

COCOMO

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

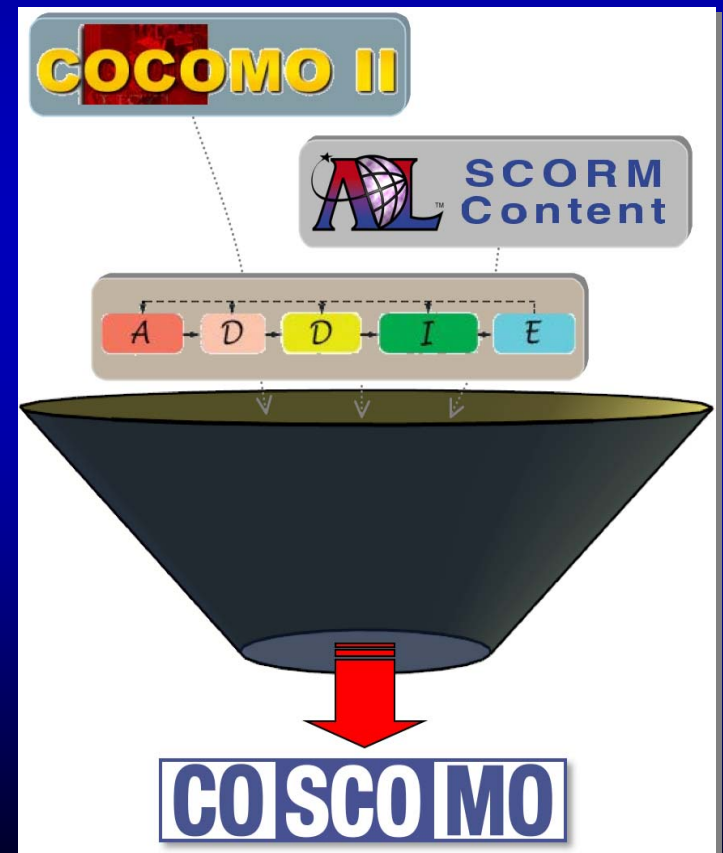
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COSCOMO Prototype Project: Concept

