Decisions, Decisions

- What decisions need to be made?
- Who makes those decisions?
- What information is available?
- How effectively do we make decisions?
- What is the impact of poorly made decisions?
Business and Technical Decisions

- Continuous Process Improvement
  - Improve Productivity
  - Reduce Time to Market
  - Increase Quality
  - Lower Costs

- Improve Margins

- Strategic Positioning (Business & Technical)
  - Satisfy Customer
  - Improve Competitive Position
  - Increase Market Share

- Shareholder Value

- Deliver Value
  - Increase Revenues

- Improve Productivity
  - Reduce Time to Market
  - Increase Quality

- Lower Costs

- Satisfy Customer
  - Improve Competitive Position

- Increase Market Share

- Increase Revenues
Establish an Information Framework

Enterprise

Executive Management Dashboard

Business Decisions

Performance Measures

Process Management

Process Repository

Enterprise Database

Process Measures

Historical Measures

Project

PAL

Project X

Project Y

Project Z

Project Data

Baseline

Establish an Information Framework

- Define
- Execute
- Control
- Measure

Executive Management Dashboard

- Process Management
- Performance Measures
- Historical Measures
- Project Data

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Historical Measures

Project
Why Are We Estimating?

- Planning
- Budgeting
- Managing Projects
- Allocating Resources
- Managing Expectations
- Proj. Portfolio Mgmt

0% 20% 40% 60% 80% 100%
Decisions Relevant to Project Managers

• Shifting priorities
  – Scope
  – Schedule

• Managing expectations
  – Customer
  – Senior Management

• Lack of performance
  – Productivity
  – Skill levels

• Controlling Costs
Estimating Best Practices

The Software Engineering Institute’s (SEI) requirements for good estimating:

• Corporate **historical database**
• Structured processes for estimating product size and reuse
• Mechanisms for extrapolating **benchmark characteristics** of past projects
• Audit trails
• Integrity in dealing with **dictated costs and schedules**
• Data collection and feedback processes foster correct data interpretation
Basis of Estimates

Prior Experience

Historical Data

Commercial Data Bases

Industry Benchmark Data

Other
Establishing a Level of Performance

Collection

- COLLECT QUANTITATIVE DATA
  - Size
  - Effort
  - Duration
  - Cost
  - Quality

- COLLECT QUALITATIVE DATA
  - Process
  - Methods
  - Skills
  - Tools
  - Management

Analysis

- Measured Performance

Results

- Capability Profiles
- Baseline Performance
Developing a Performance Profile

Product Deliverable

Performance Indicators
- Time to Market
- Level of Effort
- Quality (Defects)

Performance Risk Factors
- Management
- Definition
- Design
- Build
- Test
- Environment

MEASURES (Size)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>A</td>
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DELIVERY RATE

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<thead>
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<tr>
<td></td>
<td>19 FP/PM</td>
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<tr>
<td></td>
<td>13 FP/PM</td>
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<tr>
<td></td>
<td>16 FP/PM</td>
</tr>
<tr>
<td></td>
<td>10 FP/PM</td>
</tr>
<tr>
<td></td>
<td>5 FP/PM</td>
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PROFILES

PROFICIENCIES
INADEQUACIES
Quantitative Performance Evaluation

Quantitative Assessment:

- Perform functional sizing on all selected projects.
- Collect data on project level of effort, cost, duration and quality.
- Calculate productivity rates for each project, including functional size delivered per staff month, cost per functional size, time to market, and defects delivered.

Results:

<table>
<thead>
<tr>
<th></th>
<th>Baseline Productivity</th>
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<tbody>
<tr>
<td>Average Project Size</td>
<td>133</td>
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<tr>
<td>Average FP/SM</td>
<td>10.7</td>
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<tr>
<td>Average Time-To-Market (Months)</td>
<td>6.9</td>
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<tr>
<td>Average Cost/FP</td>
<td>$939</td>
</tr>
<tr>
<td>Delivered Defects/FP</td>
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</table>
Create a Profile of Key Variables

<table>
<thead>
<tr>
<th>Management</th>
<th>Definition</th>
<th>Design</th>
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<tbody>
<tr>
<td>• Team Dynamics</td>
<td>• Clearly Stated Requirements</td>
<td>• Formal Process</td>
</tr>
<tr>
<td>• Morale</td>
<td>• Formal Process</td>
<td>• Rigorous Reviews</td>
</tr>
<tr>
<td>• Project Tracking</td>
<td>• Customer Involvement</td>
<td>• Design Reuse</td>
</tr>
<tr>
<td>• Project Planning</td>
<td>• Experience Levels</td>
<td>• Customer Involvement</td>
</tr>
<tr>
<td>• Automation</td>
<td>• Business Impact</td>
<td>• Experienced Development Staff</td>
</tr>
<tr>
<td>• Management Skills</td>
<td>•</td>
<td>• Automation</td>
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</table>

