COSYSMO Workshop

- Participants
    - Garry Roedler, Lockheed Martin
    - Jared Fortune, Aerospace Corp., USC
    - Gan Wang, BAE Systems
    - Ricardo Valerdi, MIT *
    - Barry Boehm, USC
    - Elizabeth O'Donnell, Boeing
    - Marilee Wheaton, Aerospace Corp.
    - Jim Cain, BAE Systems
    - Dan Liggett, SoftStar
    - Gary Hafen, Lockheed Martin
    - Howard Schimmoller, Lockheed Martin *
    - Jeffrey Allen, Lockheed Martin *
    - Miles Nesman, Boeing
    - Darryl Webb, Aerospace Corp.
    - Rick Selby, Northrop Grumman
    - Cynthia Nikolai, Notre Dame
    - Ali Nikolai, SAIC
    - JoAnn Lane, USC

    * People who participated remotely by phone

- Prioritization of Improvement Projects (Garry Roedler)
    - Order of Priority
        - High: Reuse; Risk Modeling
        - High/Medium: Integration of SWE and SE Estimation; Best Practices
        - Medium: Assumption of Linearity in Cost Drivers; Effect of Cost Drivers and Scale Factors; Recursive Levels
        - Low: Consideration of SoS Scope in COSYSMO; Estimation of O&M Phase; Requirements Volatility
    - See table of Priorities for details

- Reuse (Jared Fortune)
    - Central question: What is the effect of reuse in estimating systems engineering size/effort?
    - Hypothesis: A COSYSMO reuse submodel will improve the model's estimation accuracy
    - Discussed ongoing efforts by the COSYSMO team, Lockheed Martin and BAE Systems.
    - Discussed further work to perform in the area of addressing Reuse in COSYSMO
    - Primary objective is to develop quantitative Reuse factors
    - *Action: Jared Fortune to develop and conduct a Delphi survey on the impact of reuse at October COSYSMO Workshop as a first step towards quantifying reuse*

- *Action: Jared Fortune to develop a short data collection survey form for reuse projects (by October meeting)*
    - *Consider asking a couple questions to discriminate between Opportunistic and Systematic reuse*
- Currently are looking for data from all companies
    - LMC and BAE are likely to be able to provide data
    - *Action: (All) Upon receiving the Reuse data collection survey form, solicit and provide data sets to USC-Jared Fortune (due date dependent on when survey available).*
- Following receipt of the reuse data, the following tasks will be performed
    - Develop Reuse factors from data analysis
    - Develop at least one good anecdotal example
        - Incorporate this into the Best Practices

- Integration between SWE & SE Estimation (Gan Wang)
    - Central question: What is the overlap between COCOMO II and COSYSMO?
    - Hypothesis: By identifying the WBS elements in COSYSMO that overlap with the WBS in COCOMO II, the systems engineering resource estimation accuracy increases.
    - Identifying the WBS elements in COSYSMO that are in common with the WBS elements in COCOMO II will help determine the potential areas of overlap in the estimation models (i.e., double counted when used together)
    - Looking at scope overlap, not model integration at this point
    - Use of MIL-STD-881A to support the analysis
        - Asked which discipline "owns" the task, not where it currently is covered in the models
        - Established a first cut
    - *Action: Gan Wang will clean up the WBS matrix mapping and make it available to the team*
    - May be able to address the problem through operational guidance after investigation determine area of concern.

- Risk Modeling (Garry Roedler)
    - Central question: How can risk associated with the COSYSMO estimate be quantified?
    - Hypothesis: The output generated by COSYSMO can be quantified using probability distributions for better assessment of the likelihood of meeting the estimate.
    - Presented overview summary of the risk approach that was developed and approved in 2007.
        - Leverages work done by Lockheed Martin in its COSYSMOR (COSYSMO Risk and Reuse application)
    - Sustained agreement of the need and the mechanics.
    - Would be good to get a peer/SME review of the mathematics used for the calculation and graphing of the values – possibly Book and Garvey.

