CORADMO: A Software Cost Estimation Model for RAD Projects

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and

Barry Boehm

ISPA/SCEA 2001 Presentation
Introduction

RAD (Rapid Application Development)
• an application of any of a number of techniques or strategies to reduce software development cycle time

CORADMO
• COCOMO II model extension
• Focuses on software development costs using RAD techniques
Constructive Rapid Application Development Model

- Calculates/predicts
  - schedule (months, M)
  - personnel (P)
  - adjusted effort (person-months, PM)

- Based on
  - Effort and schedule distribution to the various phases
  - Selected schedule driver ratings impacts on the M, P, and PM of each phase.
Six Classes of Strategies for RAD

- Reuse, Very High-level Languages (RVHL)
- Development Process Reengineering (DPRS)
- Collaboration Support (CLAB)
- Architecture, Risk Resolution (RESL)
- Prepositioning Assets (PPOS)
- RAD Capability of Personnel (RCAP)
Background

COCOMO II Schedule shortfalls:
• Reflects a large project model (Effort > 120 PM)
• Duration calculation unreasonable for small projects
• Model does not address RAD strategies

COCOMO II.2000 Duration Calculation
Cube Root Law: Months \( \sim 3.67 \) (Person-Months)\(^f\)
where \(0.28 \leq f \leq 0.34\)

CORADMO differs from COCOMO:
• A square root instead in computing the number of months needed to complete a small project
• Square root law (i.e. \( f = 0.5 \))
COPSEMO

Constructive Phased Schedule and Effort Model

Inputs: the baseline effort and schedule from COCOMO II

Outputs: the effort and schedule by phase needed for CORADMO.

Phases: Inception, Elaboration, Construction, and Transition

Source: MBASE/RUP (Model-Based Architecting & Software Engineering/Rational Unified Process) life-cycle model
COPSEMO Months as F(PM)

- CII-M [Cube Root]
- COPSEMO-M
- M [Square Root]

~3*cube-root (COCOMO II)

Months (M)

Effort (PM)
Physical Model

COCOMO II cost drivers

Baseline Effort & Sched.

COCOMO IL2000 via COCOMO_charts.xls

RESL; Baseline effort, schedule

Effort, schedule by phase; No SCED

Schedule calculated; SCED removed; PM & M distributed per phase

RAD Extension (CoRADMo.xls)

RAD effort, schedule by phase

RVHL

DPRS

CLAB

PPOS

RCAP

Phase Distributions (COPSEMO Extension)

University of Southern California Center for Software Engineering

CSE USC
Results

• Delphi Exercise Forms distributed
• Experts from Academia, Industry and Government
  – Affiliates, Professors, and Researchers
• EMR (Effort Multiplier Range)
  – Highest divided by Lowest across the rating scale for effort
• SMR (Schedule Multiplier Range)
  – Highest divided by Lowest across the rating scale.
<table>
<thead>
<tr>
<th>Phase</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inception – I</td>
<td>10.4</td>
<td>6.61</td>
</tr>
<tr>
<td>Elaboration – E</td>
<td>23.8</td>
<td>6.36</td>
</tr>
<tr>
<td>Construction – C</td>
<td>70.6</td>
<td>13.19</td>
</tr>
<tr>
<td>Total I, E, &amp; C</td>
<td>104.8</td>
<td>4.80</td>
</tr>
</tbody>
</table>
% Schedule per phase

<table>
<thead>
<tr>
<th>Phase</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Inception – I</td>
<td>16.6</td>
<td>7.06</td>
</tr>
<tr>
<td>Elaboration – E</td>
<td>31.7</td>
<td>7.10</td>
</tr>
<tr>
<td>Construction – C</td>
<td>62.7</td>
<td>11.46</td>
</tr>
<tr>
<td>Total I, E, &amp; C</td>
<td>110.9</td>
<td>8.12</td>
</tr>
</tbody>
</table>
## Reuse, Very High-level Languages

Degree to which re-use of artifacts other than code and/or very high-level languages are utilized