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

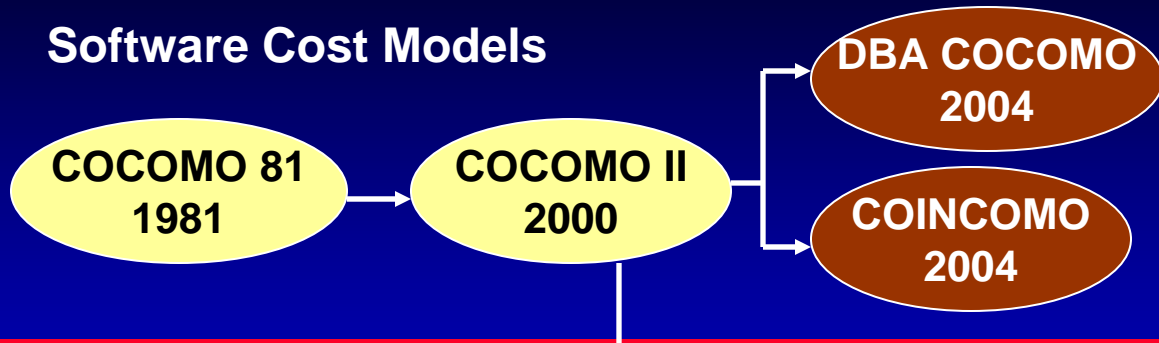


Applicability & Value to Community

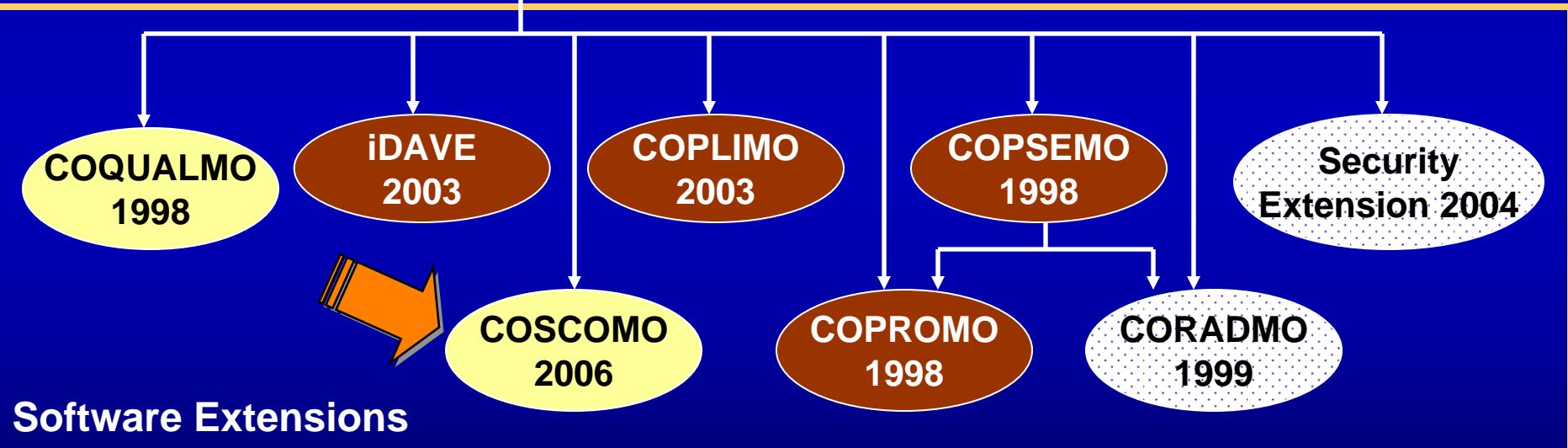
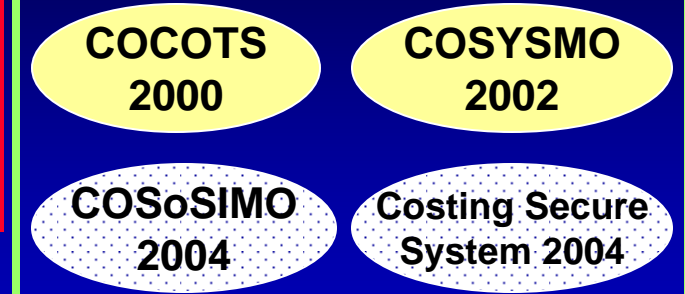
- **Consistent, objective, and reliable estimation tool for SCORM content and projects**
- **First step in formalizing an estimation method in the ADL community**
- **Create a tool that other projects can apply, modify, and mature**
 - COCOMO II has been evolving for 25 years.
 - COSCOMO prototype from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

COCOMO Model Family

Software Cost Models



Other Independent Estimation Models



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

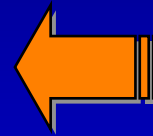


COSCOMO Algorithm

$$PM = A * (Size)^E * \prod EM_i$$

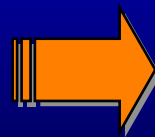
where

$$E = B + 0.01 * \sum SF_j$$



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)

