Development of a Software Cost Estimation Process

Ray Madachy
Litton Data Systems

Ninth International Forum on COCOMO and Software Cost Modeling

University of Southern California
October 6, 1994
Outline

- Highlights
- Organizational background
- Documentation
- Tools and databases
- Cost driver rating
- Risk management
- Future and ongoing work
Process Highlights

- Evolutionary COCOMO framework
- Coordinated by SEPG
- Defined software metrics process
- Required post-mortem reporting
- Profile of historical cost driver ratings
- Knowledge-based estimation tool
- Automated measurement
Software Engineering Process Group

- Mission: improve software process
- Supports all business units through:
  - definition of data collection policies and procedures
  - database creation and maintenance
  - data analysis and feedback to projects
  - ongoing model calibration
  - conducting training courses in relevant disciplines
- Related working groups
  - metrics, reuse, systems engineering, risk management
- First assessment: fully satisfied goals for CMM level 3 key process areas except for partial satisfaction in training
CER Process Action Team

- Division-wide team to develop cost estimating relationships for all business activities
- Global process definition
- Software role model
- Coordinated with SEPG activities
- CER matrix
COCOMO 2.0 Program

- Updating COCOMO for new processes and products
- Program provides resources for metrics automation and analysis
- Lead corporate partner
  - data definitions
  - toolproofing data collection
- Will incorporate incremental research results into tools and costing procedures
Documentation

- Policy and procedure guide for software sizing, costing, and scheduling
- Software Management Handbook:
  - Estimating Size, Cost and Schedule
  - Litton COCOMO User’s Guide and COCOMO Description
  - Other relevant chapters/appendices:
    - Metrics, Planning and Controlling a Project, Managing Risk, Project Post-Mortems
- Training Class Material
Tools

- Integrating metrics tools and databases
  - Litton COCOMO
  - Amadeus®
    - automated code measurement
    - metrics data repositories
  - Company network with standard spreadsheet and database applications
  - Heterogeneous S/W development environments
Litton COCOMO

- Based on Expert COCOMO [Madachy 93], ported to Excel on Windows
- Knowledge-based tool to enable consistent planning, estimation and risk assessment across the division
  - detects input anomalies, identifies risk situations and provides advice
- Incorporates calibrated CERs for individual product lines
<table>
<thead>
<tr>
<th>COST DRIVER</th>
<th>LITTON COCOMO V.1.1</th>
<th>RATING</th>
<th>lc</th>
<th>19300 LOC</th>
<th>30 Months</th>
<th>Organic</th>
<th>Embdedded</th>
<th>Product Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Attributes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RELY - required software reliability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DATA - data base size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPLA - product complexity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Attributes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TIME - execution time constraint</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STOR - main storage constraint</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIRT - virtual machine volatility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TURN - computer turnaround time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personnel Attributes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACAP - analyst capability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AEXP - applications experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCAP - programmer capability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VEXP - virtual machine experience</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEXP - programming language exp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Attributes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NLUP - use of modern prog practice</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOOL - use of software tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BCED - required exprent schedule</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Litton
Data Systems
Metrics Databases and Repositories

- Estimate Repository
- Post-Mortem Repository
- Experience Database (CMM "process database")
  - merged with COCOMO 2.0 data
- All maintained by the SEPG
- CERs derived from Experience Database and post-mortem reports
Cost Driver Rating

- Need to rate cost drivers in a consistent and objective fashion within an organization.

- Cost driver ratings profile:
  - graphical depiction of historical ratings to be used as a reference baseline
  - used in conjunction with estimating tools to gauge new projects against past ones objectively
Ratings Profile

Ratings Profile

RELY - required software reliability

- Very Low: slight inconvenience
- Low: low, easily recoverable losses
- Nominal: moderate, easily recoverable losses
- High: high financial loss
- Very High: risk to human life
- Extra High

DATA - data base size

- DB: 10 ≤ D/P < 100 ≤ D/P < 1000 ≤ D/P ≥ 1000
- bytes/Prog.: 100 < 1000
- SLOCS: < 10

CPLX - product complexity

See attached table

Litton
Data Systems
Generating a Cost Driver Ratings Profile

- Single person (time efficient, but may impose bias and person may be unfamiliar with all projects)

- Group
  - converge ratings in a single meeting (dominant individual problem)
  - Wideband Delphi technique (longer calendar time, but minimizes biases). See Software Engineering Economics, p. 335

Litton
Data Systems
Risk Management

- Cost estimation is heavily allied with risk management activities
- Litton COCOMO:
  - taxonomic risk assessment during cost estimation
  - will add probabilistic estimation
  - incorporated into standard planning and management practices
- Division risk management plan
- Integrated analysis of cost, schedule and risk assessment data
- Process simulation for risk analysis
Future and Ongoing Work

- Overseeing and supporting the implementation of cost estimation procedures
- Maintenance of the databases and cost models
- Validation of the knowledge-based risk assessment scheme
- Documentation of the evolving processes
- Implementing calibrated dynamic process model for cost estimation and process improvement evaluation