability (no one wants to admit to having bad managers)

PSM Roles, Next Steps

- Independent review of model, parameter definitions, rating scales
- Contribute data, iterate model
- Coordinate progress via PSM, INCOSE meetings

24 Attendees:

- Cheryl Jones
- Ruth Buys
- Esteban Zuttion
- Dana Van Orman
- Guy Mercurio
- Rick Eidson
- Linda Leslie
- Becky Grant
- Bill Criss
- Aaron Silver
- Dennis Ahern

- Garry Roedler
- Joe Dean
- Tom Davis
- Bikshapathhi Adepu
- Betsy Clark
- Jack Ferguson
- Bill Henry
- Renee Schreiber
- Chris Miller
- Ander Marcotte
- Carl Newman
- David Magidson
- Mia Hernandez