# Project Portfolio Management Planning

## *A Method for Prioritizing Projects*

Mike Ross
Galorath Incorporated
100 North Sepulveda Boulevard
Suite 1801
El Segundo, California  90245
(480) 488-8366 (phone)     (480) 488-8420 (fax)
mross@galorath.com     http://www.galorath.com

**Abstract.** IT departments are caught between a rock and a hard place these days. Budgets are shrinking while the dependence on IT products and services is increasing. The pressure to demonstrate that each new project will either save money, increase sales, or result in enterprise-wide efficiencies is greater than ever. And yet, the majority of Global 1000 companies are still choosing which projects get funding either by the ***first-come/first served*** method, the ***squeaky-wheel gets the grease*** method, or the ***most powerful sponsor*** method. Deciding which IT projects get funding should be based on more than just subjective judgment; rather, the project should be analyzed objectively, looking at a number of factors – cost of ownership, cycle time, quality, risk, and benefit(s) being just a few. By analyzing projects objectively, they can be more effectively prioritized. CIOs and IT managers can then make wiser and more insightful decisions about which projects should get funding and which should be either postponed or shelved.

# Introduction

## Purpose

The purpose of this paper is to establish some basic taxonomy for the notion of ***portfolio management*** and then to describe a process for performing the ***portfolio planning*** part of portfolio management.

## Scope

The subject matter in this paper, while primarily geared to large enterprise Information Technology (IT) functions is nonetheless applicable to any enterprise seeking to improve the way it attempts to make decisions about investing in software development projects.

## Background

Back during high-growth days of the "go-go '90s," funding for Information Technology (IT) projects wasn't a big deal at many companies. If a project showed interesting potential and/or caught the eye of the right decision maker, it would likely get the thumbs-up.

Times have certainly changed, with competition for resources to complete IT projects more intense than ever. To help them prioritize multiple projects, many CIOs and IT managers are applying the principles of investment portfolio management to their ***portfolios*** of IT projects. This enables them to evaluate projects based on their contributions to the high-level strategic and financial objectives of the enterprise.

In other words, they're attempting to manage their project portfolios just like portfolios of investments – continually tracking outlays, returns, potential value and the risk of each project in order to maximize return on investment and accomplish corporate objectives. Just like an investment portfolio, the goal is to find the proper balance in their project portfolios in order to make the best investments that will maximize returns and minimize risk.

For example, a company might fund a few high-risk projects that have higher potential returns, but would want to balance this with other low-risk projects that offer more modest returns. Traditionally, this kind of risk-based decision making has only been applied at the individual project level – the portfolio management concept expands this to *collections* of projects.

The process of managing Information Technology (IT) projects using a financial investment portfolio metaphor has attracted much interest from CIOs in Fortune 1000 companies. This so-called IT ***portfolio management*** process is expected to improve returns on IT investments by ensuring that resources are funneled to those projects that will contribute the most to the company's overall success.

# A Taxonomy Framework for Portfolio Management

This paper first proposes a definition for Portfolio Management that closely parallels the essence of Software Project Management as described in the Software Engineering Institute's (SEI) Capability Maturity Model (CMM). This essence consists of key process areas for Software Project Planning and Software Project Tracking and Oversight [Paulk 1 et. al., 1993]. Consequently, the paper proposes that ***portfolio management*** be decomposed into analogous *key elements*: one called ***portfolio planning*** and one called ***portfolio tracking and oversight***. The idea is to *zoom out* from an individual project view (characteristic of Level 2 organizations) to one that encompasses a collection of projects associated with a particular business enterprise (characteristic of Level 3 and higher organizations).

To facilitate this analogy we first review the CMM definitions for Software Project Planning and Software Project Tracking and Oversight.

## Software Project Planning

The purpose of Software Project Planning as a key process area is to establish achievable plans for performing and managing software development [3].

Software Project Planning involves developing estimates for the work to be performed, establishing the necessary commitments, and defining the plan to perform the work [4].

Software Project Planning begins with a statement of the work to be performed and the goals and constraints that define and bound the software project (those established by the practices of Requirements Management). The software planning process includes steps to estimate the management measures (size, technology, time, cost/effort/staffing, and reliability), identify and describe the activities to be performed, identify and assess risks and opportunities, and negotiate commitments. Iterating through these steps may be necessary to establish a baseline plan [4].

## Software Project Tracking and Oversight

The purpose of Software Project Tracking and Oversight is to provide adequate visibility into actual progress so that management can take effective actions when the software project's performance deviates significantly from the software plans [3].

Software Project Tracking and Oversight involves tracking and reviewing the software accomplishments and results against documented estimates, commitments, and plans, and adjusting these plans based on the actual accomplishments and results [4].

The baseline plan (the primary product of the Software Project Planning process) is used as the basis for tracking progress, communicating status, and revising plans. Software management measures, activities, risks/opportunities, and commitments are periodically tracked and compared to their corresponding planned values. When it is determined that the software project's plans are not being met, corrective actions are taken. This may include revising the baseline plan to reflect the actual accomplishments and replanning the remaining work or taking actions to improve performance [4].

