EFFORT ESTIMATION AND RISK MANAGEMENT USING THE COBRA® APPROACH
Galorath International Conference, Eindhoven, Netherlands, Dec. 8, 2011

Dr. Jens Heidrich
Division Manager
Process Management
Fraunhofer IESE
Fraunhofer-Platz 1
D-67663 Kaiserslautern
Deutschland
Tel.: +49 (0) 631-6800-2193
Fax: +49 (0) 631-6800-9-2193
Email: jens.heidrich@iese.fraunhofer.de
About the Fraunhofer Gesellschaft

- Named after Joseph von Fraunhofer (1787-1826), a researcher and inventor and entrepreneur
- Germany’s leading organization for applied research and technology transfer
- 60 institutes
- 18000 employees
Software Cost and Effort Estimation - Common Mistakes and Challenges

- Estimating before knowing basic requirements
- Creating estimates solely as a rule of thumb
- Not considering basic risks
- Brooks’s Law: “adding manpower to a late software project makes it later” (fixing wrong estimates in runtime is difficult)
- Using „Off the shelf“ estimation models work without calibration
## Existing Cost Estimation Methods

<table>
<thead>
<tr>
<th>Expert-based</th>
<th>Hybrid</th>
<th>Data-driven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule-of-thumb</td>
<td>CoBRA®</td>
<td>SEER</td>
</tr>
<tr>
<td>Wide-band Delphi</td>
<td>BBN-based</td>
<td>COCOMO</td>
</tr>
<tr>
<td>Planning Game (XP)</td>
<td>...</td>
<td>CART-based</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Human Expertise**

**Typical Software Organization**

**Quantitative Data**
The CoBRA® Method: Cost Estimation, Benchmarking, and Risk Assessment

- Creates a custom-tailored estimation model
  - Company-specific size measure
  - Company-specific influencing factors
- Follows a hybrid approach
  - Makes use of historical data (at least 10 projects)
  - Captures expert knowledge about effort drivers
- More characteristics
  - Accurate: Estimation error about 9%-14% (MMRE)
  - Reusable: Documents company experiences (white box models)
  - Customizable: Estimation model can be adapted to company needs
Basics: Cost/Effort Estimation Equation

Effort = \frac{1}{P_N} \times \text{Size} \times (1 + \text{Effort Overhead})

Characterization of the new projects regarding size and effort drivers

Productivity Model (e.g., FP/PH)

Historical Project Data

Nominal Productivity

Size (e.g., FP) \times \text{Effort Overhead}

Quantified Causal Model

Customer Participation

Requirements

Volatility

Project Team Capabilities

Multiplier

Requirements

Volatility

Requirements

Customer Participation
Basics: Underlying Idea of the CoBRA Approach

- Build causal effort model that allows explaining the variance of productivity over projects in a certain context.

**Diagram:**
- Distribution of actual productivity
- Causal effort model

**Explain:**
- Productivity variance
- Nominal productivity
Basics: Causal Model and Cost Drivers Interaction

- F1: Requirements Volatility
  - F2: Disciplined Requirements Management
  - F3: Customer Participation
  - F4: Customer Competence
  - F5: Meeting Reliability Requirements
  - F6: Key Project Team Capabilities

Indirect influence

V6.1: Domain Experience
V6.2: Communication Capabilities
Decomposition of a complex 3-dimensional concept

Effort Overhead

**Basics: Causal Model and Cost Drivers Interaction**

*(with Generic Triangular Distributions)*

F2: Disciplined Requirements Management

F1: Requirements Volatility

F3: Customer Participation

F4: Customer Competence

F5: Meeting Reliability Requirements

F6: Key Project Team Capabilities

V6.1: Domain Experience

V6.2: Communication Capabilities

Per Expert

**Basics:** Example Simulation Runs using Random Sampling (Monte Carlo Simulation)

Random selection of **expert and overhead value** from triangular distribution
Basics: Cost Estimation, Benchmarking & Risk Assessment

