Project Portfolio Management Planning:
A Method for Prioritizing Projects

Presented by:
Mike Ross, Chief Engineer
Galorath Incorporated
100 North Sepulveda Boulevard
Suite 1801
El Segundo, California 90245
480.488.8366 (o) 480.488.8420 (f)
mross@galorath.com
Summary

- **Software Project Management** ↔ **Software Project Planning,** **Software Project Tracking and Oversight**
- **Portfolio Management** ↔ **Portfolio Planning,** **Portfolio Tracking and Oversight**
- Measurement objectifies management
- **Size, Technology** ⇒ **Time, Effort, Defects**
- **Size and Technology** are Uncertain
- **Uncertainty** ⇒ **Confidence**
- **Effort, Confidence** ⇒ **Risk-Adjusted Investment**
- **Pairwise Comparison Process** ⇒ **Relative Return**
- **Risk-Adjusted Investment, Relative Return** ⇒ **RARROI**
- **Portfolio Sorted by RARROI** ⇒ **Project Priority, Budget Cut Line**
SEI CMM
Software Project Management KPAs

- Software Project Planning
- Software Project Tracking and Oversight
Portfolio Management

Key Elements

- Portfolio Planning
- Portfolio Tracking and Oversight
Fundamental Measures

Size
Effective Technology
Time
Effort, Cost, Staffing
Defects
**Planning**
- PROJECT PLANNING
- Predict future performance

**Tracking**
- PROJECT TRACKING AND OVERSIGHT
- Control current performance

**Learning**
- PROCESS MANAGEMENT
- Learn from past performance
- *Facilitates communication that is:*
  - Objective (fact-based)
  - Repeatable

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es·ti·mate (es'ti mit), n.

an approximate *judgment* or *calculation*, as of the value or amount of something

*a prediction that is equally likely to be above or below the actual result* (Tom DeMarco)
**Quote:** *Adding people to a late project makes it later.*

**Interpretation:** *Productivity is inversely proportional to some function of the project’s average staffing rate.*

**Assumptions (based on regression analysis of historical data):**
- The function is a *power function*.
- The exponent (beta) represents process entropy and is approximately *0.5*.
- The constant of proportionality represents *effective technology*.

\[
\frac{\text{Size}}{\text{Effort}} \propto \left( \frac{\text{Effort}}{\text{Time}^2} \right)^{-a}
\]

\[
\frac{\text{Size}}{\text{Effort}} = \text{Technology} \times \left( \frac{\text{Effort}}{\text{Time}^2} \right)^{-0.5}
\]
Software Equation Conceptually Simplified

\[ \text{Effort}^{0.5} \times \text{Time} = \frac{\text{Size}}{\text{Technology}} \]

- The family of project time-effort solutions depends on the software’s size and the project’s effective technology.
- As the size goes up, the effort and/or time goes up.
- As the effective technology goes up, the effort and/or time goes down.
- As the time goes up, the effort goes down.
Software Development Dynamics

Elapsed Calendar Time (months)

Effort (person-months)

Minimum Time

Complexity Limit

Idealized Tradeoff

Inefficient

Impossible

For a Given Size and Technology

Optimal Effort

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Uncertainty and Confidence

For a Given Size & Technology

Effort (person-months)

Elapsed Calendar Time (months)

Effort Confidence (%) 1 25 50 75 99

Time Confidence (%) 1 25 50 75 99

= Goals

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Low Confidence (Risky) Effort
(less time – more effort, cost, defects)

Effort (person-months)

Confidence (%)

Elapsed Calendar Time (months)

TIME Confidence (%)

Effort Confidence (%)

= Goals

For a Given Size & Technology

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Low Confidence (Risky) Schedule

*(more time – less effort, cost, defects)*

For a Given Size & Technology

TIME
Confidence

(%)

Effort
Confidence
(%)

Elapsed Calendar Time (months)

= Goals

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For a Given Size & Technology

Balanced Risk

Effort (person-months)

Elapsed Calendar Time (months)

Effort Confidence (%)

TIME Confidence (%)

= Goals
Reduced Uncertainty

For a Given Size & Technology

Effort (person-months)

Elapsed Calendar Time (months)

Effort Confidence (%)

TIME Confidence (%)

= Goals

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What About This One?

For a Given Size & Technology

Effort (person-months)

Elapsed Calendar Time (months)

Effort Confidence (%)

TIME Confidence (%)

1 25 50 75 99

1 25 50 75 99

= Goals
Expressing Uncertainty

Estimates of Size and Technology expressed as single point values don’t tell the whole story:

• How confident am I in this value; i.e., what is the probability of not exceeding this value?
• How certain am I in this value; i.e., how wide is the probability distribution?