## Portfolio Planning

This paper proposes that ***portfolio planning*** is a key element of ***portfolio management*** and is analogous to the CMM Key Process Area (KPA) called Software Project Planning. This paper further proposes that, conceptually, ***portfolio planning*** as it relates to IT projects means making IT project investment (go – no go) decisions as some function of potential (***estimated***) ***Return on Investment*** (***ROI***). Historically this has sometimes been referred to as doing a cost-benefit analysis or a trade study.

## Portfolio Tracking and Oversight

Completing the analogy in the previous paragraph, this paper proposes that ***portfolio tracking and oversight*** is a key element of ***portfolio management*** and is analogous to the

CMM KPA called Software Project Tracking and Oversight. This paper further proposes that, conceptually, ***portfolio tracking and oversight*** as it relates to IT projects means using the artifacts produced by the ***portfolio planning*** process as the basis for effectively and efficiently scheduling the tasks of and allocating resources to each project in the portfolio as some function of inter-task dependencies, resource availability, and priority. There are numerous tools on the market today that have specialized in performing this process at the project level and are now offering enhancements that make this possible at the portfolio level as well.

## Portfolio Planning Process

This paper suggests that what's been missing from most of the discussion about the ***portfolio planning*** part of ***portfolio management*** is some clear notion of quantification; without which, objective fact-based decisions are virtually impossible to make.

This paper proposes an approach (summarized in Figure 1) that prioritizes (rank-orders) the projects in a given portfolio by a calculated value called ***Risk-Adjusted Relative Return on Investment*** (***RARROI***). Calculation of ***RARROI*** requires knowledge of two key ***estimated quantities***, the project's worth to the enterprise (***relative return***) and the project's cost of ownership (***risk-adjusted investment***). Knowing these two ***estimated quantities*** allows the IT manager to make business decisions the same way a fund manager makes buy, sell, and hold decisions.

