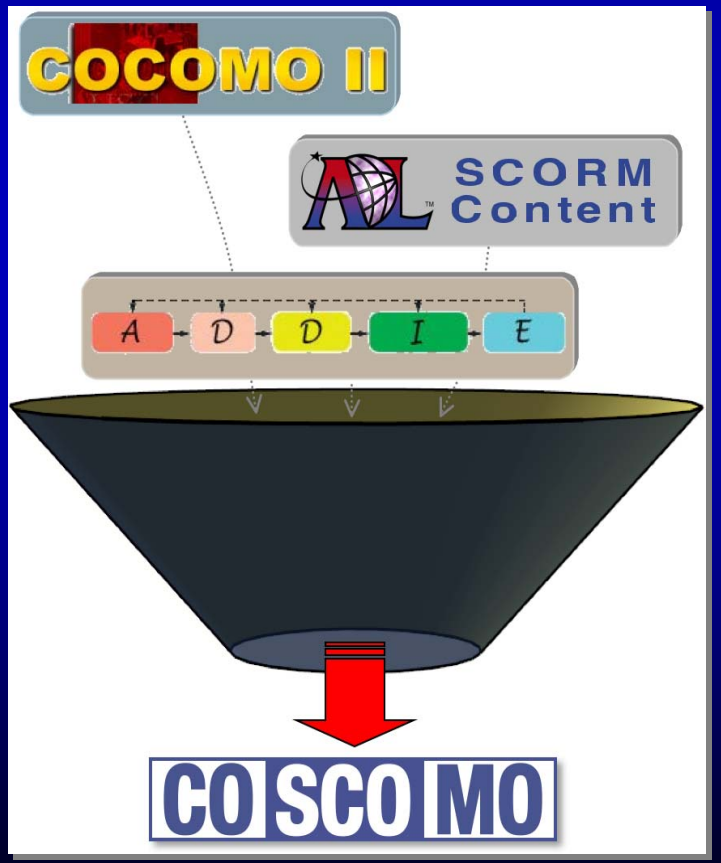
COCOMO and SCORM: Cost Estimation Model for Web-Based Training

Roger Smith
U.S. Army PEO STRI

COSCOMO Prototype Project: Concept

It is challenging for both sponsors and developers to estimate the expected level of effort, duration, and cost of developing web-based SCORM conformant courseware.

