RT-181
COSYSMO 3.0:
An Extended, Unified Cost Estimating Model for Systems Engineering

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SYSTEMS ENGINEERING RESEARCH CENTER

Research Task / Overview

Why COSYSMO 3.0?

- The practice of systems engineering is changing
  - Current and future trends create challenges for full-system cost estimation
  - Current development practices can minimize the cost of one phase, such as development, while raising full-system cost
- The intent of COSYSMO 3.0 is to help mitigate this situation by supporting accurate estimates of systems engineering costs. This encourages allowing time for thoughtful systems engineering, supporting:
  - Choosing new technologies that reduce total system cost
  - Systems that support life-cycle flexibility

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Goals & Objectives

Research Hypothesis

- It is possible to develop a systems engineering cost estimating model ("COSYSMO 3.0") with these properties:
  - Is applicable to a wide range of systems engineering projects;
  - Includes all the major features of COSYSMO 1.0 and its extension models, except for interoperability;
  - Provides continuity to users of previous COSYSMO-family models;
  - When calibrated to data from a particular organization, estimates actual systems engineering costs with a PRED(.30) accuracy of 50%.

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Data & Analysis

COSYSMO 3.0 Top-Level Model

$$PH = A \cdot (AdjSize)^{E} \cdot \prod_{j=1}^{15} EM_j$$

Elements of the COSYSMO 3.0 model:

- PH = Estimated effort
- Calibration parameter A
- Adjusted Size model
  - eReq submodel, where 4 products contribute to size
  - Reuse submodel
- Exponent (E) model
  - Accounts for diseconomy of scale
  - Constant and 3 scale factors
- Effort multipliers EM
  - 13 cost drivers

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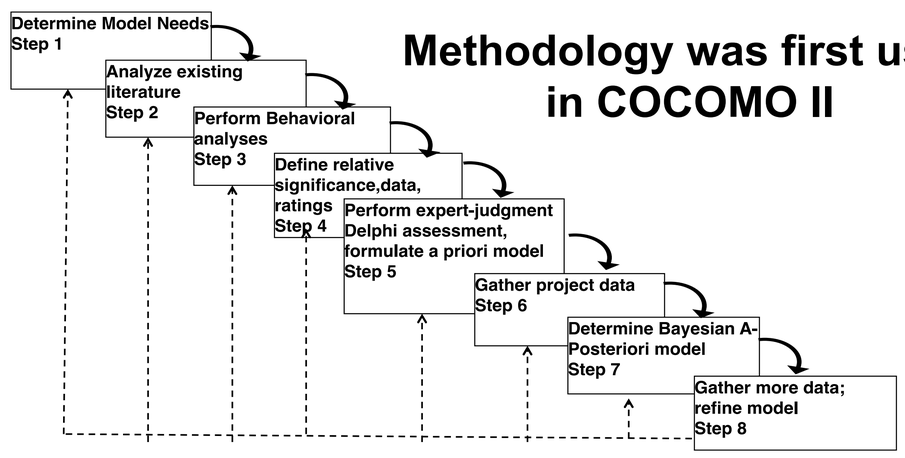
Methodology

USC CSSE Model Creation Methodology



Methodology was first used in COCOMO II

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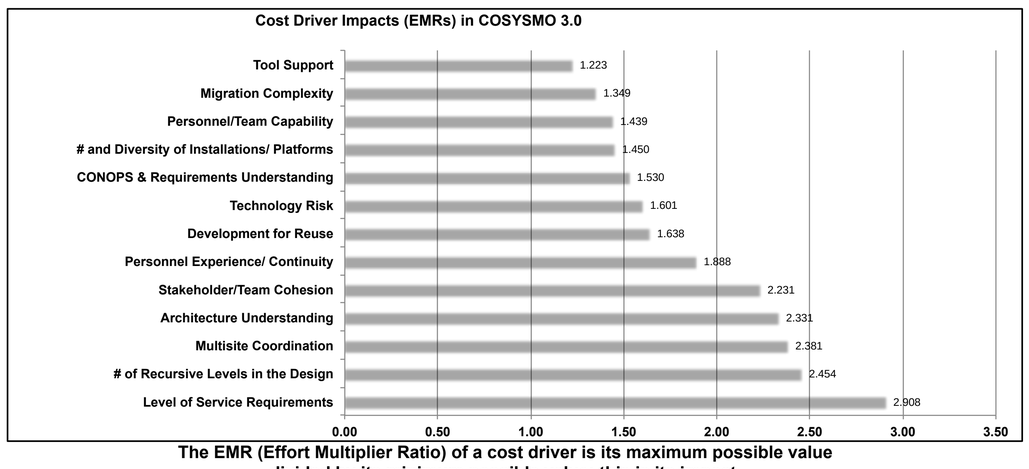
Cost Drivers Vary in their Impact on the Estimate



The EMR (Effort Multiplier Ratio) of a cost driver is its maximum possible value divided by its minimum possible value; this is its impact.

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Methodology Details

- Create "Expert-Based Model"
  - Parameters determined from Delphi sessions
- Obtain a dataset
  - 44 completed projects, with (partial) ratings
- Fit COSYSMO 3.0 parameters
  - Most via Bayesian fit, using Expert-Based Model as prior
  - A few directly from Expert-Based Model
- Demonstrate validity by calibrating model to yield PRED(.30) >= 50%

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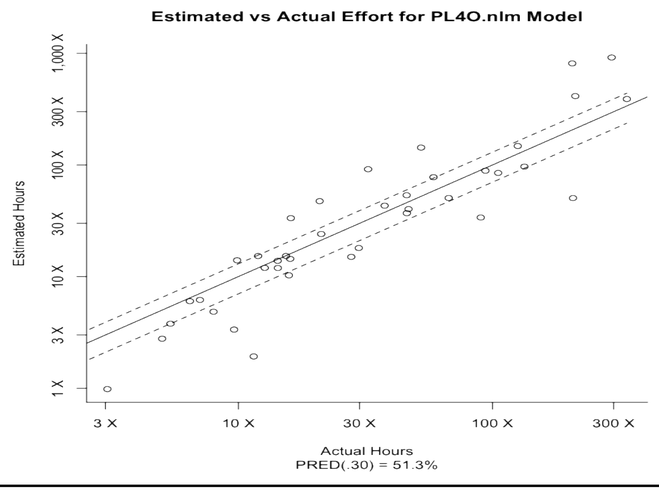
The Model Can Be Calibrated to a Dataset with PRED(.30) >= 50%



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Future Research

Future Research

- Future research topix:
  - Create a validated model for interoperability
  - Create tailored models for different types of project
  - Estimating model for total development cost, based primarily on COSYSMO 3.0 drivers
    - Some work already done at Lockheed-Martin
  - Better integrate activity levels between DWR and DFR

Calibration Took Some Imagination

- A simple-minded fit resulted in either:
  - Some non-credible parameter values; or
  - PRED(.30) < 50%.
- I was able to calibrate by:
  - Dropping a few outliers; and
  - Using a hill-climbing algorithm to find suitable parameter values.

Contacts/References

Contact Information

- Jim Alstad
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  - 310/344-0894 (cell)

- Dissertation:
  - Alstad, JP (2018). COSYSMO 3.0: *An Extended, Unified Cost Estimating Model for Systems Engineering*. Los Angeles CA: USC.

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