<table>
<thead>
<tr>
<th>Build</th>
<th>Test</th>
<th>Environment</th>
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<tbody>
<tr>
<td>• Code Reviews</td>
<td>• Formal Testing Methods</td>
<td>• New Technology</td>
</tr>
<tr>
<td>• Source Code Tracking</td>
<td></td>
<td>• Automated Process</td>
</tr>
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<td>• Code Reuse</td>
<td>• Test Plans</td>
<td>• Adequate Training</td>
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<td>• Data Administration</td>
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<td>• Organizational Dynamics</td>
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<tr>
<td>• Experienced Staff</td>
<td>• Staff Testing Experience</td>
<td>• Certification</td>
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<tr>
<td>• Automation</td>
<td>• Effective Test Tools</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Customer Involvement</td>
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</tr>
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</table>
Qualitative Performance Evaluation

Qualitative Assessment

- Conduct interviews with members of each project team
- Collect Project Profile information
- Develop Performance Profiles to display strengths and weaknesses among the selected projects

Results

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Profile Score</th>
<th>Management</th>
<th>Definition</th>
<th>Design</th>
<th>Build</th>
<th>Test</th>
<th>Environment</th>
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<td>23.08</td>
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<td>9.38</td>
<td>30.77</td>
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<td>30.77</td>
<td>9.38</td>
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<td>43.75</td>
<td>38.46</td>
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<td>0.00</td>
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<td>0.00</td>
<td>11.54</td>
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<td>46.15</td>
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</tbody>
</table>
Overall Information Framework

Enterprise

Executive Management Dashboard

Business Decisions

Process Management

Process Repository

Performance Measures

Enterprise Database

Baseline

History Measures

End User

Project

PAL

Project X

Project Y

Project Z

Project Estimates
Benefits of Good Estimating

• Reduce Risk
• Reduce Costs
• Gain Credibility
• Manage Expectations
• Resource Capacity Planning
• Improve Decision Making Capability
Barriers to Successful Estimating

- Availability of Data
- Lack of Skills
- No Documented Procedure
- Lack of Automation
- Lack of Sr. Mngmnt Support
- Est. Not Id as Problem
- Other
- No Perceived Value
Basic Estimating Model

- Quantify the size
- Assess the complexity
- Understand the capacity to deliver

**DEFINITION**

**CAPABILITY**

**ESTIMATE**

Estimating Model
Why is Sizing Important?

Finding –
   Nine out of ten projects that fail have not been properly sized

Consider –
   When you build a house you specify all the functions and features you want – these are your requirements
   The builder then generates an estimate based on the size (square footage) of your requirements

• Size is the key to effectively managing software projects
Sizing Options

Internal vs. External Definitions
- Organizational Specific Definitions
- Industry Defined
- Modules, Use Cases, Test Cases
- Story Points
- Lines of Code
- Use Case Points
- Cosmic, NESMA FP IFPUG Function Points Mark II

Consistency/Accuracy
- Less Accurate
- More Accurate
- Story Points
- Lines of Code
- Use Case Points
- COSMIC NESMA FP IFPUG Function Points Mark II
- Hours, Days

Power vs. Ease of Use
- Fewer Rules
- More Rules
- Hours, Days
- Story Points
- Use Case Points
- COSMIC NESMA FP IFPUG Function Points Mark II
- Easier to Learn
- Harder to Learn

Power Increases

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Why Function Points?

Function Point Analysis is a standardized method for measuring the functionality delivered to an end user.

- Consistent method
- Easy to learn
- Available early in the lifecycle
- Acceptable level of accuracy
- Meaningful internally and externally

- Function Point counts have replaced Line of Code counts as a sizing metric that can be used consistently and with a high degree of accuracy.
The Function Point Methodology

The software deliverable is sized based upon the functionality delivered.

