Experience with the COCOMO II Application Point Model

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Topics Covered

- Objective: Investigate Utility of Application Point Model
- Project Description
  - Product
  - Process
- Analysis
  - Estimates
  - Actuals
  - Productivity
  - Discussion
- Topics for Future Research
Project Overview (1 of 2)

• Product: A project management system for Government contracts
  – Task Order Management, Cost tracking and analysis
  – Generate invoices and detailed cost reports
  – Provide access to General Project Information
  – Web access to reports for SAIC, subcontractors, and customers

• Architecture: Built on standard commercial technology
  – Data and web servers (SQL Server 7.0)
  – Normalized data base
  – Simple interfaces with other systems (downloaded 2 tables)
  – Access based on user’s role and assignments
  – Power users needed high capacity access (WIN32)
Project Overview (2 of 2)

• Process: JAD supported by RAD
  – Several application domains involved
  – Used Microsoft Access to prototype screens
  – Used Microsoft Excel to format reports
  – Small dedicated core team of four good developers
  – Full-time expert served as Chief Engineer, trainer, and mentor

• Project: Schedule-driven (6.5 months)
  – Schedule:
    15AUG99 – Project Kickoff
    01MAR00 – Target for release 1 (200 calendar-days)
    13APR00 – Release 1 operational (243 calendar-days)
  – Funding: Internal sources
  – Stakeholders: Hard to secure commitment
Project Chronology

04aug99  Published “Product Overview”
05aug99  Defined “Project Goals”
15aug99  Project Kickoff
22sep99  Completed information model
23sep99  Started prototyping tables and “bare bones” screens in Access (for user feedback)
01nov99  Added Contracts/Subcontracts as stakeholders
18nov99  Major review of all screens and logic by SMEs from all functional areas.
06jan00  Discovered that the billing rules supplied by the SMEs were incorrect. (This necessitated a complete redesign of 6 data tables for rate loading.)
25jan00  Completed redesign of the data tables for rate loading (now 20 tables)
31jan00  Began independent testing (Build 01)
01mar00  Target date for Release 1.0
13apr00  Release 1.0 began operation (Build 8)
Initial Estimates (1 of 2)

• Assumptions and Rationale
  – Many data tables due to highly modular, reconfigurable design
  – “# & source of data tables” is “8+” ⇒ Medium
  – “# views” is “< 3” ⇒ Medium
  – No reuse

• Application Size

<table>
<thead>
<tr>
<th>Object</th>
<th>Number</th>
<th>Weight</th>
<th>Application Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screens</td>
<td>57</td>
<td>2</td>
<td>114</td>
</tr>
<tr>
<td>Reports</td>
<td>70</td>
<td>5</td>
<td>350</td>
</tr>
<tr>
<td>3GL</td>
<td>4-6</td>
<td>10</td>
<td>40-60</td>
</tr>
</tbody>
</table>

Total = 504-524
Initial Estimates (2 of 2)

• Developer productivity
  – Developers good but learning new domain*
    ⇒ Experience is LOW-NOM
  – We chose the latest Microsoft Windows technology
    ⇒ ICASE maturity is LOW-NOM
  – Estimated productivity is 7-13 NAP/PM
  – 152 phrs/PM

• Development Effort

\[ E_{\text{LOW}} = \frac{504 \text{ AP}}{13 \text{ AP/PM}} = 38.8 \text{ PM} \approx 5900 \text{ phrs} \]

\[ E_{\text{HIGH}} = \frac{524 \text{ AP}}{7 \text{ AP/PM}} = 74.9 \text{ PM} \approx 11,400 \text{ phrs} \]
Odyssey Builds By Date

![Graph showing builds by date](image-url)

Elapsed Days Since 01feb00

- Tables
- "Views"
- "Reports"
- "Forms"
- "Modules"
Updated Estimates

• Calculations

<table>
<thead>
<tr>
<th>Object</th>
<th>Number</th>
<th>Weight</th>
<th>Application Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screens</td>
<td>141</td>
<td>2</td>
<td>282</td>
</tr>
<tr>
<td>Reports</td>
<td>6</td>
<td>5</td>
<td>30</td>
</tr>
<tr>
<td>3GL</td>
<td>14</td>
<td>10</td>
<td>140</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Total = 452</strong></td>
</tr>
</tbody>
</table>