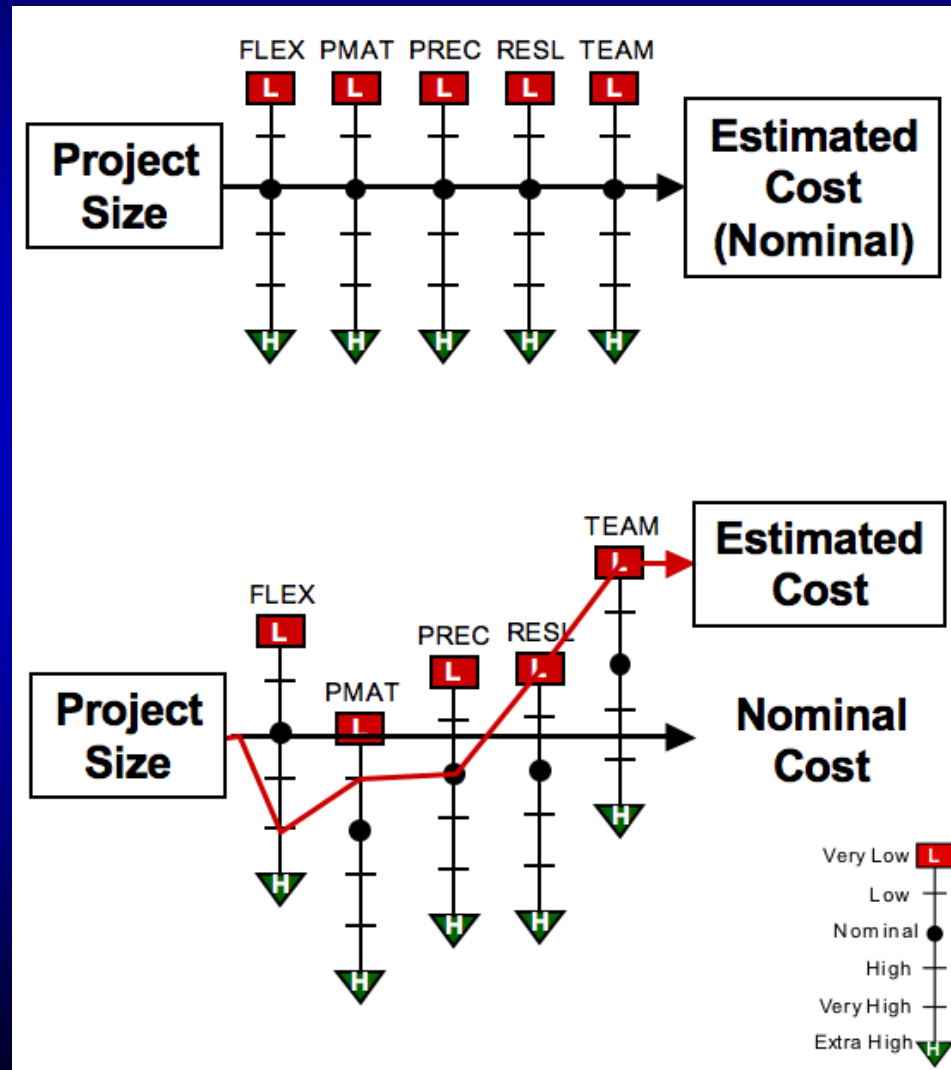
- **Scale Drivers**

- Development Flexibility (FLEX)
- Process Maturity (PMAT)
- Precedentedness (PREC)
- Arch/Risk Resolution (RESL)
- Team Cohesion (TEAM)

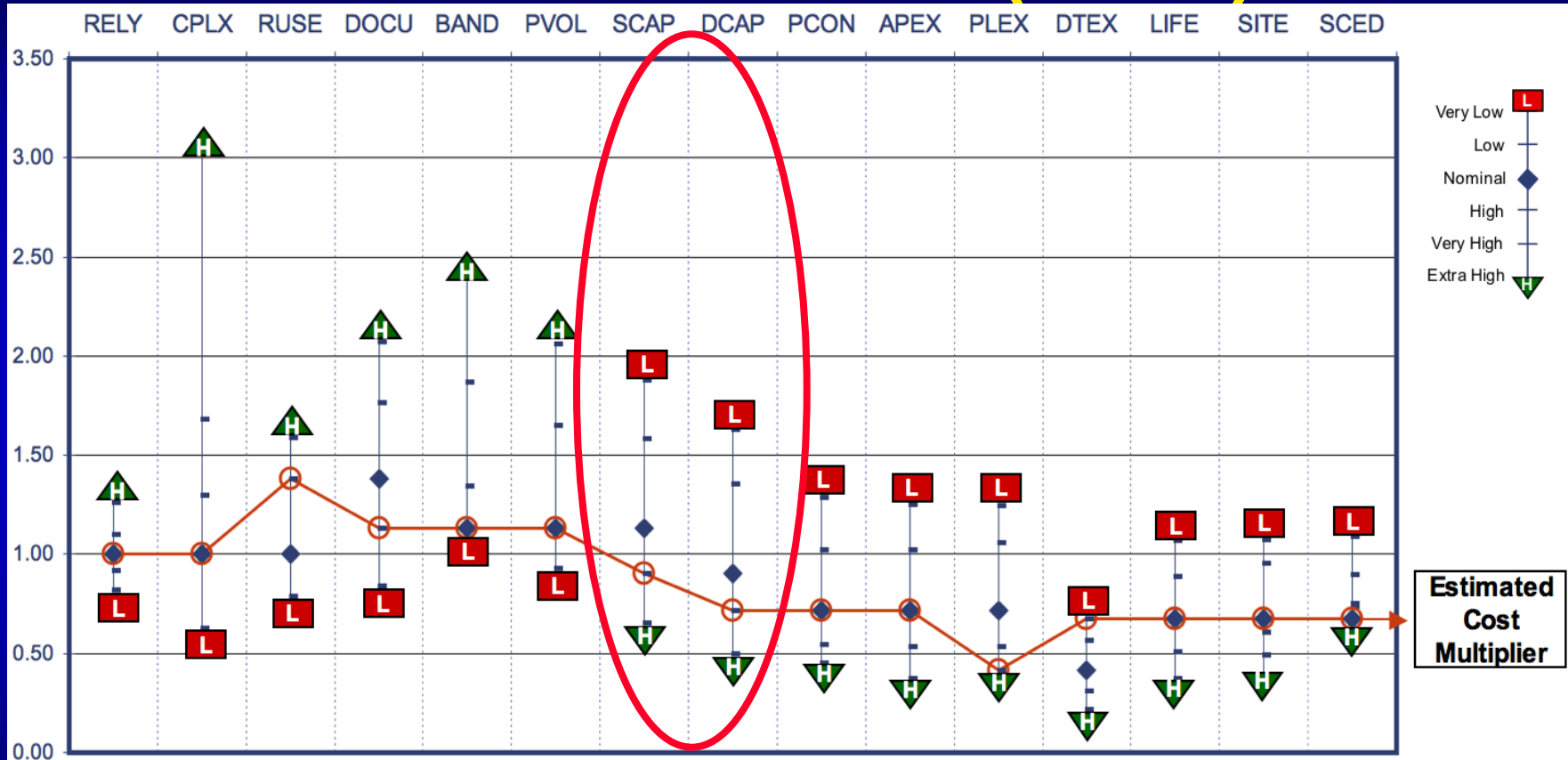
Scale Factors: Effect on Project Cost Estimates on Project Cost