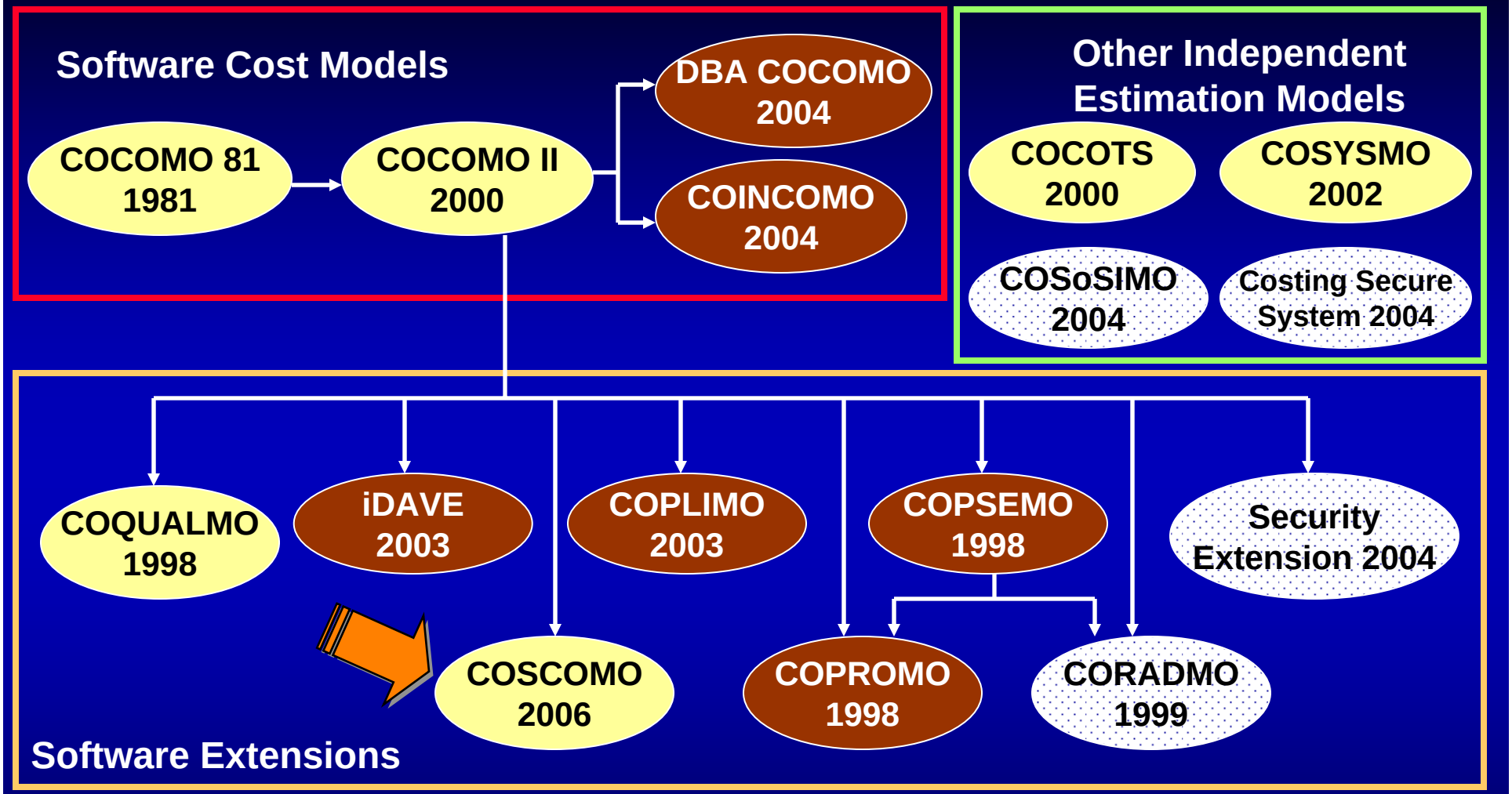
- **Project Goal: create an interactive project estimation tool "COSCOMO" for ISD/SCORM content**
  - Domain focus: ADL Sharable Content Object Reference Model (SCORM) conformant content
  - ISD methodology: Analysis, Design, Development Implementation, Evaluation (ADDIE) model
  - Algorithmic foundation: COCOMO II model for software project estimation



Applicability & Value to Community

- **Consistent, objective, and reliable estimation tool for SCORM content and projects**
- **First step in formalizing an estimation method in the ADL community**
- **Create a tool that other projects can apply, modify, and mature**
  - COCOMO II has been evolving for 25 years.
  - COSCOMO prototype from this project will be the first step in the long evolution and improvement of a tool for this community

COCOMO Model Family



Legend:
Model has been calibrated with historical project data and expert (Delphi) data
Model is derived from COCOMO II
Model has been calibrated with expert (Delphi) data

