COPROMO

Constructive Productivity Model

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Goals of Presentation

You should get a working overview of the COPROMO

• What it is & how it works
• Principles behind it
• How it's distinct from COCOMO-II

You should learn about ...

• How it supports
  – Strategic Planning
  – Technology/Process Improvement Planning
• How it was used for KBSA Technology Impact Assessment
Outline

Background

Model Definition

Example

Results to Date

Open Issues

Background

Decision assistant for
- Software Engineering Senior Management
- Strategic Planning

Supported by
- Method/Process
- Technology impact evaluation tool

Valuation bases
- COCOMO II.1998/1999 model
- CORADMO
Background (cont.)

Related work: Tool ROI (as a SEDA)
- Based on COCOMO-II.1999
- One driver, more detailed
- Thus, narrower & deeper

COPROMO
- Allows mixed strategies on investments:
  - Tools
  - Process
  - Reuse
  - Training
- Estimates cost of constructing software: bottom line impact
- Estimates projected effects over time


Outline

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Method

Identify prototypical application

Benchmark current developments in domain

Select time frames and technologies

Specify COCOMO-II driver values per technology & time
  - Scale Factors
  - Effort Multipliers: product, platform, personnel and project

Specify CORADMO driver values per technology & time
  - Stage distribution percentages
  - Schedule and Effort multipliers

Run the Evaluator

Evaluator Implementation Model

- COCOMO-II Driver value per strategy over time with rationale
- RAD Driver value per strategy over time with rationale
- COCOMO-II: 1988 for single time and strategy
- CORADMO
  - Inception
  - Elaboration
  - Construction
  - Totals

Impact Charts
Method Specifics

Identify prototypical application:
- Representative of domain
- Average/target size

Benchmark current developments in domain
- Run COCOMO-II on recent projects
- Perform local calibration
- Analyze the driver values
- Select representative values

Select time frames and technologies
- Time frames typically eight to fifteen years; long enough to have technologies evolve and mature
- Technologies: relatively clearly defined
- Technologies: one should be commercial and environs specific

Specify COCOMO-II/CORADMO driver values per technology & time
- Delphi or modified-Delphi (preferred)
- Record driver values over time with rationales (Evaluator Tool designed to assist)
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Example - AFRL Contract Objectives

Assess the near-term and longer-term impact
- of Knowledge-Based Software Assistant (KBSA) technology
- on software cost and schedule

Apply the model to other sources of technology
- Commercial technology
- DARPA/AFRL Evolutionary Design of Complex Software (EDCS) technology
- Combinations of technologies

Determine likely near-term (2006) and longer-term (2013) impact of technologies on model parameter settings
Example Values Used

Project types: Embedded, high-assurance, real-time (EHART) DoD applications
- Critical DoD warfighting software
- Commercial technology investment relatively low
- Protoypical size picked as 100K SLOC

Baseline: COCOMO II data for calibration
- Well-calibrated to 161 projects for effort, schedule

<table>
<thead>
<tr>
<th>Prediction Accuracy</th>
<th>General</th>
<th>Calibrated to Organization</th>
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<tbody>
<tr>
<td>Effort</td>
<td>PRED(.30)</td>
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<tr>
<td>Schedule</td>
<td>PRED(.30)</td>
<td>72%</td>
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</table>

Baseline (cont.):
Subset of 106 1990's projects for current-practice baseline

Average Multiplier for 1990's projects
Example Values Used (cont.)

1998 Baseline (cont.):
COCOMO II 1990's-projects average ratings

- Conservative since organizations with well-collected data are generally more advanced
- Balanced by fact that COCOMO II projects’ average completion year was 1994

Selected time frames and technologies:

- Technologies: KBSA & EDCS (another current initiative)

Technology combinations

- CD: Commercial technology and DoD general practice
- Commercial plus DoD-sponsored technology combinations
  - KG: KBSA-Applications Generations
  - KD: KBSA-Project Decision Support
  - K: both KG and KD
  - E: EDCS
  - EK: both EDCS and KBSA

Focus: potential impact of overall KBSA technology

- Applications generation, including KB domain engineering
- KB project decision support: SE Decision Assistant concept
Example Values Used (cont.)

Driver value selection & rationales

- Dr. Boehm's expert engineering judgement as initial
- Modifications based on feedback to Dr. Boehm
- Rationales updated when values settled

RESL: Architecture/Risk Resolution

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<tr>
<th>Year</th>
<th>CD</th>
<th>KG</th>
<th>KD</th>
<th>E</th>
<th>DK</th>
<th>EK</th>
<th>SF</th>
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<td>2.70</td>
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Significant gains due to open systems technology, commercial OO architecture technology and DoD emphasis on risk management.