Estimation

Effort/Cost

Probability

Mean

Risk Assessment

Effort/Cost

Probability

Mean

Benchmarking Projects

Overhead

Probability

Low Risk

Mean Risk

High Risk

Estimation (Cumulative)

Effort/Cost

Probability

Mean

Risk Minimization

Team

Capabilities

Requirements

Volatility

Customer

Participation

Sensitivity

The CoBRA Approach
Basics: CoBRA® Life Cycle

1 Characterize
   Define CoBRA® Application Environment (Context, Size Measure, etc.)

2 Set Goals
   Define Estimation Goals and Determine Application Scope

3 Build Model
   Define CoBRA® Model, Collect Data, and Perform Initial Validation

4 Execute Model
   Characterize New Project, Apply CoBRA® Model, and Validate Estimation Quality

5 Analyze Results
   Analyze Model Performance and Identify Improvement Potentials

6 Package and Improve
   Improve CoBRA® Model and Package for future use

© Fraunhofer IESE
Basics: Tool Support via CoBRIX
**Case 1: Oki Electric Ltd., Japan**

Based on collaboration with Japanese Information-technology Promotion Agency (IPA) / SEC

- **Goal:** Improve estimation accuracy and effectiveness as well as understanding of basic cost/effort drivers.

- **Context**
  - 16 historical projects from business applications domain
  - 12 experienced project and quality manager

- **Approach:** Iterative application of the CoBRA® approach

- **Results**
  - Significant improvement of estimation accuracy (MMRE: 14%)
  - Better understanding of individual cost/effort drivers
  - Improvement of data collection processes
  - High acceptance of the model users
Case 1: Final Causal Model for Oki Electric Ltd.
Case 1: Iterative Improvement of the Model

Estimation Error of CoBRA Model

Refinement Iterations

Custom-tailored models need to be developed iteratively.

Initial model 1st iteration 2nd iteration 3rd iteration 4th iteration

Estimation error

MdMRE

MMRE
Case 2: Mitsubishi Research Institute (MRI), Japan

- **Goal**: Benchmarking productivity of projects of Japanese industries and recommend improvement actions

- **Context**
  - 30 historical projects of a Japanese company

- **Approach**
  - Use SEER-SEM and the IPA/SEC data white book for benchmarking projects
  - Develop CoBRA causal model with experts for identifying individual improvement potential

- **Results**
  - Industry-proven ranking of projects
    - International (SEER)
    - Japanese (IPA/SEC data white book)
  - Better understanding of individual cost/effort drivers (CoBRA)
Case 2: Combining Data-Driven and Hybrid Approaches

Combining the “best” of both worlds:
- **SEER** for benchmarking and
- **CoBRA** for individual improvement models

SEER Benchmark Causal Model

Benchmark Report (SEER, IPA/SEC)

 Improvement Recommendations (COBRA)
Conclusion: Common Challenges in Practice

- **Output measure** (sizing)
  - Candidates limited by context
  - LOC depends on the PL and may be hard to estimate early
  - Functional sizing may be too costly

- **Data collection**
  - Data completeness/reliability
  - High measurement effort

- **Influencing factors**
  - Hard to identify and quantify
  - Factor dependencies makes analysis extremely difficult

- **Interpretation** may be misleading

Around 60% of organizations do not measure and consider influencing factors explicitly.

[Results from 126 literature studies, 25 IESE industry projects, and survey among 24 companies]
Conclusion: Lessons Learned

- Effective effort estimation is **key for successful project management**
- There is no ultimate „best“ method that works everywhere
  - Success depends on many factors
  - The „right“ method may create many synergies
  - Combining existing methods may maximize your benefits
- An estimation method is **no oracle**
  - Results need to be checked and interpreted
- A good estimation approach is…
  - integrated into organizational processes
  - adapted to the specific needs
  - continually improved
Contact

Dr. Jens Heidrich
Department Head
Processes, Measurement, and Improvement PMI
Fraunhofer IESE
Fraunhofer-Platz 1
D-67663 Kaiserslautern
Germany
Phone: +49 (0) 631-6800-2193
Fax: +49 (0) 631-6800-9-2193
Email: jens.heidrich@iese.fraunhofer.de