COSCOMO Algorithm

$$PM = A*(Size)^{E} * \Pi\, EM_i$$

where

$$E = B + 0.01 * \Sigma\, SF_j$$

COCOMO II equation form

COSCOMO algorithm

$$PM = A*(Size)^{E} * \prod_{i=1}^{15} EM_i$$

where

$$E = B + 0.01 * \sum_{j=1}^{5} SF_j$$

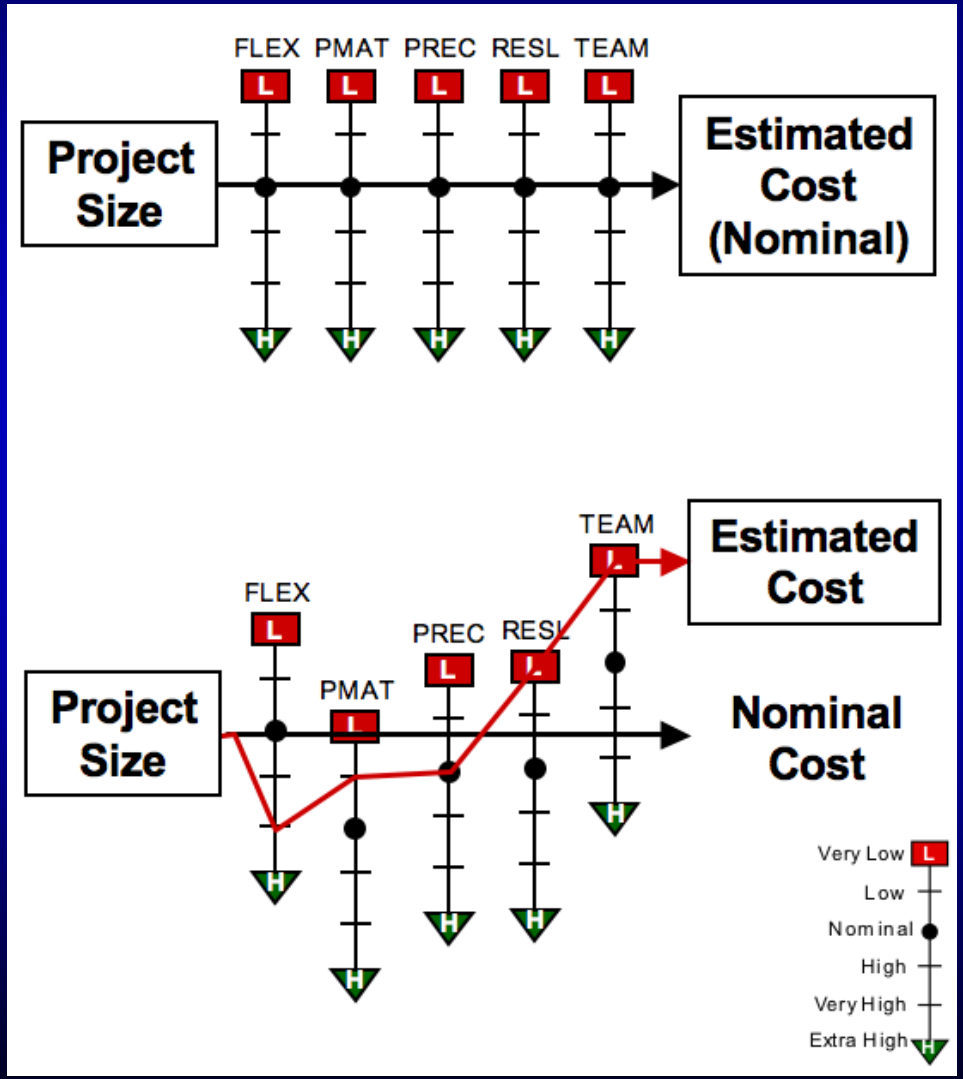
COSCOMO Mods to the COCOMO II Input Variable Set

- **Size**
  - NO – Source Lines of Code (SLOC)
  - NO – Design Modification (DM)
  - NO – Code Modification (CM)
  - NO – Integration (IM)
  - NO – Assessment (AA)
  - NO – Understanding (SU)
  - NO – Unfamiliarity (UNFAM)
  - – Requirements Evolution (REVL)
- **Product Effort Multipliers (EM)**
  - – Required Reliability (RELY)
  - NO – Database Size (DATA)
  - – Product Complexity (CPLX)
  - – Required Reuse (RUSE)
  - – Documentation (DOCU)
- **Platform EM**
  - NO – Execution Time Constraints (TIME)
  - – Main Storage Constraints (STORE)
  - NO – Platform Volatility (PVOL)
- **Personnel EM**
  - – Analyst Capability (ACAP)
  - – Programmer Capability (PCAP)
  - – Personnel Continuity (PCON)
  - – Applications Experience (APEX)
  - – Platform Experience (PLEX)
  - – Language/Toolset Experience (LTEX)
- **Project EM**
  - – Use of Software Tools (TOOL)
  - – Multisite Development (SITE)
  - – Required Development Schedule (SCED)
- **Scale Drivers**
  - – Development Flexibility (FLEX)
  - – Process Maturity (PMAT)
  - – Precedentedness (PREC)
  - – Arch/Risk Resolution (RESL)
  - – Team Cohesion (TEAM)