- Inputs
- Outputs
- Inquiries
- Data Stores
- Interface Files

Five key components are identified based on logical user view.
**Simplifying the Methodology**

The Formal Process:
1. Identify Components
2. Assess Complexity
3. Apply Weightings
4. Compute Function Points

<table>
<thead>
<tr>
<th>Components</th>
<th>Low</th>
<th>Avg</th>
<th>High</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Stores</td>
<td>__ x 7</td>
<td>__ x 10</td>
<td>__ x 15</td>
<td></td>
</tr>
<tr>
<td>Interfaces</td>
<td>__ x 5</td>
<td>__ x 7</td>
<td>__ x 10</td>
<td></td>
</tr>
<tr>
<td>Inputs</td>
<td>__ x 3</td>
<td>__ x 4</td>
<td>__ x 6</td>
<td></td>
</tr>
<tr>
<td>Outputs</td>
<td>__ x 4</td>
<td>__ x 5</td>
<td>__ x 7</td>
<td></td>
</tr>
<tr>
<td>Inquiries</td>
<td>__ x 3</td>
<td>__ x 4</td>
<td>__ x 6</td>
<td></td>
</tr>
</tbody>
</table>

**Total Function Points**
Common Criticisms of Function Points

- FP methodology terms are confusing
- Too long to learn, need an expert
- Need too much detailed data
- Does not reflect the complexity of the application
- Takes too much time
- We tried it before
Simplifying the Methodology

• Assume complexity to be average

### Complexity

<table>
<thead>
<tr>
<th>Components:</th>
<th>Low</th>
<th>Avg</th>
<th>High</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Stores</td>
<td>__ x 7</td>
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<td>__ x 15</td>
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<tr>
<td>Interfaces</td>
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<td></td>
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<td>__ x 4</td>
<td>__ x 6</td>
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<tr>
<td>Outputs</td>
<td>__ x 4</td>
<td>__ x 5</td>
<td>__ x 7</td>
<td></td>
</tr>
<tr>
<td>Inquiries</td>
<td>__ x 3</td>
<td>__ x 4</td>
<td>__ x 6</td>
<td></td>
</tr>
</tbody>
</table>

Total Function Points ___
Exercise: Identify the Functionality

Inputs:
- ADD, CHG INVOICES
- PAYMENTS

Data Stores:
- INVOICES
- VENDOR
- PAYMENTS
- ACCOUNTS PAYABLE

Interface:
- PURCHASE ORDER SYSTEM
- PURCHASE ORDER INFO

Inquiry:
- PAYMENT STATUS

Output:
- USER
- PAID INVOICES
- USER

Inputs:
- USER

User ADD, CHG INVOICES, PAYMENTS.

Data Stores:
- INVOICES
- VENDOR
- PAYMENTS
- ACCOUNTS PAYABLE

Interface:
- PURCHASE ORDER SYSTEM
- PURCHASE ORDER INFO

Inquiry:
- USER
- PAYMENT STATUS

Output:
- USER
- PAID INVOICES
- USER
## Determine the Functional Size

The FP Lite™ Process:
1. Identify Components
2. Assess Complexity
3. Apply Weightings
4. Compute Function Points

### Components

<table>
<thead>
<tr>
<th>Components</th>
<th>Low</th>
<th>Average</th>
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<td>Inquiries</td>
<td>x3</td>
<td>x4</td>
<td>x6</td>
<td>4</td>
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</tbody>
</table>

### Function Point Size

- User
- Vendor
- Invoices
- Payments
- System
- Accounts Payable

Total Function Point Size: 58
Estimating Techniques

- Manual, using organizational baseline data
- Manual, using standard industry data
- Automated, using a commercial estimating software package
Estimating Using Delivery Rates

DEFINITION

REQUIREMENT

PROJECT SIZE

FUNCTIONAL SIZE

PROJECT COMPLEXITY

PROFILE

CAPABILITY

RATE OF DELIVERY

ESTIMATE

Schedule

Effort

Costs

Estimating Using Delivery Rates
A Comprehensive Measurement of Capability

Collection

COLLECT QUANTITATIVE DATA

Size
Effort
Duration
Defects

COLLECT QUALITATIVE DATA

Process
Methods
Skills
Tools
Management

Analysis

Measured Performance

Capability Profiles

Results

Benchmark Data

Delivery Rates

Action

Best Practices

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Developing a Performance Profile

Product Deliverable

Performance Indicators
- Duration (Months)
- Cost (Effort)
- Quality (Defects)

Performance Risk Factors
- Management
- Definition
- Design
- Build
- Test
- Environment

Profile Profiles

Inadequacies

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tbody>
<tr>
<td>21</td>
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<td>550</td>
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</table>

Rate of Delivery
- 19 FP/PM
- 13 FP/PM
- 16 FP/PM
- 10 FP/PM
-  5 FP/PM
Estimating Using Delivery Rates