- KG: Significant additional gains over CD via domain architectures
- KD: Significant additional gains over CD via architecture and risk advisor technology
- K: Complementary gains from KG and KD
- E: Major additional gains over CD via domain architecture, general architecture technology, high assurance technology, and rationale capture
- EK: Complementary gains from E and KD
TOOL: Use of Software Tools

TOOL: Use of Software Tools

CD: Significant gains due to general tool technology capabilities
KG: Same as CD
KD: Solid gains over CD via rxB decision support tools, particularly in longer term
E: Significant gains over CD due to advanced EDCS tool capabilities, particularly in evolution support and EHART domain tools
EK: Complementary combination.

Size (KSLOC) is the primary determinant of software effort in COCOMO II (and other SCE models).

For COCOMO II, effective size = f(KSLOC or FP, BRAK, ADSI, DM, CM, IM, SU, UNFM).

Baseline is a 100 KSLOC embedded, high-assurance, real-time (EHART) software application.
SIZE: KSLOC (Rationales cont.)

CD: Commercial technology will provide better reuse infrastructure (e.g. ORBs) and some of the componentry technology need for EHART applications. Better requirement's technology will reduce breakage somewhat. The overall effects for EHART applications will be less than the effects for mainstream commercial applications since much of the commercial technology will not fit EHART applications. Significant gains will come from existing DoD initiatives such as the SEI Product Line Systems program.

KD: Same as CD

SIZE: KSLOC (Rationales cont.)

KG, K: Significant gains over CD due to EHART domain-specific architectures, reuse, and application generators

E: Similar domain-specific gains, plus additional reduced breakage due to requirements and rationale capture technology, and reduced software understanding penalties due to software understanding technology

EK: Gains over E due to stronger KB application generator technology
COCOMO-II. 1998 Scale Factors & Multipliers
Projected Over Time for KBSA Evaluation

Results are conservative, particularly for EDCS:
Maintenance savings greater than development savings

- Due to reductions in amount of effort because
  - software understanding
  - redesign
  - recode
  - retest effort
- Particularly via incremental
  - software analysis
  - generation
  - verification technology.

RVHL: Reuse and Very High Level Language

Schedule RVHL: Reuse and Very High Level Language Inception

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<td>CD+KG+KD</td>
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RVHL Projection Rationale

- As indicated under SIZE in the Effort impact analysis, commercial technology and DoD ENAWT domain initiatives will provide some but not much improvement over standard 3GL module reuse.
- Some gains over CD via domain oriented reuse asset identification and decision support.
- Some gains over CD via domain oriented prototype applications generation.
- Significant gains over CD via domain architecture technology and associated prototype applications generation.
- Some complementarity gains from KD and KG.
RVHL: Reuse and Very High Level Language (cont.)

Schedule RVHL: Reuse and Very High Level Language Elaboration

<table>
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<tr>
<th>Year</th>
<th>RVHL Schedule Multipliers Elaboration</th>
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<tbody>
<tr>
<td>1995</td>
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<tr>
<td>2000</td>
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<td>2005</td>
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<td>2010</td>
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RVHL Projection Ratios (Repeats)

Baseline: Relatively low current use/WHM and experience in EHART domain standard 3GL module reuse

CD: Some gains over C0 via domain oriented reuse asset identification and decision support
KD: Complementary gains from KD and KD
E: Significant gains over CD via domain architecture technology and associated prototype application generation
K: Some complement any gains from E and K

Note: RVHL Construction schedule multipliers are all 1.0

Impact of Technologies on Software Effort or Cost

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v1.0 - 02/08/99
Impact of Technologies on Software Schedule

Effect of 50% Reduction in Effort Improvement Factors

Constructive Productivity Model

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Results and Reactions

Example's technical review was favorable

Reaction from affiliates exposed concept
  • Started them thinking about the future
  • See potential benefit in
    – Corporate benchmarking
    – Strategic planning

ODDR&E
  • Saw value as general support for DoD guidelines on investment
Open Issues

Looking for KBSA Technical Impact Assessment tool user/experimenters

Looking for early adopters
- To work with us
- To generate more examples and experience

Areas for future extensions
- Investment cost projections/calculations
- ROI calculations