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

- COCOMO 81 1981
- COCOMO II 2000
  - DBA COCOMO 2004
  - COINCOMO 2004

Other Independent Estimation Models

- COCOTS 2000
- COSYSMO 2002
- COSSoSIMO 2004
- Costing Secure System 2004

Software Extensions

- COQUALMO 1998
- iDAVE 2003
- COPLIMO 2003
- COPSEMO 1998
- CORADMO 1999
- Security Extension 2004
- COSCOMO 2006
- COPROMO 1998

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

\[ PM = A \times (\text{Size})^E \times \prod EM_i \]

where

\[ E = B + 0.01 \times \sum SF_j \]

COCOMO II equation form

\[ PM = A \times (\text{Size})^E \times \prod_{i=1}^{15} EM_i \]

where

\[ E = B + 0.01 \times \sum_{j=1}^{5} SF_j \]
COSCOMO Mods to the COCOMO II
Input Variable Set

• **Size**
  - Source Lines of Code (SLOC)
  - Design Modification (DM)
  - Code Modification (CM)
  - Integration (IM)
  - Assessment (AA)
  - Understanding (SU)
  - Unfamiliarity (UNFAM)
    - Requirements Evolution (REVL)

• **Product Effort Multipliers (EM)**
  - Required Reliability (RELY)
  - Database Size (DATA)
  - Product Complexity (CPLX)
  - Required Reuse (RUSE)
  - Documentation (DOCU)

• **Platform EM**
  - Execution Time Constraints (TIME)
  - Main Storage Constraints (STORE)
  - 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)
  - Precededness (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 #2**

**Constructive Cost Model for SCORM-Conformant Courseware**

- **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 5% 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

Constructive Cost Model for SCORM-Conformant Courseware

PM = 7.6 Person Months

Stage 1: Effect of Scale Factor Inputs

Stage 2 (cont'd from Stage 1): Effect of Product Effort Multiplier Inputs

Stage 3 (cont'd from Stage 2): Effect of Personnel Effort Multiplier Inputs

Stage 4 (cont'd from Stage 3): Effect of Platform & Project Effort Multiplier Inputs

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

Coursware hours in final product:
Level 1: 2
Level 2: 12
Level 3: 4
Level 4: 2

Reuse of Existing Coursware:
75% Brand new
10% Reused after some modification
15% Reused without modification

Size = 29.5 Adjusted Courseware Hours
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)
• 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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