Tool Ratings and Effects on Software Development Effort

Jongmoon Baik
USC-CSE Annual Research Review
Feb 8, 1999

Presentation Outline

• Motivation
• Technical Approach
• CASE Tool Rating Scale
• ROI Analysis for CASE Tool Adoption
• Results to Date
• Future Work
Motivation

- Very Simple Tool Rating Scale in COCOMOII Model
- Strong Statistical Significance of TOOL Effect on Effort & Schedule
- Possible Correlations and Overlaps with Other Parameters

COCOMOII TOOL Rating Scale

<table>
<thead>
<tr>
<th>Rating</th>
<th>CASE Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>Edit, code, debug</td>
</tr>
<tr>
<td>Low</td>
<td>Simple, front-end CASE, back-end CASE</td>
</tr>
<tr>
<td>Nominal</td>
<td>Basic life cycle tools, Moderately integrated</td>
</tr>
<tr>
<td>High</td>
<td>Strong mature life cycle tools, Moderately integrated</td>
</tr>
<tr>
<td>Very High</td>
<td>Strong, mature, proactive life cycle tools, Well integrated with processes, methods, reuse</td>
</tr>
</tbody>
</table>

- No Comparison of the Same Kind of Tools
- No Clear Definition of Tools
- Possible Interactions with Other Factors
COCOMOII.1999 Productivity Range

COCOMOII.1999 Bayesian TOOL Analysis

161 Projects

Statistically Significant: $t > 1.96$
Distribution of TOOL Ratings

From COCOMO II 1999 161 Data

Correlations of TOOL with Others

- TOOL Ratings Largely Orthogonal to Other Ratings
  - PMAT only correlation higher than 0.4 for 161 COCOMO II projects
  - May be complex size interactions (e.g., GUI-builder tools)
Presentation Outline

- Motivation
- Technical Approach
  - CASE Tool Rating Scale
  - ROI Analysis for CASE Tool Adoption
  - Results to Date
  - Future Work

Technical Approach

- Establish a tool rating framework that more effectively correlates COCOMO II TOOL ratings with relative effort
- Perform more in-depth analysis of tool interactions with other factors and effects on software development effort
- ROI Analysis that relates CASE tool costs to savings
Presentation Outline

- Motivation
- Technical Approach
- CASE Tool Rating Scale
- ROI Analysis for CASE Tool Adoption
- Results to Date
- Future Work

New Tool Rating Scale:
Activity Coverage

- Basis of Tool Rating Scale
  - Breadth of Activity Coverage
    - Specification, Analysis, Design, Programming, Test, CM, QA, Collaboration, Management, etc.
  - Degree of Tool Integration
    - CMM Tool/Process Integration Support
  - Tool Maturity and User Support
Software Tools Coverage by Activity

Tool-Use Characteristics at CMM Levels

CMU/SE-94-TR-007
Alan M. Christie
CASE Tool Rating Scale

- 3 Individual Rating Scales
  - Completeness of Activity Coverage
  - Degree of Tool Integration
  - Tool Maturity and User Support

- Weighted-Sum or Subjective Combination of Individual Ratings

CASE Tool Rating Scale (Cont.)

<table>
<thead>
<tr>
<th>Completeness of Activity Coverage</th>
<th>Degree of Tool Integration</th>
<th>Tool Maturity and User Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>Low</td>
<td>Very Low</td>
</tr>
<tr>
<td>Low</td>
<td>Very Low</td>
<td>Low</td>
</tr>
<tr>
<td>Nominal</td>
<td>Low</td>
<td>Very Low</td>
</tr>
<tr>
<td>High</td>
<td>Very Low</td>
<td>Low</td>
</tr>
<tr>
<td>Very High</td>
<td>Very Low</td>
<td>Low</td>
</tr>
<tr>
<td>Extra high</td>
<td>Very Low</td>
<td>Low</td>
</tr>
</tbody>
</table>


- Version in pre-release phase. Simple documentation and help.
- Version in period of less than 6 months. Up-dated documentation and help available.
- Version in period of between 6 months and 1 year. Good documentation and help available.
- Version in period of between 1 and 2 years. Limited documentation and help available.
- Version in period of between 2 and 3 years. Some level of documentation and help available.
- Version in period of more than 3 years. Fully Consistent among Process Assumptions and Object Semantics.

- Distributed-Associative Repository. Extended Point-to-Point Message Passing for Tool Activation.
- Fundamental Incompatibilities among Process Assumptions and Object Semantics.
Presentation Outline

- Motivation
- Technical Approach
- CASE Tool Rating Scale
- ROI Analysis for CASE Tool Adoption
- Results to Date
- Future Work

Simple ROI Analysis for CASE Adoption

CASE Expenditures

1. Initial Investment:
   1.1 Technical Assessments
   1.2 CASE Software
   1.3 Tool Tailoring and Integration
   1.4 Skill Development/Training
   1.5 Tool Consultants
   1.6 Workstations

2. Ongoing Operations: x Years
   2.1 Tool Support Group
   2.2 Software Upgrades/Maintenance
   2.3 Ongoing Training
   2.4 Workstation Maintenance

\[ \text{CASE}_{\text{expenditure}}(t) = \sum_{i=1}^{m} I_i + \sum_{j=1}^{n} O_j \]

\( m \): the number of Initial investment items
\( n \): the number of Ongoing investment items

COCOMO Benefit Parameters

\[ \text{TOOL}(t) = f(\text{Coverage, Integration, Maturity}(t)) \]
\[ \text{LTEX}(t) = f(\text{LTEX}_{\text{premise}}, \text{TOOL}(t), \text{Training}(t)) \]

Adapted from Clifford C. Haff, ACM Communications, April 1992
Presentation Outline

- Motivation
- Technical Approach
- CASE Tool Rating Scale
- ROI Analysis for CASE Tool Adoption
- Results to Date
- Future Work
Results to Date

- Low Correlation between TOOL and Other Cost Drivers
  - PMAT: Highest at 0.41
- Refined aspects of tools
  - From 6 Dimensions
    - Vendor Support, Methodology Support, Consistency/Integrity/Integration, Workgroup/Team Support, Customization, Error Handling/Control
  - To 3 Dimensions
    - Completeness of Activity coverage, Degree of Integration, User Support/Maturity
- TOOL driver: Statistically Significant in regression analysis of 161 projects
  - $t = 2.49$ (Vs. 1.96 significance threshold)

Presentation Outline

- Motivation
- Technical Approach
- CASE Tool Rating Scale
- ROI Analysis for CASE Tool Adoption
- Results to Date
- Future Work
Future Work

- Refine behavioral analysis of TOOL effects
  - Investigate TOOL/SIZE/COMPLEXITY interactions
- Data Collection for interactions among TOOL rating scales
- Determine weights of individual CASE TOOL rating-scale effects on S/W development effort
- Tool Support for ROI Analysis of CASE tool adoption
- Integration of ROI Analyzer with USC-COCOMOII