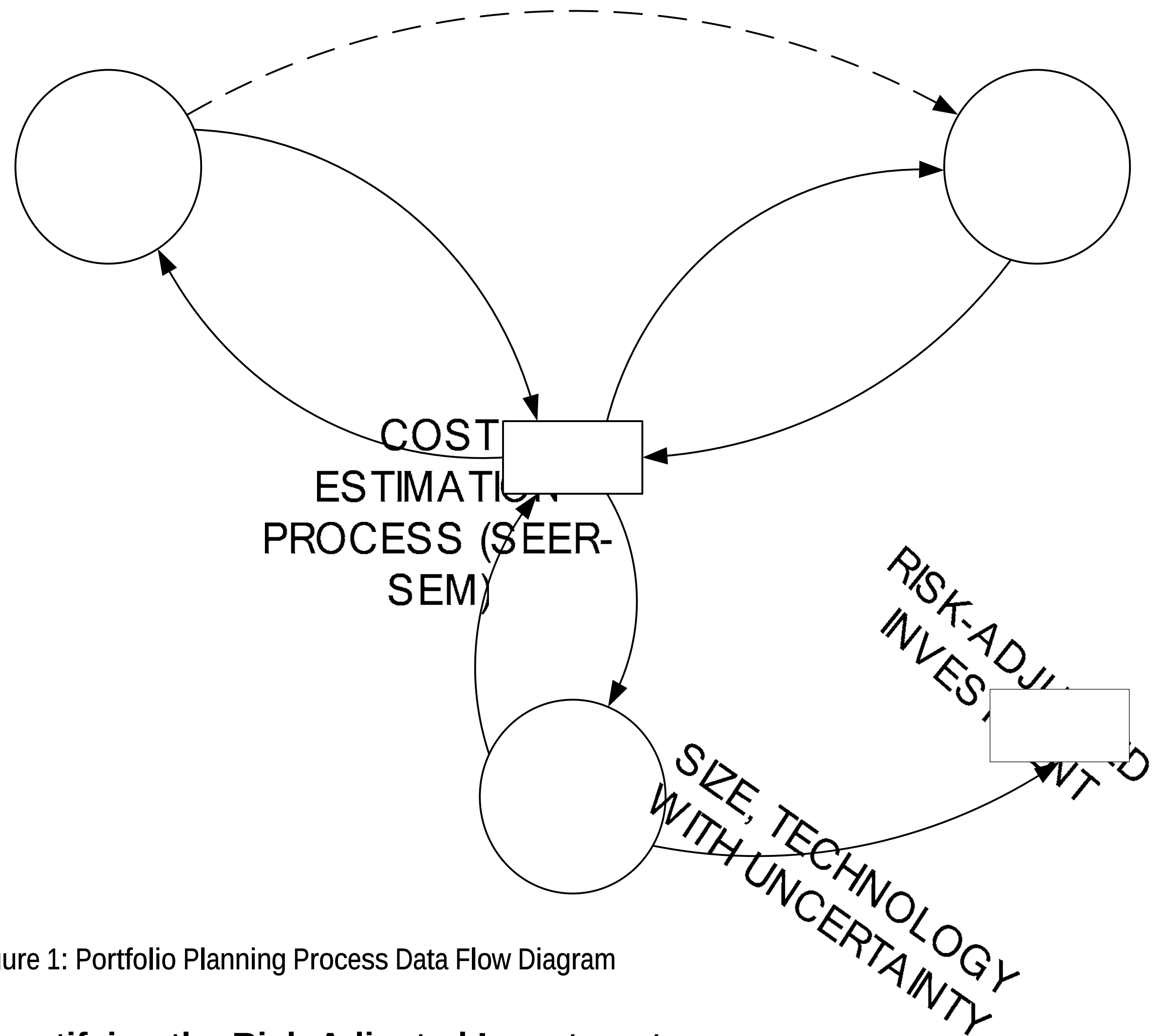


Figure 1: Portfolio Planning Process Data Flow Diagram

## Quantifying the Risk-Adjusted Investment

The ***risk-adjusted investment*** part of ***RARROI*** can be ***estimated*** as a function of ***size*** and ***technology*** using a structured process that is based on accepted statistical methods and real performance data. ***Structured estimating*** methods and tools, such as Galorath's ***SEER-SEM™***, are well established solutions for this part of the problem (see Figure 2).