Three-point estimates are better:

• **LEAST:** 1% Probability; “I can’t imagine the result being any smaller than this.”
• **LIKELY:** Best Guess; “If I were forced to pick one value, this would be it.”
• **MOST:** 99% Probability; “I can’t imagine the result being any larger than this.”
Managing Risk

Cost

Expect (50%)

Commit (maybe 80%)

Probability of Success

< 1%

10%

20%

30%

40%

50%

60%

70%

80%

90%

> 99%

Cost
Portfolio Planning Process

Data Flow

COST ESTIMATION PROCESS (SEER-SEM)

RISK-ADJUSTED INVESTMENT

SIZE, TECHNOLOGY WITH UNCERTAINTY
Structured Estimating Process

Data Flow
Example Decision Hierarchy for Return Parameters
AccuScope Comparison Options

- \( i \) having *much smaller* impact than \( j \).
- \( i \) having *smaller* impact than \( j \).
- \( i \) having a *slightly smaller* impact as \( j \).
- \( i \) having *equal* impact as \( j \).
- \( i \) having *slightly bigger* impact than \( j \).
- \( i \) having *bigger* impact than \( j \).
- \( i \) having a *much bigger* impact than \( j \).
### Analytic Hierarchy Process

#### Relative Importance Ratio Mapping

<table>
<thead>
<tr>
<th>Labels</th>
<th>Ratio between left and right items</th>
<th>Suffix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Much Bigger</td>
<td>70 : 10</td>
<td>Than</td>
</tr>
<tr>
<td>Bigger</td>
<td>50 : 10</td>
<td>Than</td>
</tr>
<tr>
<td>Slightly Bigger</td>
<td>30 : 10</td>
<td>Than</td>
</tr>
<tr>
<td>Equal</td>
<td>10 : 10</td>
<td>To</td>
</tr>
<tr>
<td>Slightly Smaller</td>
<td>10 : 30</td>
<td>Than</td>
</tr>
<tr>
<td>Smaller</td>
<td>10 : 50</td>
<td>Than</td>
</tr>
<tr>
<td>Much Smaller</td>
<td>10 : 70</td>
<td>Than</td>
</tr>
</tbody>
</table>

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Arbitrarily-Selected Relative Baseline Project
Other Projects Relative to Baseline

![Diagram of SEER-AccuScope interface]

The diagram shows the interface for SEER-AccuScope, a tool for customer satisfaction importance. The interface allows users to specify reference and estimated items using buttons below and then make comparisons. The Estimated Items table displays the relative impact of various projects, as follows:

<table>
<thead>
<tr>
<th>Name</th>
<th>Relative Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 2</td>
<td>587</td>
</tr>
<tr>
<td>Project 3</td>
<td>7190</td>
</tr>
<tr>
<td>Project 4</td>
<td>3624</td>
</tr>
<tr>
<td>Project 5</td>
<td>7190</td>
</tr>
<tr>
<td>Project 6</td>
<td>1809</td>
</tr>
<tr>
<td>Project 7</td>
<td>7190</td>
</tr>
<tr>
<td>Project 8</td>
<td>3624</td>
</tr>
<tr>
<td>Project 9</td>
<td>1809</td>
</tr>
</tbody>
</table>

Additional buttons for adding items, editing, removing, and adding reference items from analogy or repository are also visible. The Current Selection area is empty, indicating no active selection at the moment.

The diagram includes buttons for single and multiple comparisons, along with other menu options for file, edit, view, options, reports, charts, and help.

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Individual Pairwise Comparison

Size By Comparison

Compare

Is Slightly Bigger Than

Project 1

Next comparison

Project 2

All comparisons made

Click on grid to navigate comparisons.

Comparison made
Not Sure
No comparison made
Automatically calculated

Help
Consistency ...
Hide comparison grid
Done
Cancel

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### Example Parameter Importance to the Overall Return

#### Pairwise Comparison Matrix

**Return Parameters**

<table>
<thead>
<tr>
<th>i</th>
<th>Customer Satisfaction</th>
<th>Productivity Improvement</th>
<th>Relative Weight</th>
<th>Normalized Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Satisfaction</td>
<td></td>
<td>Slightly Bigger</td>
<td>1000</td>
<td>0.75</td>
</tr>
<tr>
<td>Productivity Improvement</td>
<td></td>
<td></td>
<td>333</td>
<td>0.25</td>
</tr>
</tbody>
</table>

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## Example Project Importance to Customer Satisfaction