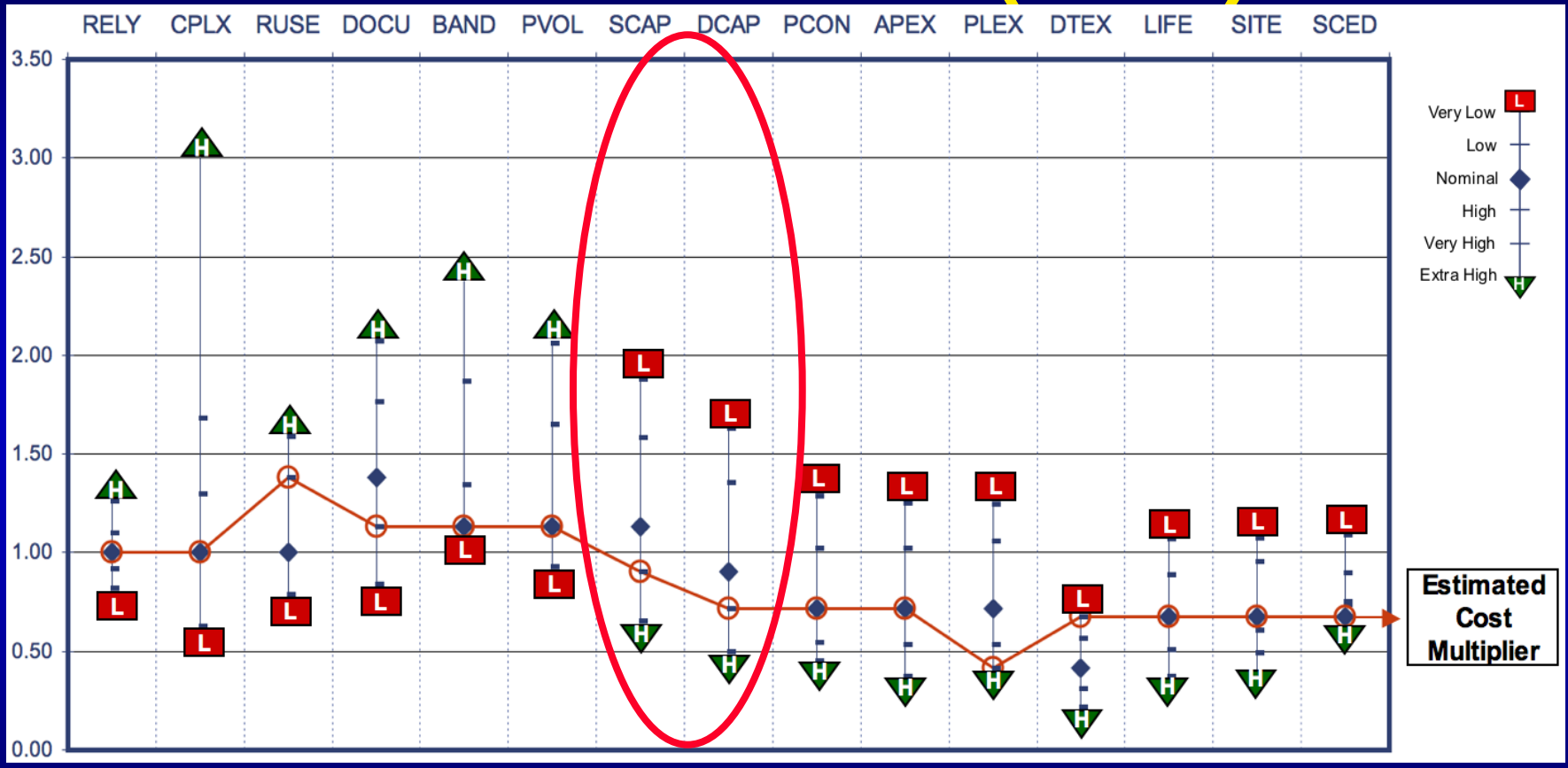
Scale Factors: Effect on Project Cost Estimates on Project Cost

