

## Project Selection in Large Engineering Construction Programs<sup>1</sup>

By Bob Prieto

One of the most important steps in implementation of a program management approach is the selection of the projects which will comprise the program. This selection process, done appropriately, is neither intuitively obvious nor simple. Done poorly, the program may achieve less than optimum results or be exposed to risks which may degrade its value over time. Project selection must flow from strategy which in turn is defined by an organization's strategic business objectives. Key performance indicators which are established to assure strategic business objectives are met, must cascade down through strategy assessment into overall project portfolio assessment and ultimately into individual projects.



The selection of the portfolio of projects that will comprise the program must:

- optimize multiple strategic business objectives
- address sequencing required for optimization
- address interdependencies between projects
- reflect real world resource constraints
- enhance program (and organizational) flexibility and resiliency

<sup>1</sup> Second Editions are previously published papers that have continued relevance in today's project management world, or which were originally published in conference proceedings or in a language other than English. Original publication acknowledged; authors retain copyright. This paper was originally published in the PM World Today eJournal in June 2011. It is republished here with author's permission.

Programs which experience weak project selection may have failed to:

- maintain focus on strategic business objectives allowing biases to enter the process
- establish a sufficiently strong methodology for project portfolio evaluation, often only considering one primary strategic business objective without attention to other such objectives
- appropriately cascade metrics down to the assessment of project portfolio performance
- inadequately reflect uncertainty and risks in portfolio evaluation

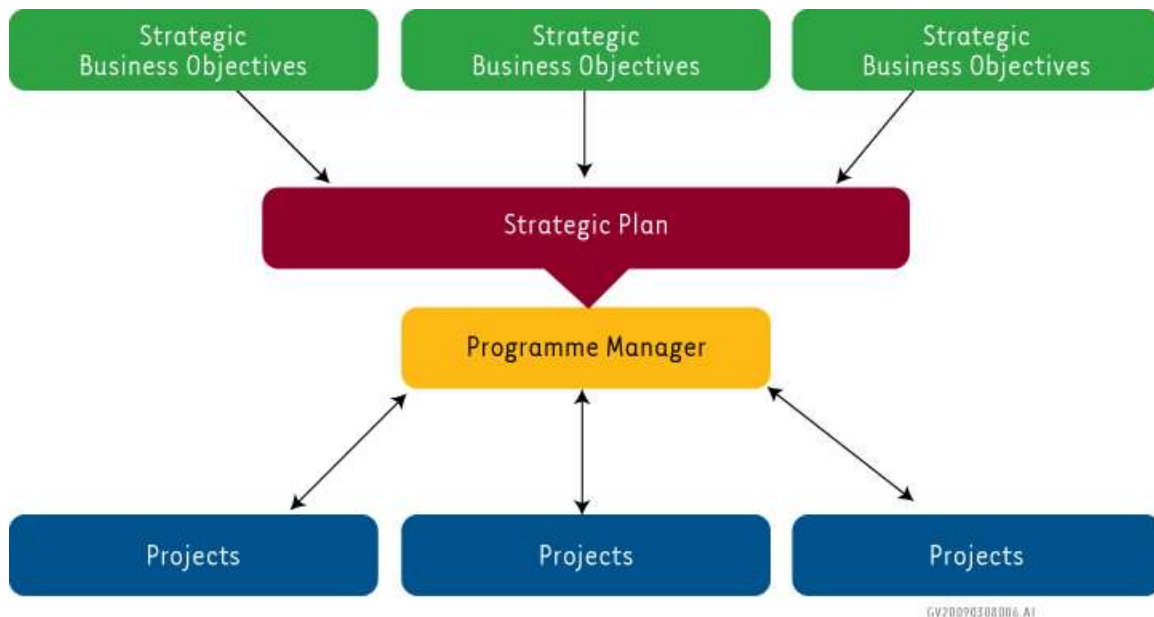
Weak project selection will result in lower value capture and, to the extent to which project selection appears to be driven by non-objective factors, undermine organizational honesty and openness.

Projects selection must be monitored as well as project performance under program management. This is an area which requires increased focus in the engineering and construction industry. Changes in market conditions, resource constraints, risk levels or execution performance may drive a re-evaluation of the portfolio which shows that redeployment of resources is in the best interest of achieving the programs strategic business objectives even when sunk costs and commitments are fully considered.

Termination of a previously selected project may be a simpler matter if it is performing below expectations (schedule delays, cost overruns) but when driven by a reduction in the benefits that will accrue or value derived it is a much harder matter. Who wants to be the program manager who terminates a strong performing project (ahead of schedule, under budget)?

### **Optimize Multiple Strategic Business Objectives**

A key attribute of project selection in major engineering and construction programs is the need to simultaneously optimize multiple strategic business objectives.