**DEFINITION**

- REQUIREMENT

**CAPABILITY**

- PROJECT SIZE
- PROJECT COMPLEXITY

**ESTIMATE**

- FUNCTIONAL SIZE = 58
- PROFILE = 16

\[ \text{Person Months} = 3.6 \]
Estimating Techniques

- Manual, using organizational baseline data
- Manual, using standard industry data
Industry Data Reveals Best Practices

Research

<table>
<thead>
<tr>
<th>MEASURES</th>
<th>CHARACTERISTICS</th>
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<tbody>
<tr>
<td>Software Size</td>
<td>Skill Levels</td>
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<tr>
<td>Level of Effort</td>
<td>Automation</td>
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<tr>
<td>Time to Market</td>
<td>Process</td>
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<td>Delivered Defects</td>
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<tr>
<td>Cost</td>
<td>User Involvement</td>
</tr>
<tr>
<td></td>
<td>Environment</td>
</tr>
</tbody>
</table>

Analysis

PERFORMANCE LEVELS

RESULTS

• Correlate Performance Levels to Characteristics
• Substantiate Impact of Characteristics
• Identify Best Practices
# Delivery Rates

## Productivity per Person Month by Application Release

<table>
<thead>
<tr>
<th>Category</th>
<th>1-150</th>
<th>151-300</th>
<th>301-500</th>
<th>501-750</th>
<th>751+</th>
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<tbody>
<tr>
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<td>10.6</td>
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<td>6.7</td>
</tr>
<tr>
<td>New Dev C-S</td>
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<td>13.8</td>
<td>11.8</td>
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<tr>
<td>Internal</td>
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<td>12.3</td>
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<td>15.9</td>
<td>13.3</td>
<td>11.4</td>
<td>9.3</td>
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</tbody>
</table>

Note: Above values are expressed in Function Points delivered per Person Month (equivalent to 130 hours)

## Delivery Cycle Time in Calendar Months by Application Release

<table>
<thead>
<tr>
<th>Category</th>
<th>1-150</th>
<th>151-300</th>
<th>301-500</th>
<th>501-750</th>
<th>751+</th>
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<td>8.3</td>
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<td>3.8</td>
<td>6.3</td>
<td>8.7</td>
<td>10.4</td>
<td>12.7</td>
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<tr>
<td>Enh Mainframe</td>
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<td></td>
<td></td>
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<tr>
<td>Internal</td>
<td>3.9</td>
<td>7</td>
<td>9.6</td>
<td>12.5</td>
<td>16.6</td>
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<td>Package</td>
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<td>6.6</td>
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<tr>
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<td>3.8</td>
<td>6.8</td>
<td>9.2</td>
<td>12.4</td>
<td>16.4</td>
</tr>
</tbody>
</table>

Note: Above values are expressed in Calendar Months to deliver a project within the specified range of Function Points. Any time for work stoppage is excluded.
Estimating Using Delivery Rates

**DEFINITION**

- REQUIREMENT
- PROJECT SIZE

**CAPABILITY**

- PROJECT COMPLEXITY
- RATE OF DELIVERY

**ESTIMATE**

- FUNCTIONAL SIZE: 58
- PROFILE: 15.7

\[
3.7 \text{ Person Months} = \frac{58 \times 15.7}{100}
\]
Estimating Techniques

• Manual, using organizational baseline data
• Manual, using standard industry data
• Automated, using a commercial estimating software package

**Estimating Model**

Input

PROJECT SIZE x PROJECT COMPLEXITY x CAPACITY to DELIVER

Output
Benefits of Automation

- Sophisticated Analysis
- Information displays – charts, graphs, reports
- Interfaces to PM systems, others
- Simulation, modeling capabilities
- Multi-variable modeling
- Calibrated based on actuals
SEER-SEM User Interface

- **Menu Bar**
- **Tool Bar**
- **WBS Window**
- **Parameter Window**
- **Inputs**
- **Reports Window**
- **Views Window**
- **Outputs**
- **Charts Window**
SEER: Risk-Driven Estimates
The Engine for Project Evaluation

- SEER predicts outcomes
- SEER uses inputs to develop probability distributions
- The result is a probabilistic estimate
- SEER will predict a likely range of outcomes
- Monte Carlo provides project-level assessments of risk

Least, likely, and most inputs provide a range of cost and schedule outcomes

Confidence (probability) can be set and displayed for any estimated item
SEER for Software Example; Goals/Risks/Outcome Probabilities
What Can a Parametric Model Tell You?