when the input values for the five scale factors are at their default ‘Nominal’ levels, the scale factors have no impact on the estimated cost value

higher than nominal scale factor value levels reduce the estimated cost; lower than nominal scale factor value levels increase the estimated cost

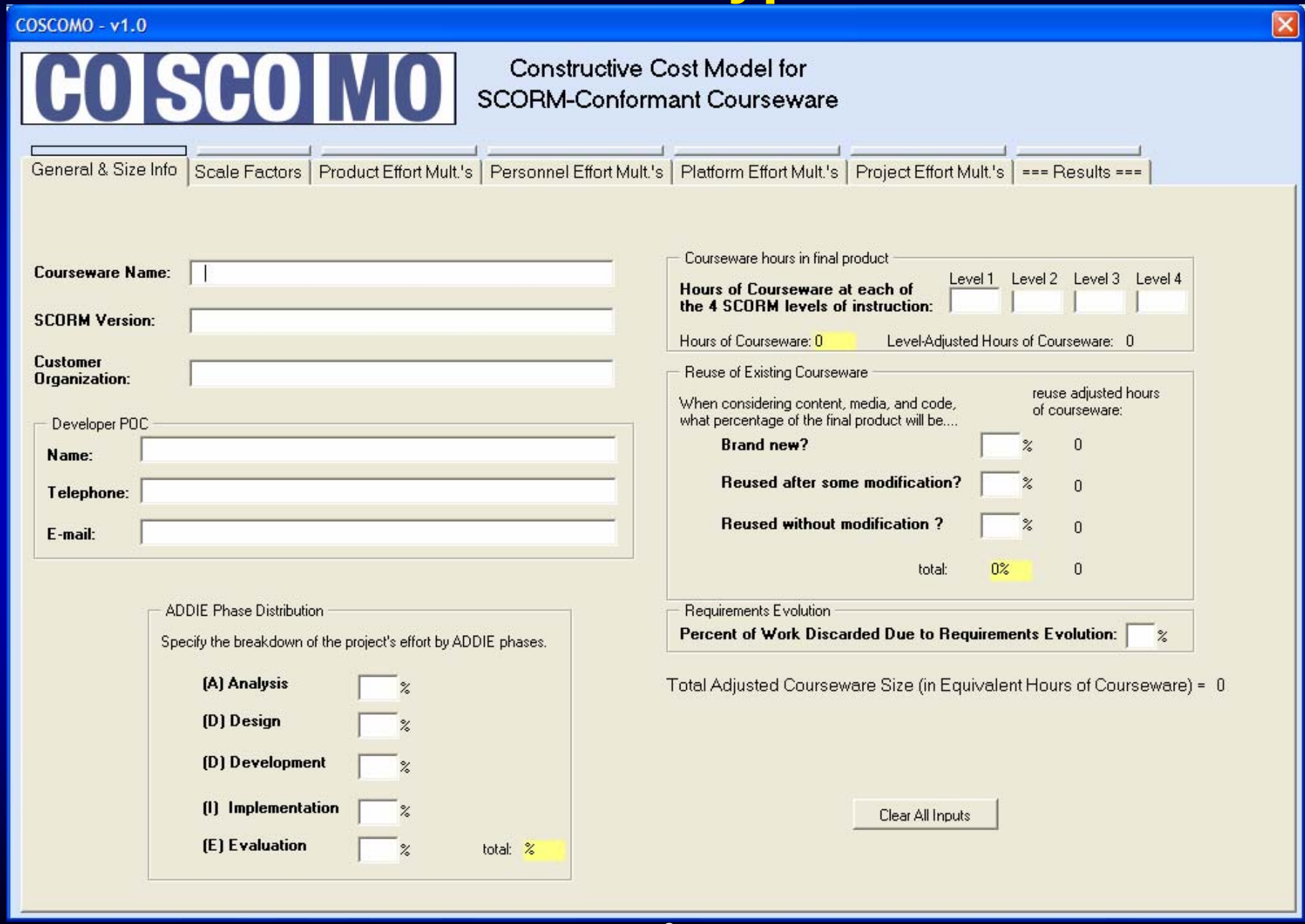


Effort Multipliers: Effect on Project Cost Estimates (con't)