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 - v1.0



Constructive Cost Model for
SCORM-Conformant Courseware

General & Size Info

Scale Factors

Product Effort Mult.'s

Personnel Effort Mult.'s

Platform Effort Mult.'s

Project Effort Mult.'s

=== Results ===

Courseware Name:

SCORM Version:

Customer Organization:

Developer POC

Name:

Telephone:

E-mail:

ADDIE Phase Distribution

Specify the breakdown of the project's effort by ADDIE phases.

(A) Analysis %

(D) Design %

(D) Development %

(I) Implementation %

(E) Evaluation %

total: %

Courseware hours in final product

Hours of Courseware at each of the 4 SCORM levels of instruction:

Level 1

Level 2

Level 3

Level 4

Hours of Courseware: Level-Adjusted Hours of Courseware:

Reuse of Existing Courseware

When considering content, media, and code, what percentage of the final product will be...

reuse adjusted hours of courseware:

Brand new? %

Reused after some modification? %

Reused without modification ? %

total: %

Requirements Evolution

Percent of Work Discarded Due to Requirements Evolution: %

Total Adjusted Courseware Size (in Equivalent Hours of Courseware) =

Clear All Inputs

COSCOMO Tool Prototype - Screenshot #2

COSCOMO - v1.0



Constructive Cost Model for
SCORM-Conformant Courseware

General & Size Info

Scale Factors

Product Effort Mult.'s

Personnel Effort Mult.'s

Platform Effort Mult.'s

Project Effort Mult.'s

=== Results ===

Rate the capability level of the personnel who work on high-level instructional, technical, and artistic design.

Senior ISD, Human Performance Team Capability (SCAP)

- 15th percentile 35th percentile 55th percentile 75th percentile 90th percentile

Rate the capability of the developers as a team rather than as individuals. Major factors which should be considered in the rating are ability, efficiency, thoroughness, and the ability to communicate and cooperate.

ISD, Human Performance Team Capability (DCAP)

- 15th percentile 35th percentile 55th percentile 75th percentile 90th percentile

Characterize the project's annual personnel turnover.

Personnel Continuity (PCON)

- Turnover of 48% per year Turnover of 24% per year Turnover of 12% per year Turnover of 6% per year Turnover of 3% per year

Rate the level of courseware applications experience of the project team developing the software system or subsystem. The ratings are defined in terms of the project team's equivalent experience level with web-based courseware or courseware in general, not just SCORM-compliant courseware.

Courseware Applications Experience (APEX)

- 3 months 1 year 2 years 3 years 6 years

Rate the team's experience developing courseware for the deployment platform (LMS, web server, database, operating system, and network).

Platform Experience (PLEX)

- 3 months 1 year 2 years 3 years 6 years

Rate the team's experience with the development tools that will be used on the project.