### Pairwise Comparison Matrix

**Customer Satisfaction**

<table>
<thead>
<tr>
<th>i</th>
<th>Project 1</th>
<th>Project 2</th>
<th>Project 3</th>
<th>Project 4</th>
<th>Project 5</th>
<th>Project 6</th>
<th>Project 7</th>
<th>Project 8</th>
<th>Project 9</th>
<th>Project 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1</td>
<td>-</td>
<td>Slightly Bigger</td>
<td>Smaller</td>
<td>Smaller</td>
<td>Smaller</td>
<td>Slightly Smaller</td>
<td>Smaller</td>
<td>Smaller</td>
<td>Slightly Smaller</td>
<td>Equal</td>
</tr>
<tr>
<td>Project 2</td>
<td>Slightly Bigger</td>
<td>-</td>
<td>Much Smaller</td>
<td>Smaller</td>
<td>Smaller</td>
<td>Much Smaller</td>
<td>Smaller</td>
<td>Smaller</td>
<td>Slightly Smaller</td>
<td>Bigger</td>
</tr>
<tr>
<td>Project 3</td>
<td>Smaller</td>
<td>Much Smaller</td>
<td>-</td>
<td>Slightly Bigger</td>
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<td>Bigger</td>
<td>Equal</td>
<td>Slightly Bigger</td>
<td>Bigger</td>
<td>Bigger</td>
</tr>
<tr>
<td>Project 4</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Slightly Smaller</td>
<td>-</td>
<td>Slightly Bigger</td>
<td>Slightly Smaller</td>
<td>Slightly Smaller</td>
<td>Equal</td>
<td>Slightly Bigger</td>
<td>Bigger</td>
</tr>
<tr>
<td>Project 5</td>
<td>Bigger</td>
<td>Equal</td>
<td>Smaller</td>
<td>Slightly Bigger</td>
<td>Smaller</td>
<td>Slightly Bigger</td>
<td>Smaller</td>
<td>Slightly Bigger</td>
<td>Smaller</td>
<td>Equal</td>
</tr>
<tr>
<td>Project 6</td>
<td>Bigger</td>
<td>Equal</td>
<td>Smaller</td>
<td>Slightly Bigger</td>
<td>Smaller</td>
<td>Slightly Bigger</td>
<td>Smaller</td>
<td>Slightly Bigger</td>
<td>Bigger</td>
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</tr>
<tr>
<td>Project 7</td>
<td>Slightly Bigger</td>
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<td>Smaller</td>
<td>Slightly Bigger</td>
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<td>Slightly Bigger</td>
<td>Bigger</td>
<td>Slightly Bigger</td>
<td>Bigger</td>
<td>Equal</td>
</tr>
<tr>
<td>Project 8</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Bigger</td>
<td>Smaller</td>
<td>Slightly Bigger</td>
<td>Bigger</td>
<td>Slightly Bigger</td>
<td>Bigger</td>
<td>Equal</td>
<td>Equal</td>
</tr>
<tr>
<td>Project 9</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Bigger</td>
<td>Bigger</td>
<td>Equal</td>
<td>Equal</td>
</tr>
<tr>
<td>Project 10</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Slightly Bigger</td>
<td>Bigger</td>
<td>Bigger</td>
<td>Equal</td>
<td>Equal</td>
</tr>
</tbody>
</table>

**Relative Weight (AccuScope)**

**Normalized Weight**
### Example Project Importance to Productivity Improvement

#### Pairwise Comparison Matrix

<table>
<thead>
<tr>
<th></th>
<th>Project 1</th>
<th>Project 2</th>
<th>Project 3</th>
<th>Project 4</th>
<th>Project 5</th>
<th>Project 6</th>
<th>Project 7</th>
<th>Project 8</th>
<th>Project 9</th>
<th>Project 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1</td>
<td>Slightly Bigger</td>
<td>Equal</td>
<td>Slightly Smaller</td>
<td>Slightly Smaller</td>
<td>Bigger</td>
<td>Slightly Smaller</td>
<td>Bigger</td>
<td>Slightly Bigger</td>
<td>Bigger</td>
<td></td>
</tr>
<tr>
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<td>Bigger</td>
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<td>Smaller</td>
<td>Slightly Bigger</td>
<td>Equal</td>
<td>Slightly Bigger</td>
<td></td>
</tr>
<tr>
<td>Project 3</td>
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<td>Slightly Smaller</td>
<td>Bigger</td>
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<td>Bigger</td>
<td>Slightly Bigger</td>
<td>Bigger</td>
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<td></td>
</tr>
<tr>
<td>Project 4</td>
<td>Equal</td>
<td>Much Bigger</td>
<td>Equal</td>
<td>Bigger</td>
<td>Bigger</td>
<td>Bigger</td>
<td>Bigger</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project 5</td>
<td>Much Bigger</td>
<td>Equal</td>
<td>Bigger</td>
<td>Bigger</td>
<td>Bigger</td>
<td>Bigger</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project 6</td>
<td>Much Smaller</td>
<td>Slightly Smaller</td>
<td>Smaller</td>
<td>Slightly Smaller</td>
<td>Bigger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project 7</td>
<td>Bigger</td>
<td>Bigger</td>
<td>Bigger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Project 8</td>
<td>Slightly Smaller</td>
<td>Equal</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project 9</td>
<td>Slightly Bigger</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project 10</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Relative Weight (AccuScope)