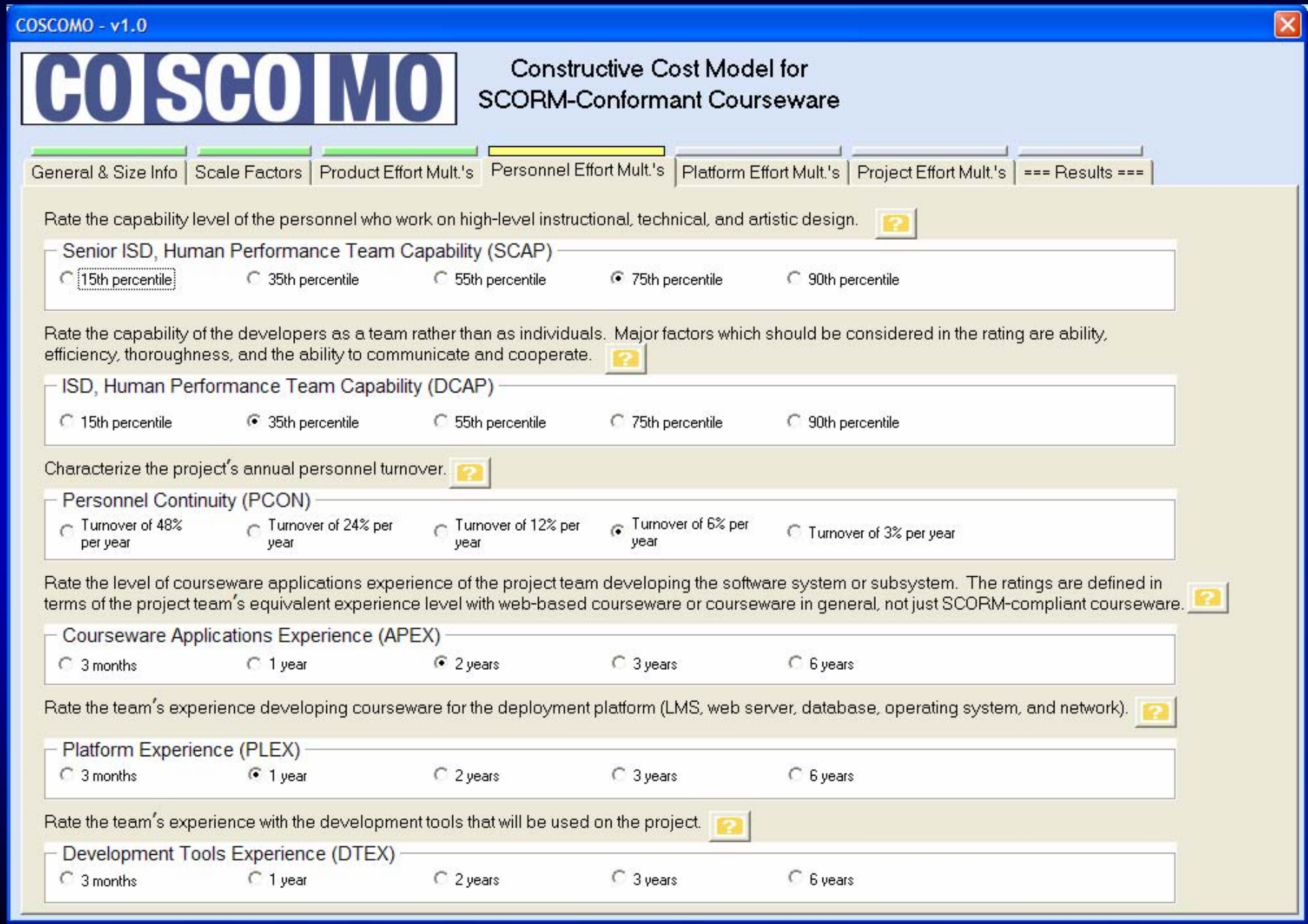


One use of the COSCOMO tool output graph is to aid in identifying which variables are driving the estimate. In this notional graph, high senior team capability (SCAP) and high development team capability (DCAP) are contributing significantly to reducing the project cost.

COSCOMO Tool Prototype - Screenshot #1



COSCOMO Tool Prototype - Screenshot #2



COSCOMO Tool Prototype - Screenshot #3

COSCOMO - v1.0

COSCOMO

Constructive Cost Model for
SCORM-Conformant Courseware

PM = 7.6 Person Months

General & Size Info | Scale Factors | Product Effort Mult.'s | Personnel Effort Mult.'s | Platform Effort Mult.'s | Project Effort Mult.'s | === Results ===