        - *Action: Ricardo agreed to get the additional reviewers to ensure validity.*
        - *Action: Ricardo will set up a telecon with John Gaffney and the reviewers to discuss validity and pros/cons of the alternative distribution approaches.*

- Assumption of Linearity in Cost Drivers (Gan Wang)
    - Central question: How do we characterize the non-linearity of cost drivers across the system life cycle?
    - Hypothesis: Not all cost drivers have a constant impact on systems engineering effort throughout the life cycle.
    - Many of the cost drivers result in changes that appear to be too dramatic from one step to the next
        - Cumulative effect from the drivers is too great
    - Some of the drivers may not have linear impacts across the whole life cycle
    - Significant data and analysis are needed
    - Some options to try to address the problem
        - Divide the drivers into those that have relatively linear effect (drivers – multipliers) and those that affect primarily parts of the life cycle (scale factors in the exponent)
        - Mimic the phase dependent effort multipliers in COCOMO 81
        - Establish a better (more realistic) weighting of the drivers (based on data)
        - Adjust the drivers values to compress the range, but keep the relative
    - *Action: Form a team to investigate the options and address in more detail*
        - *Lead – Gan Wang; Support – Marilee Wheaton, Jared Fortune, Ricardo Valerdi, Rick Selby, Dan Liggett, Jim Cain, Garry Roedler*

- Modeling Organizational Factors in Space Systems (Darryl Webb)
    - Discussed long term experience and observations in impacts of organization factors on cost
    - Different organization models have different effects on the costs
        - Factors include:
            - Number of Interfaces
            - Direct / Indirect interfaces
            - Requirements Volatility
            - Organizational Structure Complexity
    - Analysis of cost and schedule uncertainty showed that all cases fell in the upper right quadrant of the graph for increasing cost plotted against increasing schedule
        - Indicates that we almost always miss accounting for factors, as well as other influences that drive us to overly optimistic estimates
    - A small under-estimation will drive much larger impact, since it drives replanning and rework

- Best Practices (Garry Roedler)

    - Central question: How can misuse of the COSYSMO cost drivers be avoided?
    - Hypothesis: By developing a best practice guide that describes common pitfalls associated with COSYSMO cost drivers, over-estimation can be reduced or avoided.
    - Key areas to focus best practice information
        - Use of Cost Drivers – avoid over/under estimation – tie to linearity assumption – independence – operational considerations
        - Reuse – guidance to ensure consistency across organizations, including effects of opportunistic vs. systematic reuse
        - Consistent use of Recursive Levels – see discussion under the Recursive level agenda topic
    - *Action: Garry Roedler to establish team to develop a set of best practice guidance. Collect and assemble input for review and discussion at October COSYSMO Workshop.*
        - *Team members to work this project – Garry Roedler, Marilee Wheaton, Gan Wang, Ricardo Valerdi, Jared Fortune, John Gaffney*
        - *Dan Liggett will send some guidance he has on best practices*
        - *Ricardo will provide heuristics paper.*

- Cost drivers vs. scale factors (Gan Wang)
    - Central question: Can some of the cost drivers become scale factors in the cost estimating relationship calibrated by the new data set?
    - Hypothesis: The current set of size and cost drivers are too sensitive to small variations in rating levels.
    - Explained and handed out survey for Cost Driver Correlation.
    - *Action: (All) Complete the survey and get it back to Gan by end of Tuesday*
        - *Use both positive and negative correlation*
    - Potential relationship between this and best practice effort.
    - May also have relationship to number of recursive levels.

- Cost Driver Impact Survey Results from Oct ’07 (Gan Wang)
    - Focused on relationship between Requirements Reuse and the Cost drivers
    - Showed some drivers have relationships to Requirements Reuse that can be used to develop some user guidance
        - Positive relationship to Requirements Understanding, Architecture Understanding, and Personnel Experience/Continuity
        - Negative relationship to TRL
    - *Action: (Wang, Roedler) Develop any applicable best practice guidance that is evident from the survey results.*
    - Strong vote to have same reuse categories for all 4 size drivers

- Recursive Levels in the Design (Ricardo Valerdi)
    - Central question: How can the integration complexity of system elements one layer below the system-of-interest be operationalized?
    - Hypothesis: The integration complexity of system elements is a predictor of systems engineering effort.

    - Provided preliminary guidance on the application of recursive levels in the model
    - Significant differences in opinion on how this needs to be addressed
        - Account for all SE work at all levels vs. account for all SE work at System-of-Interest level and one level below vs. some hybrid
    - Need to continue discussion and analysis of this work, including analysis of specific examples, examination of results from alternative approaches for the use of recursive levels, and development of detailed guidance
    - *Action: Ricardo Valerdi to set up a team to do further investigation of the best usage of recursive levels in the design.*

- Joint meeting with SoS cost estimation group (JoAnn Lane)
    - Central question: How can COSYSMO be updated to address system of systems effort estimation?
    - Discussed current investigation of the relationship of the system in the SoS.
        - Does being a part of a SoS cause additional unexpected effort not accounted for in the development of the system?
            - The consensus appeared to be that the inclusion of the system as part of a SoS would be addressed through the requirements, both functional and external interface.
            - The activities associated would be accounted for in the planning and costing of the system
        - Discussed and administered a survey to support this investigation.