- Project 1: 1000 (0.10)
- Project 2: 499 (0.05)
- Project 3: 1000 (0.10)
- Project 4: 1984 (0.21)
- Project 5: 1984 (0.21)
- Project 6: 162 (0.02)
- Project 7: 1984 (0.21)
- Project 8: 276 (0.03)
- Project 9: 499 (0.05)
- Project 10: 276 (0.03)
Risk-Adjusted Relative Return on Investment Calculation

\[ RARROI_P = \frac{\sum_{i=1}^{n} R_i W_i}{I_C} \]

- \( RARROI_P \) is the Risk Adjusted Relative Return on Investment for project \( P \).
- \( R_i \) is the normalized project relative importance for the \( i^{th} \) return parameter.
- \( W_i \) is normalized relative parameter importance (weight) for the \( i^{th} \) return parameter.
- \( I_C \) is normalized relative investment (cost of ownership) with confidence percentage \( C \) where \( C \) represents the enterprise standard risk tolerance (desired probability of success).
## Example Project RARROI Calculations

### RARROI Computations

*Before Sorting*

<table>
<thead>
<tr>
<th>Project Name</th>
<th>80% Confidence Estimated Cost of Ownership</th>
<th>Relative Weight</th>
<th>Customer Satisfaction</th>
<th>Productivity Improvement</th>
<th>RARROI</th>
<th>Cumulative Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1</td>
<td>$28,500.00</td>
<td>0.01</td>
<td>0.03</td>
<td>0.75</td>
<td>0.10</td>
<td>0.25</td>
</tr>
<tr>
<td>Project 2</td>
<td>$237,000.00</td>
<td>0.11</td>
<td>0.02</td>
<td>0.75</td>
<td>0.05</td>
<td>0.25</td>
</tr>
<tr>
<td>Project 3</td>
<td>$304,500.00</td>
<td>0.14</td>
<td>0.21</td>
<td>0.75</td>
<td>0.10</td>
<td>0.25</td>
</tr>
<tr>
<td>Project 4</td>
<td>$173,500.00</td>
<td>0.08</td>
<td>0.10</td>
<td>0.75</td>
<td>0.21</td>
<td>0.25</td>
</tr>
<tr>
<td>Project 5</td>
<td>$283,000.00</td>
<td>0.13</td>
<td>0.21</td>
<td>0.75</td>
<td>0.21</td>
<td>0.25</td>
</tr>
<tr>
<td>Project 6</td>
<td>$680,000.00</td>
<td>0.31</td>
<td>0.05</td>
<td>0.75</td>
<td>0.02</td>
<td>0.25</td>
</tr>
<tr>
<td>Project 7</td>
<td>$68,000.00</td>
<td>0.03</td>
<td>0.21</td>
<td>0.75</td>
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<td>0.25</td>
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<tr>
<td>Project 8</td>
<td>$108,500.00</td>
<td>0.05</td>
<td>0.10</td>
<td>0.75</td>
<td>0.03</td>
<td>0.25</td>
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<tr>
<td>Project 9</td>
<td>$200,000.00</td>
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<td>0.05</td>
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<td>0.25</td>
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<tr>
<td>Project 10</td>
<td>$87,000.00</td>
<td>0.04</td>
<td>0.03</td>
<td>0.75</td>
<td>0.03</td>
<td>0.25</td>
</tr>
</tbody>
</table>
### Example Project Ranking with Budget Cut Line

#### RARROI Computations

Sorted by Descending RARROI with Budget Cut Line Shown

<table>
<thead>
<tr>
<th>Project Name</th>
<th>80% Confidence Estimated Cost of Ownership</th>
<th>Relative Weight</th>
<th>Customer Satisfaction</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 7</td>
<td>$68,000.00</td>
<td>0.03</td>
<td>0.21</td>
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<tr>
<td>Project 1</td>
<td>$28,500.00</td>
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<td>0.05</td>
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Summary Revisited

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- Portfolio Management ⇔ Portfolio Planning, Portfolio Tracking and Oversight
- Measurement objectifies management
- Size, Technology ⇒ Time, Effort, Defects
- Size and Technology are Uncertain
- Uncertainty ⇒ Confidence
- Effort, Confidence ⇒ Risk-Adjusted Investment
- Pairwise Comparison Process ⇒ Relative Return
- Risk-Adjusted Investment, Relative Return ⇒ RARROI
- Portfolio Sorted by RARROI ⇒ Project Priority, Budget Cut Line