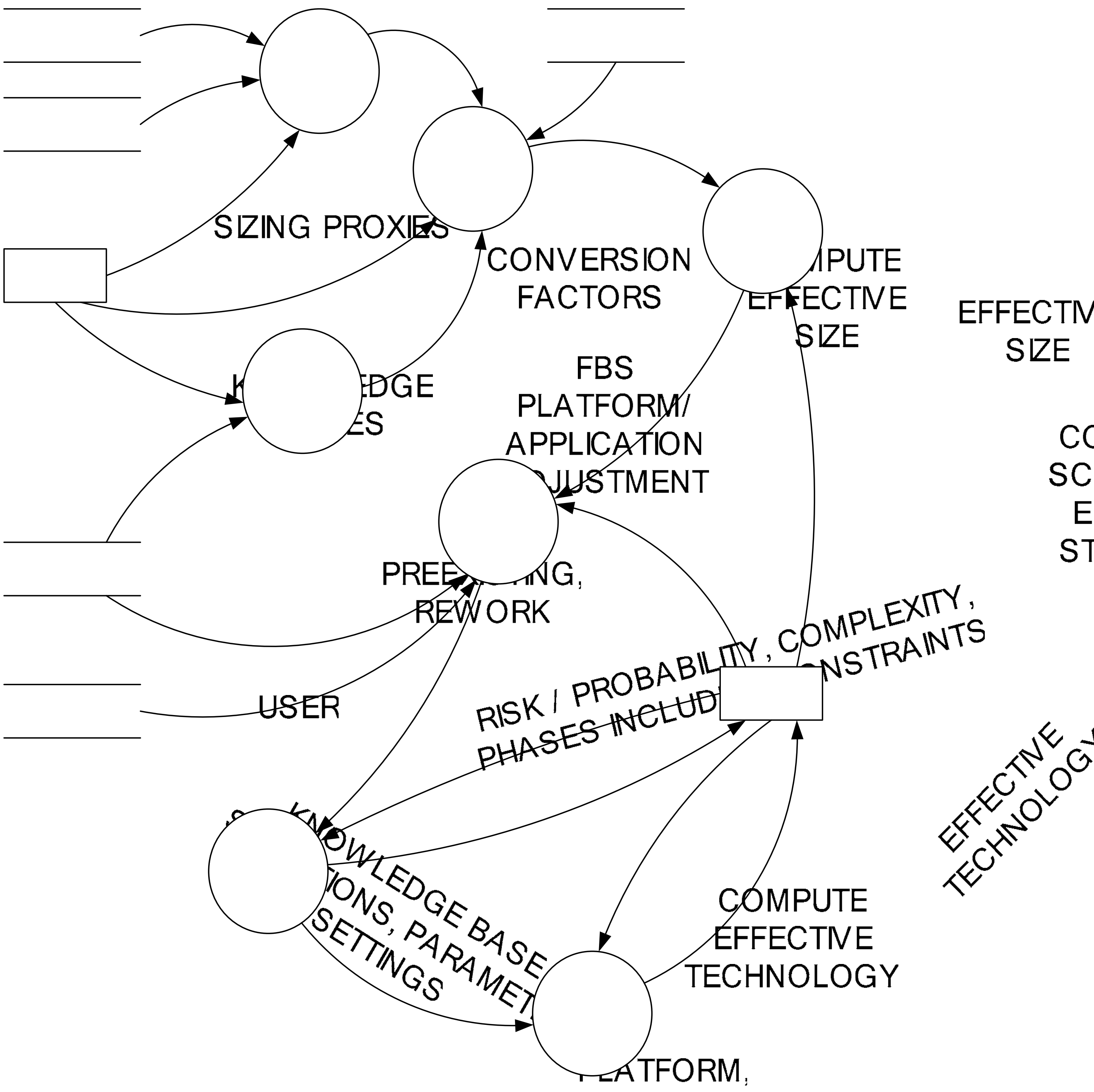


Figure 2: Structured Estimation Process as Implemented in Galorath's SEER-SEM™

***Structured estimating*** begins by hierarchically decomposing the proposed software product into manageable pieces and then describing each piece in terms of its ***expected effective size***, (volume of new and pre-existing software), its ***expected effective technology*** (based on a set of detailed ***technology parameters***), and the associated ***uncertainties*** about each. Various estimation-tool-supported sizing techniques; e.g., by ***direct measure*** (SLOC, Function Points, Use Cases, etc.), by ***pairwise comparison***, and by ***analogy***, aid the IT manager in describing ***expected effective size*** and its ***uncertainty***. ***Knowledge bases*** (a compilation and stratification of the data from thousands of real completed projects) aid in describing the detailed ***technology parameters*** and their ***uncertainty*** as a function of a project/product's general characteristics (Platform, Application, Acquisition Method, Development Method, and Development Standard).

***Expected effective size*** with ***uncertainty*** and ***expected effective technology*** with ***uncertainty*** are mathematically combined to yield ***calculated estimates*** for ***duration***, ***effort***, ***cost***, ***staffing***, and ***delivered defects***, as well as the ***confidence probability density functions*** associated with each. It is possible, therefore, to determine a project solution where the cost of ownership (***risk-adjusted investment***) value has, say, an 80% confidence; i.e., there is an 80% probability that the actual outcome cost will not exceed this determined value. Note that 80% is merely an example; each individual enterprise must determine its own risk tolerance. Typical reasonable confidence percentage values range from about 70% to 90%.

Incidentally, as a byproduct of this ***structured estimating*** process, an activity-artifact-skill distribution over calendar time can be generated that, in essence, represents the baseline plan; the key artifact required as input to the Software Project Tracking process.

## Quantifying the Return and its Associated Confidence

The ***return***, of course, will vary tremendously from project to project as a function of the business environment. ***Return*** is very difficult to quantify in terms of some absolute units like dollars since it tends to be influenced by multiple factors such as value to the marketplace, influence on customer satisfaction, influence on enterprise productivity / quality, etc. It is much more tractable to treat return as a normalized relative value. This ***relative return*** value can be estimated straight away or it can perhaps be a weighted average of several ***return parameters***.

Regardless of whether return is estimated in aggregate or parametrically, since relationships and influences vary from organization to organization, trying to develop specific algebraic estimation relationships (regressions) may not be the best approach. Instead, this paper proposes establishing normalized ***relative return*** values using the Analytic Hierarchy Process (AHP) [6]. Tools, such as Galorath's ***SEER-AccuScope***, aid in the implementation of this process.

### AHP Step 1

The first step in the AHP elicits a hierarchical representation of the decision criteria. The root node of the hierarchy represents the overall objective. The leaf nodes represent the set of decision alternatives. Intermediate levels in the hierarchy represent a decomposition of the relevant attributes of the decision process; i.e., selection criteria.

## AHP Step 2

The second step in the AHP elicits relational data for comparing the alternatives. This is done via a series of pairwise comparisons between each of the criteria at a given level in the hierarchy with respect to a criterion at the parent level (one level up). The value of a comparison $w$ between the $i^{th}$ criterion ($A$) in level $q$ and the $j^{th}$ criterion ($B$) in level $q$ with respect to a level $q-1$ (parent) criterion $U$ is assigned as follows:

- $\frac{w_i}{w_j}=1$ for $A$ having the same importance as $B$ with respect to $U$.
- $\frac{w_i}{w_j}=3$ for $A$ having slightly more importance than $B$ with respect to $U$.
- $\frac{w_i}{w_j}=5$ for $A$ having more importance than $B$ with respect to $U$.
- $\frac{w_i}{w_j}=7$ for $A$ having a lot more importance as $B$ with respect to $U$.
- $\frac{w_i}{w_j}=9$ for $A$ totally dominating $B$ with respect to $U$.
- $\frac{w_i}{w_j}=\frac{1}{3}$ for $A$ having slightly less importance than $B$ with respect to $U$.
- $\frac{w_i}{w_j}=\frac{1}{5}$ for $A$ having less importance than $B$ with respect to $U$.
- $\frac{w_i}{w_j}=\frac{1}{7}$ for $A$ having a lot less importance than $B$ with respect to $U$.
- $\frac{w_i}{w_j}=\frac{1}{9}$ for $A$ totally dominated by $B$ with respect to $U$.
- $\frac{w_i}{w_j}=2,4,6,8,\frac{1}{2},\frac{1}{4},\frac{1}{6},\frac{1}{8}$ can be used as intermediate values.