<table>
<thead>
<tr>
<th>RVHL</th>
<th>EMR</th>
<th>SMR</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
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</tr>
<tr>
<td>Inception</td>
<td>1.23</td>
<td>0.11</td>
</tr>
<tr>
<td>Elaboration</td>
<td>1.26</td>
<td>0.08</td>
</tr>
<tr>
<td>Construction</td>
<td>1.14</td>
<td>0.18</td>
</tr>
</tbody>
</table>
Development Process Reengineering

Measures the degree to which the project and organization allow and encourage streamlined or reengineered development processes

<table>
<thead>
<tr>
<th>DPRS</th>
<th>EMR</th>
<th>SMR</th>
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<tbody>
<tr>
<td></td>
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<td>Standard Deviation</td>
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<tr>
<td>Inception</td>
<td>1.32</td>
<td>0.12</td>
</tr>
<tr>
<td>Elaboration</td>
<td>1.24</td>
<td>0.06</td>
</tr>
<tr>
<td>Construction</td>
<td>1.29</td>
<td>0.12</td>
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</table>
Collaboration Support
Accounts for Multisite tool support plus special collaboration tools, yields a reduced effect on schedule and effort

<table>
<thead>
<tr>
<th>CLAB</th>
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<th>SMR</th>
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<tr>
<td>Construction</td>
<td>1.20</td>
<td>0.13</td>
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</table>
# Architecture, Risk Resolution

Same as COCOMO II RESL

<table>
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<tr>
<th>RESL</th>
<th>EMR</th>
<th>SMR</th>
</tr>
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<tbody>
<tr>
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<td>Mean</td>
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<td>1.11</td>
<td>1.08</td>
</tr>
<tr>
<td></td>
<td>0.17</td>
<td>0.10</td>
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<tr>
<td>Elaboration</td>
<td>1.11</td>
<td>1.06</td>
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<tr>
<td></td>
<td>0.13</td>
<td>0.11</td>
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<td>1.20</td>
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<td></td>
<td>0.12</td>
<td>0.20</td>
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Prepositioning Assets

Degree to which assets are pre-tailored to a project and furnished to the project for use on demand

<table>
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</thead>
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<td></td>
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<td>Standard Deviation</td>
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<tr>
<td>Inception</td>
<td>1.14</td>
<td>0.09</td>
</tr>
<tr>
<td>Elaboration</td>
<td>1.14</td>
<td>0.11</td>
</tr>
<tr>
<td>Construction</td>
<td>1.17</td>
<td>0.14</td>
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RAD Capability of Personnel

Personnel effects associated with the degree to which the personnel is familiar with RAD

<table>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>Inception</td>
<td>1.50</td>
<td>0.26</td>
</tr>
<tr>
<td>Elaboration</td>
<td>1.48</td>
<td>0.13</td>
</tr>
<tr>
<td>Construction</td>
<td>1.50</td>
<td>0.14</td>
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Example

With RCAP = Nominal => PM=25, M=5, P=5
Result: The square root law: 5 people for 5 months: 25 PM

With RCAP=XH (Extra High) => PM=20, M=2.8, P=7.1
Result: A super team can put on 7 people and finish in 2.8 months: 20 PM

With RCAP = XL (Extra Low) => PM=30, M=7, P=4
Result: Trying to do RAD with an unqualified team makes them less efficient (30 PM)
RCAP Effort/Schedule Effect

\[ M \]

\[ PM \]

- \( 3.7 \) (Cube root)
- \( 3 \) (Cube root)
- Square root

RCAP = XL
RCAP = XH
Next Steps

• Possible removal of drivers
  - e.g., RVHL and RESL drivers
• Complete another Delphi Round
• Analyze Data from RAD projects
• Bayesian Analysis
• Calibrate Model
How you can help

• Leave me your contact information
  - E-mail address
  - Phone number
  - Business card
• Take my business card
• Send e-mail to fakharza@usc.edu
• Seeking:
  - RAD Experts for Delphi
  - RAD Data