• Calculations

\[
\text{Effort}_{\text{Low}} = \frac{452}{13} = 34.8 \text{PM} = 5285 \text{phrs}
\]

\[
\text{Effort}_{\text{High}} = \frac{452}{7} = 64.6 \text{PM} = 9815 \text{phrs}
\]
Release 1 Effort (15Aug99 – 14Apr00)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Total Effort (phrs)</th>
<th>%</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMEs</td>
<td>341.75</td>
<td>5.2</td>
<td>---</td>
</tr>
<tr>
<td>DEV (includes CM of EDL &amp; Sys. Admin)</td>
<td>4843.50</td>
<td>73.9</td>
<td>77.9</td>
</tr>
<tr>
<td>TEST</td>
<td>722.50</td>
<td>11.0</td>
<td>11.6</td>
</tr>
<tr>
<td>UM, Help, Training*</td>
<td>109.00</td>
<td>1.7</td>
<td>1.8</td>
</tr>
<tr>
<td>MGT, QA</td>
<td>540.00</td>
<td>8.2</td>
<td>8.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6556.75</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total W/O SMEs</strong></td>
<td><strong>6215.00</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Training was only planning, and collecting information. The reason is the first release was only to be used by people who were on the test team and so already knew how to use the tool. The final course materials were produced later. Thus, the reported value is low for a “complete” product.*
Analysis of Development Effort

<table>
<thead>
<tr>
<th>Object</th>
<th>Number</th>
<th>Effort (phrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reports (simple)</td>
<td>6</td>
<td>500-600</td>
</tr>
<tr>
<td>Reports (complex)</td>
<td>1</td>
<td>400-600</td>
</tr>
<tr>
<td>Data Base Tables*</td>
<td>110-180</td>
<td>~2000</td>
</tr>
<tr>
<td>Screens</td>
<td>141</td>
<td>3100-3200</td>
</tr>
<tr>
<td><strong>TOTAL =</strong></td>
<td></td>
<td>6200</td>
</tr>
</tbody>
</table>

*Normal plus lookup (split was ~50:50) was 111. There were also 67 views.
## Comparison of Production Coefficients (phrs/item)

<table>
<thead>
<tr>
<th>Object</th>
<th>Our Estimates</th>
<th>Banker et al (Table 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screen</td>
<td>22-23</td>
<td>16</td>
</tr>
<tr>
<td>Reports (simple)</td>
<td>60-100</td>
<td>40</td>
</tr>
<tr>
<td>Reports (complex)</td>
<td>500</td>
<td>---</td>
</tr>
<tr>
<td>3GL Modules</td>
<td>---</td>
<td>80</td>
</tr>
<tr>
<td>Rule Set</td>
<td>---</td>
<td>24</td>
</tr>
<tr>
<td>Data Tables</td>
<td>11-18</td>
<td>---</td>
</tr>
</tbody>
</table>
## Comparison with Feature Points

<table>
<thead>
<tr>
<th>FP Item</th>
<th>Our Item</th>
<th># Items</th>
<th>Weight</th>
<th>Product (Raw FPs)</th>
<th>Aggregated</th>
<th>FP %</th>
<th>Our Effort %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Forms</td>
<td>141</td>
<td>4</td>
<td>564</td>
<td>564</td>
<td>80</td>
<td>50-52</td>
</tr>
<tr>
<td>Output</td>
<td>Reports</td>
<td>8^</td>
<td>5</td>
<td>40</td>
<td>40</td>
<td>6</td>
<td>16-18</td>
</tr>
<tr>
<td>Query</td>
<td>(Included in forms)</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ILF</td>
<td>Data Group</td>
<td>9</td>
<td>7</td>
<td>63</td>
<td>77</td>
<td>11</td>
<td>32</td>
</tr>
<tr>
<td>EIF</td>
<td>Data File</td>
<td>2</td>
<td>7</td>
<td>14</td>
<td>14</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Algorithm</td>
<td>Algorithms</td>
<td>6^</td>
<td>3</td>
<td>18</td>
<td>18</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

|               |               |         |        | 699               | 699        | 100  | 100          |

^5 CDRLS + Invoice. Invoice and CPR count as two each!
*(CPFF, T&M, FFP) x (Proposal, Invoice) = 6*
## Comparison of Estimated Effort to Our Data

<table>
<thead>
<tr>
<th>Type of Design Activity</th>
<th>Object (&amp; Application) Points</th>
<th>Function/Feature Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Base (data groups)</td>
<td>Totally Ignored</td>
<td>About 2-3 x low</td>
</tr>
<tr>
<td>Screen (form, display)</td>
<td>Comparable with our data (especially if include action routines)</td>
<td>About 60% too high</td>
</tr>
<tr>
<td>Reports</td>
<td>About 1.5-2.5 x low</td>
<td>About 3 x low</td>
</tr>
</tbody>
</table>
Speculations

• Object and Application Points
  – Focus on user interface aspect
  – Tacitly assume data repository exists
    (Legacy system in back office)

• Function and Feature Points
  – Weights for inputs high
  – Weights for outputs and logical files low
    (especially for the files)
Caveats

- Our data includes effects of growth and volatility
  - 8+ revisions of DB schema

- Reports produced were unusual for Release 1
  - Full complement of reports not produced
  - One very hard report
Suggested Application Point Model Improvements

- Add parameter for new data tables
- Revise weights for each parameter
- Clarify definitions of the parameter ratings
- Provide allocation of effort by activity