The results of the pairwise comparisons done for level $q$ with respect a criterion at level $q-1$ where level $q$ contains $n$ criteria can be organized in a positive pairwise comparison matrix $\mathbf{A}$ as follows:

$$\mathbf{A} = \begin{pmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{pmatrix} \qquad \text{Eqn. 1}$$

Where:

$\frac{w_a}{w_b}$ Represents the relative importance of the $a^{th}$ criterion over the $b^{th}$ criterion where $a, b \in 1, 2, ..., n$.

Note two important characteristics about this type of matrix:

- $a_{ii} = 1$ (every value on the principal diagonal of $\mathbf{A}$ is 1).
- $a_{ij} = \frac{1}{a_{ji}}$ (the values on one side of the principal diagonal are the mirror reciprocals of the values on the other side of the principal diagonal).

**AHP Step 3**

The third step in the AHP determines the relative weights for each positive pairwise comparison matrix developed in Step 2. Saaty [5] introduced a method for determining the relative criteria weight vector $\mathbf{W}$ of a comparison matrix $\mathbf{A}$ using the right eigenvector of $\mathbf{A}$.

$$(\mathbf{A} - \lambda_{\max}\mathbf{I})\mathbf{W} = \mathbf{0} \qquad \text{Eqn. 2}$$

or

$$\sum_{j=1}^{n} a_{ij} w_j = \lambda_{\max} w_i \qquad \text{Eqn. 3}$$

where

$$\sum_{i=1}^{n} w_i = 1 \qquad \text{Eqn. 4}$$

The matrix algebra necessary to solve for $\mathbf{W}$ can be quite cumbersome. A convenient numerical method for approximating $\mathbf{W}$ is as follows:

n := 1

$\mathbf{A_n} := \mathbf{A}$

$\mathbf{W_n}$ := a column vector, the elements of which are the normalized row sums of $\mathbf{A_n}$

repeat

n := n+1

$\mathbf{A_n} := \mathbf{A_{n-1}} \cdot \mathbf{A_{n-1}}$

$\mathbf{W_n}$ := a column vector, the elements of which are the normalized row sums of $\mathbf{A_n}$

until $\mathbf{W_{n-1}} - \mathbf{W_n}$ is sufficiently small for all elements

AHP applied to determining ***relative return*** first determines the ***return parameter importance*** (weight) of each ***return parameter*** and then determines the relative project importance for each ***return parameter***. The aggregate ***relative return*** for a given project is the sum of the weighted ***return parameters*** for that project.

Note that the ***estimation*** process associated with the ***risk-adjusted investment*** must be done ***before*** relative project importance for each value parameter is determined since this relative importance can change as a function of the particular ***duration***, ***effort***, ***cost***, ***staffing***, and ***delivered defects*** associated with a given solution. For example, a certain value parameter could assume a greater importance (weight) for a given project if the project can be delivered sooner.

## Calculating Risk-Adjusted Relative Return on Investment (RARROI)

***Risk-Adjusted Relative Return on Investment*** (***RARROI***) is simply the ratio of the ***relative return*** to the ***risk-adjusted investment*** as shown in below.

$$RARROI_P = \frac{\sum_{i=1}^{n} R_i W_i}{I_C} \qquad \text{Eqn. 5}$$

Where:

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

## RARROI-Based Investment Decision Making

Once ***Risk-Adjusted Relative Return on Investment*** (***RARROI***) has been calculated for each project, all that remains is to rank order the projects by descending ***RARROI***. Adding a column for cumulative ***estimated investment*** in dollars provides a quick means of determining where the budget *cut line* should be drawn.

## An Example

The following is a series of figures that show the sequence of the portfolio planning process steps for a portfolio of ten projects where a project's return is determined by its importance to customer satisfaction and productivity improvement and where the enterprise's risk tolerance has been established at 80%. The enterprise's budget for this portfolio is $1,000,000.