Courseware Size Inputs

Courseware hours in final product

Level 1	Level 2	Level 3	Level 4
8	12	4	2

Reuse of Existing Courseware

75% Brand new

10% Reused after some modification

15% Reused without modification

Size = 29.5 Adjusted Courseware Hours

Estimate = 7.6 Person Months

Person Months Distribution by Phase

20% Analysis => 1.5 Person Months

30% Design => 2.3 Person Months

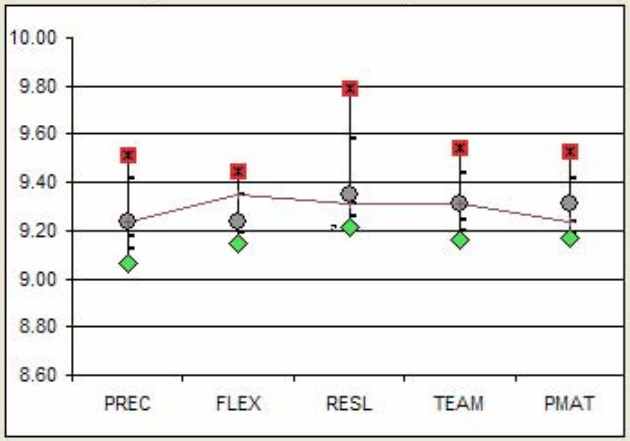
15% Development => 1.1 Person Months

15% Implementation => 1.1 Person Months

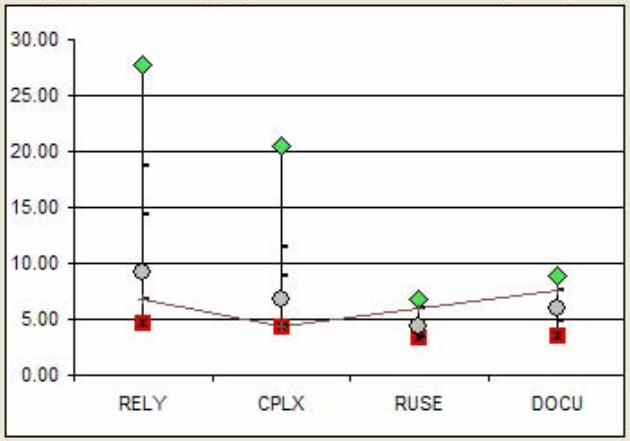
20% Implementation => 1.5 Person Months

Export Data

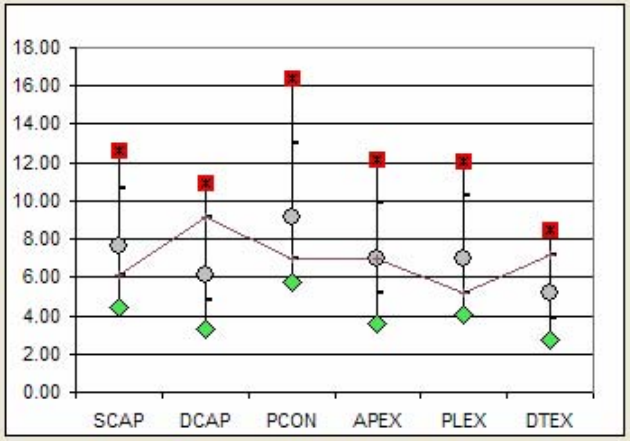
stage 1: Effect of Scale Factor Inputs



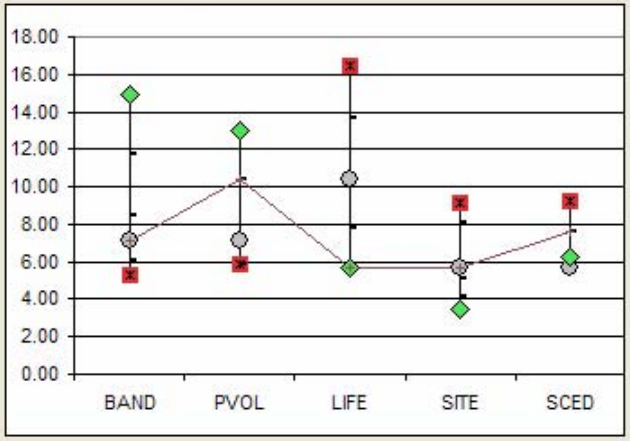
stage 2 (con't from stage 1): Effect of Product Effort Multiplier Inputs



stage 3 (con't from stage 2): Effect of Personnel Effort Multiplier Inputs



stage 4 (con't from stage 3): Effect of Platform & Project Effort Mult.Inputs



Reliability = PRED(30)

- **Reliability of COCOMO family of models is often measured by the percentage of test cases that it will estimate within 30% of the actual project costs**
  - e.g. If a project requires 300 person-months to complete, then its PRED(30) range would be (210 to 390)
  - If the model estimates 70% of its test cases within this range then the model's PRED(30) = 70%