Development Tools Experience (DTEX)

- 3 months 1 year 2 years 3 years 6 years

COSCOMO Tool Prototype - Screenshot #3

COSCOMO - v1.0



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

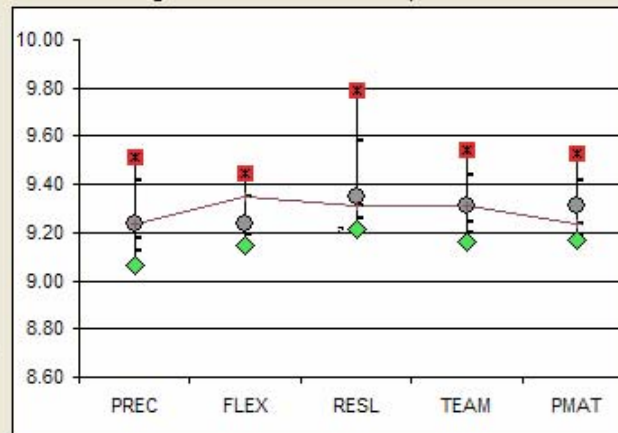
Estimate = 7.6 Person Months

Person Months Distribution by Phase

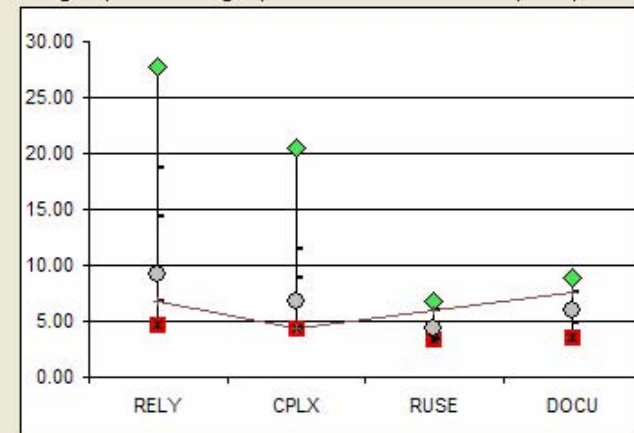
20% Analysis => 1.5 Person Months
30% Design => 2.3 Person Months
15% Development => 1.1 Person Months
15% Implementation => 1.1 Person Months
20% Implementation => 1.5 Person Months

Export Data

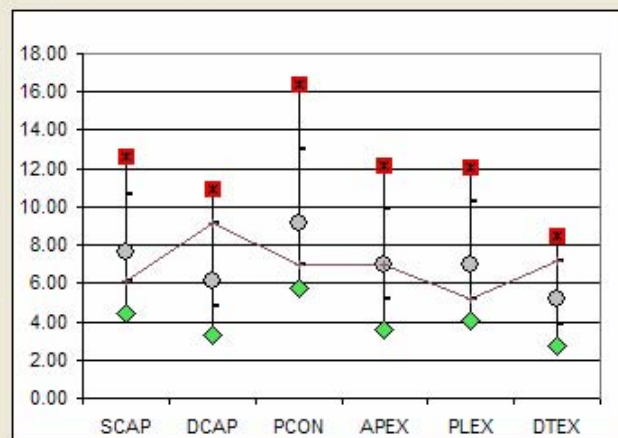
stage 1: Effect of Scale Factor Inputs



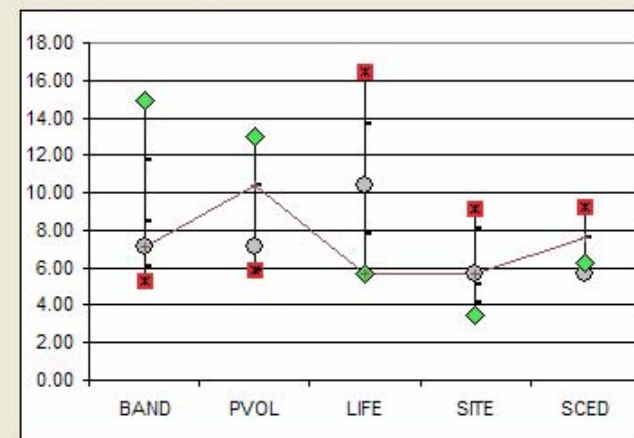
stage 2 (con't from stage 1): Effect of Product Effort Multiplier Inputs



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

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