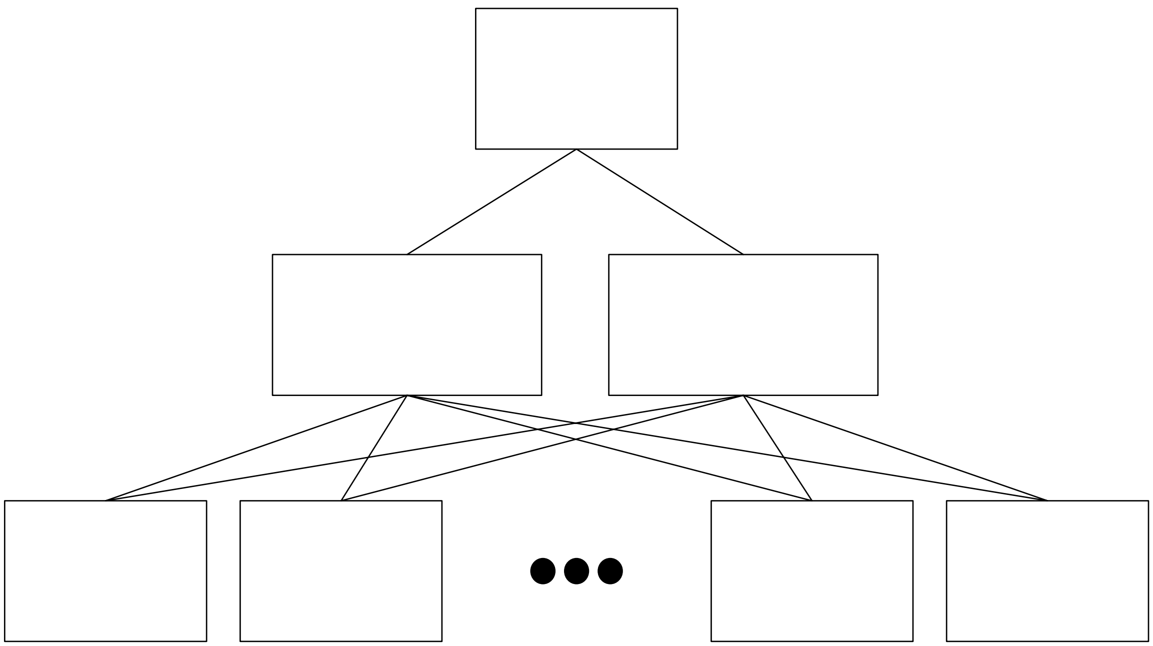

Figure 3: AHP Decision Hierarchy for the Project Portfolio's Return Evaluation

Pairwise Comparison Matrix

***Return Parameters***

| | | *j* | | |
|---|---|---|---|---|
| | | ***Customer Satisfaction*** | ***Productivity Improvement*** | ***Normalized Weight*** |
| ***i*** | ***Customer Satisfaction*** | **1.00** | 3.00 | **0.75** |
| | ***Productivity Improvement*** | 0.33 | **1.00** | **0.25** |

OVE
RETU

Figure 4: Pairwise Comparison Matrix and Normalized Relative Weights for the Return Parameters

CUSTOMER

Pairwise Comparison Matrix

***Customer Satisfaction***

| | | *j* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ***Project 1*** | ***Project 2*** | ***Project 3*** | ***Project 4*** | ***Project 5*** | ***Project 6*** | ***Project 7*** | ***Project 8*** | ***Project 9*** | ***Project 10*** | ***Normalized Weight*** |
| *i* | ***Project 1*** | **1.00** | 3.00 | 0.14 | 0.20 | 0.14 | 0.33 | 0.14 | 0.20 | 0.33 | 1.00 | **0.02** |
| | ***Project 2*** | 0.33 | **1.00** | 0.11 | 0.14 | 0.11 | 0.20 | 0.11 | 0.14 | 0.20 | 0.33 | **0.01** |
| | ***Project 3*** | 7.00 | 9.00 | **1.00** | 3.00 | 1.00 | 5.00 | 1.00 | 3.00 | 5.00 | 7.00 | **0.21** |
| | ***Project 4*** | 5.00 | 7.00 | 0.33 | **1.00** | 0.33 | 3.00 | 0.33 | 1.00 | 3.00 | 5.00 | **0.10** |
| | ***Project 5*** | 7.00 | 9.00 | 1.00 | 3.00 | **1.00** | 5.00 | 1.00 | 3.00 | 5.00 | 7.00 | **0.21** |
| | ***Project 6*** | 3.00 | 5.00 | 0.20 | 0.33 | 0.20 | **1.00** | 0.20 | 0.33 | 1.00 | 3.00 | **0.05** |
| | ***Project 7*** | 7.00 | 9.00 | 1.00 | 3.00 | 1.00 | 5.00 | **1.00** | 3.00 | 5.00 | 7.00 | **0.21** |
| | ***Project 8*** | 5.00 | 7.00 | 0.33 | 1.00 | 0.33 | 3.00 | 0.33 | **1.00** | 3.00 | 5.00 | **0.10** |
| | ***Project 9*** | 3.00 | 5.00 | 0.20 | 0.33 | 0.20 | 1.00 | 0.20 | 0.33 | **1.00** | 3.00 | **0.05** |
| | ***Project 10*** | 1.00 | 3.00 | 0.14 | 0.20 | 0.14 | 0.33 | 0.14 | 0.20 | 0.33 | **1.00** | **0.02** |

Figure 5: Pairwise Comparison Matrix and Normalized Relative Weights for Projects vis-à-vis Customer Satisfaction