- **COCOMO Family Model Levels**
  - COCOMO II (2000): PRED(30) = 69%
  - COSYSMO: PRED(30) = 56%
- **COSCOMO: PRED(30) = 43%** **(with only 9 initial data points)**

COSCOMO

- **This project is the first step in formalizing a cost estimation method in the ADL community**
  - COSCOMO tool prototype is the first step in the long evolution and improvement of a tool for the ADL community
    - » keep in mind: COCOMO II has been evolving for 25 years
- **Historical project data collection is essential, but it is also very difficult to get access and cooperation from the people with this information**
  - Have currently collected data on 9 projects
  - 40+ projects needed to calibrate the model appropriately
- **GUI prototype of the COSCOMO tool is ready for early adoption by the ADL community**
  - Not a polished, “shrink-wrapped” product, but more refined and user friendly than a raw spreadsheet
  - **Available at http://www.jointadlcolab.org**

Points of Contact

Joint ADL CoLab

Dean Marvin: Dean.Marvin2@us.army.mil
Susan Marshall: Susan.Marshall1@us.army.mil

SPARTA, Inc.

Mike Garnsey: Mike.Garnsey@sparta.com
Lacey Edwards: Lacey.Edwards@sparta.com

PEO STRI

Roger Smith: Roger.Smith14@us.army.mil

General Dynamics Information Technology

Kelly Ward: Kelly.Ward@gdit.com