**Schedule Probability**

*Example Application 1*

- Firm Fixed Price?
- Feel lucky?
- What is likely to happen

<table>
<thead>
<tr>
<th>Probability</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>99%</th>
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<table>
<thead>
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<th>Time (calendar months)</th>
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<th>4</th>
<th>8</th>
<th>12</th>
<th>16</th>
<th>20</th>
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</thead>
</table>

**Risk Estimate**

- Hours
- Effort
- Schedule
- Cost
- Defects
- Probability

**Example 1**

- Probability 80.00%
- Hours 4,567.54
- Effort 30.05
- Schedule 10.56
- Cost 441,728.00
- Defects 14

**Example 2**

- Probability 20.00%
- Hours 2,266.02
- Effort 14.91
- Schedule 8.21
- Cost 219,148.00
- Defects 33

**Example 3**

- Probability 50.00%
- Hours 3,170.89
- Effort 20.86
- Schedule 9.33
- Cost 306,658.00
- Defects 22

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SEER for Software Example: Staffing

Management Staffing Dashboard

Detailed Staffing Profile

<table>
<thead>
<tr>
<th>Month</th>
<th>Mgmt</th>
<th>SW Reqs</th>
<th>Design</th>
<th>Code</th>
<th>Data Prep</th>
<th>Test</th>
<th>CM</th>
<th>QA</th>
<th>Total</th>
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<td>0.1</td>
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<tr>
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<td>0.0</td>
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<td>0.5</td>
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<tr>
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<td>0.3</td>
<td>0.2</td>
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<tr>
<td>8 Aug-07</td>
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<td>9 Sep-07</td>
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<td>0.1</td>
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<td>11 Nov-07</td>
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<td>0.3</td>
<td>0.2</td>
<td>0.2</td>
<td>0.0</td>
<td>0.0</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Staffing Plan

Report Management Module

Labor Category Allocation

Report Management Module (Cost)

DM: 5.8%
SW Req: 5.4%
Design: 14.1%
Code: 35.8%
Data Prep: 7.2%
Test: 21.5%
CM: 2.9%
QA: 3.8%
Metrics & Analysis Benchmarking: Use to Substantiate and Benchmark

![Graph showing Development Effort Months vs Effective Size](image)

Data Points:
- Historical Data
- Current Estimate
- Reference Estimate

Trend Lines:
- History Trend (mean)
- \( r^2 = 0.88 \)
- \( y = 0.00005x^{1.2072} \)

2005 - Ground Effective Size vs. Effort
- Benchmark Trend (mean)
- Benchmark +/- 1σ
- Benchmark +/- 2σ
- Benchmark +/- 3σ

Filter:
- Platform = Ground-Based Mission C
- Application = Command/Control
- Observations = 197
The Estimating Process

The estimate is based on the best available information. A poor requirements document will result in a poor estimate.

- **REQUIREMENT**
  - Analyst

- **SIZE REQUIREMENT**
  - Measurement Specialist

- **ESTABLISH PARAMETERS**
  - Project Manager

- **SELECT MATCHING PROFILE**

- **GENERATE ESTIMATE**
  - PM / User
  - Software
  - Database
  - Profile
  - Size
  - Time
  - WHAT IF ANALYSIS

- **ACTUALS**

Accurate estimating is a function of using historical data with an effective estimating process.

Plan vs. Actual Report

Metrics
What is “Estimating on Demand?”

- Estimating On Demand is an estimating service

- It provides organizations with the information they need in order to make important decisions regarding the status of selected projects

- Establish an Estimating Center of Excellence
The On-demand Approach

- Takes advantage of acquired knowledge
- An available estimating resource when and where you need it
- Similar to a Software as a Service model
- The cost of the service is often less than 2% of the total project cost
On-demand Process

Step 1
Determine the type of project
Understand the basis for the estimate. Set expectations as to the deliverables.

Step 2
Assess the size and the complexity. Provide input to all the required project variables
- Staffing levels, & experience
- Requirements stability
- Confidence level
- Target/Host systems
- Schedule Considerations
- Reusability
- Integration
- Labor rates
- Maintenance levels

Step 3
Generate required estimates including level of effort, duration, risk analysis, and quality.

Step 4
Review the estimate with the project team. Make necessary adjustments. Re-estimate as necessary

Step 5
Generate final estimate
Estimating: Which One is Right for You?

- Manual, using organizational baseline data
  - Baseline, commitment
  - Rigorous data collection
  - Accurately reflects organization
- Manual, using standard industry data
  - FP centric
  - Values may not be representative
  - Quick start-up
- Automated, using a commercial estimating software package
  - Investment in software
  - Develop expertise
  - Increasing accuracy with calibration
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