Pairwise Comparison Matrix

***Productivity Improvement***

| | | *j* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ***Project 1*** | ***Project 2*** | ***Project 3*** | ***Project 4*** | ***Project 5*** | ***Project 6*** | ***Project 7*** | ***Project 8*** | ***Project 9*** | ***Project 10*** | ***Normalized Weight*** |
| *i* | ***Project 1*** | **1.00** | 3.00 | 1.00 | 0.33 | 0.33 | 7.00 | 0.33 | 5.00 | 3.00 | 5.00 | **0.10** |
| | ***Project 2*** | 0.33 | **1.00** | 0.33 | 0.20 | 0.20 | 5.00 | 0.20 | 3.00 | 1.00 | 3.00 | **0.05** |
| | ***Project 3*** | 1.00 | 3.00 | **1.00** | 0.33 | 0.33 | 7.00 | 0.33 | 5.00 | 3.00 | 5.00 | **0.10** |
| | ***Project 4*** | 3.00 | 5.00 | 3.00 | **1.00** | 1.00 | 9.00 | 1.00 | 7.00 | 5.00 | 7.00 | **0.21** |
| | ***Project 5*** | 3.00 | 5.00 | 3.00 | 1.00 | **1.00** | 9.00 | 1.00 | 7.00 | 5.00 | 7.00 | **0.21** |
| | ***Project 6*** | 0.14 | 0.20 | 0.14 | 0.11 | 0.11 | **1.00** | 0.11 | 0.33 | 0.20 | 0.33 | **0.01** |
| | ***Project 7*** | 3.00 | 5.00 | 3.00 | 1.00 | 1.00 | 9.00 | **1.00** | 7.00 | 5.00 | 7.00 | **0.21** |
| | ***Project 8*** | 0.20 | 0.33 | 0.20 | 0.14 | 0.14 | 3.00 | 0.14 | **1.00** | 0.33 | 1.00 | **0.02** |
| | ***Project 9*** | 0.33 | 1.00 | 0.33 | 0.20 | 0.20 | 5.00 | 0.20 | 3.00 | **1.00** | 3.00 | **0.05** |
| | ***Project 10*** | 0.20 | 0.33 | 0.20 | 0.14 | 0.14 | 3.00 | 0.14 | 1.00 | 0.33 | **1.00** | **0.02** |

Figure 6: Pairwise Comparison Matrix and Normalized Relative Weights for Projects vis-à-vis Productivity Improvement

| Project Name | Investment | | Return | | | | RARROI | Cumulative Investment |
|---|---|---|---|---|---|---|---|---|
| | 80% Confidence Estimated Cost of Ownership | Relative Weight | Customer Satisfaction | | Productivity Improvement | | | |
| | | | Relative Parameter Value | Relative Parameter Weight | Relative Parameter Value | Relative Parameter Weight | | |
| Project 1 | $ 28,500.00 | 0.01 | 0.02 | 0.75 | 0.10 | 0.25 | **3.33** | $ 28,500.00 |
| Project 2 | $ 237,000.00 | 0.11 | 0.01 | 0.75 | 0.05 | 0.25 | **0.21** | $ 265,500.00 |
| Project 3 | $ 304,500.00 | 0.14 | 0.21 | 0.75 | 0.10 | 0.25 | **1.31** | $ 570,000.00 |
| Project 4 | $ 173,500.00 | 0.08 | 0.10 | 0.75 | 0.21 | 0.25 | **1.61** | $ 743,500.00 |
| Project 5 | $ 283,000.00 | 0.13 | 0.21 | 0.75 | 0.21 | 0.25 | **1.62** | $ 1,026,500.00 |
| Project 6 | $ 680,000.00 | 0.31 | 0.05 | 0.75 | 0.01 | 0.25 | **0.13** | $ 1,706,500.00 |
| Project 7 | $ 68,000.00 | 0.03 | 0.21 | 0.75 | 0.21 | 0.25 | **6.76** | $ 1,774,500.00 |
| Project 8 | $ 108,500.00 | 0.05 | 0.10 | 0.75 | 0.02 | 0.25 | **1.64** | $ 1,883,000.00 |
| Project 9 | $ 200,000.00 | 0.09 | 0.05 | 0.75 | 0.05 | 0.25 | **0.53** | $ 2,083,000.00 |
| Project 10 | $ 87,000.00 | 0.04 | 0.02 | 0.75 | 0.02 | 0.25 | **0.61** | $ 2,170,000.00 |

Figure 7: Project RARROI Calculations

| Project Name | Investment | | Return | | | | RARROI | Cumulative Investment |
|---|---|---|---|---|---|---|---|---|
| | 80% Confidence Estimated Cost of Ownership | Relative Weight | Customer Satisfaction | | Productivity Improvement | | | |
| | | | Relative Parameter Value | Relative Parameter Weight | Relative Parameter Value | Relative Parameter Weight | | |
| Project 7 | $ 68,000.00 | 0.03 | 0.21 | 0.75 | 0.21 | 0.25 | **6.76** | $ 68,000.00 |
| Project 1 | $ 28,500.00 | 0.01 | 0.02 | 0.75 | 0.10 | 0.25 | **3.33** | $ 96,500.00 |
| Project 8 | $ 108,500.00 | 0.05 | 0.10 | 0.75 | 0.02 | 0.25 | **1.64** | $ 205,000.00 |
| Project 5 | $ 283,000.00 | 0.13 | 0.21 | 0.75 | 0.21 | 0.25 | **1.62** | $ 488,000.00 |
| Project 4 | $ 173,500.00 | 0.08 | 0.10 | 0.75 | 0.21 | 0.25 | **1.61** | $ 661,500.00 |
| Project 3 | $ 304,500.00 | 0.14 | 0.21 | 0.75 | 0.10 | 0.25 | **1.31** | $ 966,000.00 |
| Project 10 | $ 87,000.00 | 0.04 | 0.02 | 0.75 | 0.02 | 0.25 | **0.61** | $ 1,053,000.00 |
| Project 9 | $ 200,000.00 | 0.09 | 0.05 | 0.75 | 0.05 | 0.25 | **0.53** | $ 1,253,000.00 |
| Project 2 | $ 237,000.00 | 0.11 | 0.01 | 0.75 | 0.05 | 0.25 | **0.21** | $ 1,490,000.00 |
| Project 6 | $ 680,000.00 | 0.31 | 0.05 | 0.75 | 0.01 | 0.25 | **0.13** | $ 2,170,000.00 |

Figure 8: Projects Ranked by Descending RARROI with Budget Cut Line at $1,000,000

## Summary and Conclusion

Software Information Technology (IT) project ***portfolio management*** can be viewed as consisting of two key elements: ***portfolio planning*** and ***portfolio tracking and oversight***.

Time-tested software project ***estimation*** methods and tools are therefore an essential part of effective ***portfolio planning*** as they represent the best practices for ***estimating*** a project's ***estimated relative return*** and it's ***estimated risk-adjusted investment***. These ***estimated*** values yield a project's ***Risk-Adjusted Relative Return on Investment*** (***RARROI***) which, in turn, can be used as the basis for rank-ordering and ultimately selecting the projects to be funded.

A key byproduct of the ***investment*** (***cost of ownership***) ***estimation*** process is a baseline plan, which can be used as an input to the ***portfolio tracking and oversight*** process. Additionally, ***RARROI*** can be used in the ***portfolio tracking and oversight*** process as part of the basis for setting task priorities in a pre-emptive priority-based scheduling and resource allocation scheme.

***Portfolio management*** is a promising concept that needs measurement to be practical. *You can't control* [manage] *what you can't* [don't] *measure* [1]. This paper provides a reasonably simple calculation based on existing methods and tools that can serve as a foundation for applying measurement to ***portfolio planning*** and therefore help bring ***portfolio management*** into the realm of ***objective (i.e., fact-based) decision making***.

# References


[1] Chen, Y.W., "Implementing an Analytical Hierarchy Process by Fuzzy Integral," *International Journal of Fuzzy Systems*, Vol. 3, No. 3, pp. 493-502, 2001.

[2] Demarco, T., *Controlling Software Projects: Management, Measurement, and Estimation.* Yourdon Press, New York, NY, 1982.

[3] Paulk, M.C., Curtis, B., Chrissis, M.B., Weber, C.V., *Capability Maturity Model for Software, Version 1.1.* Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, 1993.

[4] Paulk, M.C., Weber, C.V., Garcia, S.M., Chrissis, M.B., Bush, M., *Key Practices of the Capability Maturity Model, Version 1.1.* Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, 1993.

[5] Saaty, T.L., "A Scaling Method for Priorities in Hierarchical Structures," *Journal of Mathematical Psychology*, Vol. 15, No. 3, pp.234-281, 1977.

[6] Saaty, T.L., *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*, McGraw-Hill, New York, NY, 1980.

# Biography

Michael A. Ross has over 28 years of practical experience in software engineering as a developer, manager, process champion, consultant, instructor, and international speaker.

Mr. Ross is currently the Chief Engineer of Galorath Incorporated, makers of the SEER suite of estimation tools, where he is responsible for the advancement and realization of the technology aspects of Galorath's mission and vision.

Prior to joining Galorath, Mr. Ross was Vice President of Education Services for another software project management firm where, during his seven-year tenure, he was responsible for the development and delivery of all training and served as one of the company's primary consultants and analysts working with Fortune 500 companies and government agencies in the areas of software measurement, sizing, estimating, tracking, forecasting, and benchmarking.

Mr. Ross, during 17 years with Honeywell Air Transport Systems (formerly Sperry Flight Systems), developed or managed the development of embedded software for avionics systems installed various commercial airplanes including the Lockheed L1011-500, Boeing 757/767, Airbus A320, Douglas MD-11, British Aerospace BAe-146, and the Boeing 777. He also co-founded the division's process improvement team (later to become its SEPG), served as a corporate SEI CMM assessor, and served as the division's focal for software project management process improvement.

Mr. Ross did his undergraduate work at the United States Air Force Academy and Arizona State University, receiving a Bachelor of Science in Computer Engineering. He is a member of the Project Management Institute (PMI), IEEE, the International Function Points Users Group, the International Society of Parametric Analysts, the Arizona Software Association, and the Phoenix area Software Process Improvement Network.