This need is driven by the outcomes focus of programs versus the outputs focus that is more typical of projects. Successful optimization will rest on:

- clear definition of strategic business objectives
- SMART key performance indicators or KPIs for each objective
  - Specific
  - Measurable
  - Achievable
  - Realistic
  - Targeted
- well defined constraints facing the program and individual projects
- delineated interdependencies between projects including any precedence requirements
- clarity around attendant risks and uncertainties at the program and project level.
- appropriate weighting of benefits and constraints that comprise the project portfolio's evaluation criteria by the executives most focused on strategic business objective achievement

Evaluation criteria and constraints may include:

- Financial
  - Life cycle return on investment
  - Return on assets employed
  - Net present value of cash flows
  - Payback period
  - Total capital expenditures
  - Product/project gross margins

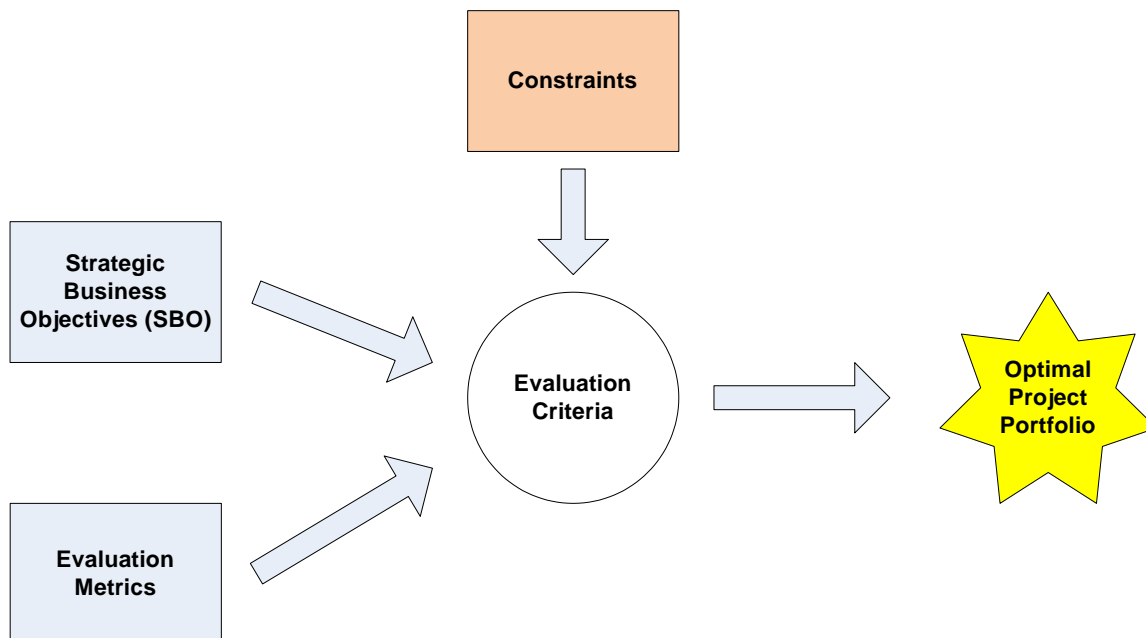
- Market
  - Market share
  - Market growth and duration
  - Period of profitable production
  - Product flexibility
  - Customer impacts
- Strategic
  - Flexibility
  - Resiliency
  - Contribution to overall portfolio performance
  - Enablement of SBO achievement
  - Enablement of other portfolio projects
  - Critical resource utilization
- Sustainability or Triple Bottom Line focused criteria
  - Economic
  - Social
    - Community impacts
    - Capacity building
    - New industry/business creation
    - Stakeholder support
    - Workforce impacts
  - Environmental, Health & Safety
    - Airborne emissions
    - Water consumption
    - Discharge water quality
    - Environmental degradation
    - Worker health and safety
    - Public health and safety
- Risk
  - Economic or market uncertainties
  - Other event risks
  - Financing uncertainties
  - Cost uncertainties
  - Schedule uncertainties
  - Labor risks
  - Stakeholder risks
  - Sovereign and legislative risks
  - Political risks
  - Technology risks
  - Intellectual property risks
  - Business model risks
  - Project execution risks

Weak project evaluation methodologies that seek to reduce all benefits to a singular cost related value, such as NPV, must be avoided in recognition that:

- Uncertainty in estimates is compounded
- Structured multi-variate risk analysis would produce a better assessment of risk
- Benefits of later phase projects are not fully appreciated
- Changes in risk profile over time are not recognized

### **Avoiding Bias in Project Selection**

Objective assessment rests on well defined objectives, constraints and evaluation metrics that can be mapped to well defined evaluation criteria.



**Avoiding Bias in Project Selection**

It is essential that the owner’s team and program manager understand potential sources of selection bias and carefully review objectives, metrics, constraints and evaluation criteria to ensure such biases have been minimized and ideally eliminated. The use of unconscious shortcuts to make complex decisions has been well documented but may lead to systematic errors in the project portfolio selection process.

The following table lists some of the biases more commonly observed in programs with weak project selection.

<b>Heuristic Biases Affecting Project Selection</b>
<b>Motivation bias</b>
<b>Status Quo bias</b>
<b>Perception bias</b>
<b>Risk aversion</b>
<b>Optimism bias</b>
<b>Comfort zone bias</b>
<b>Wishful thinking</b>
<b>Group think</b>
<b>Uncertainty acceptance</b>
<b>Judgmental biases</b>
<b>Sunk cost bias</b>
<b>Supporting evidence bias</b>
<b>Contradictory evidence avoidance</b>
<b>Biased argument framing</b>
<b>Anchoring</b>
<b>Illusion of control</b>
<b>Planning fallacy</b>
<b>Semmelweis reflex</b> – (tendency to reject new evidence that contradicts an established paradigm)
<b>Bounded awareness</b>
<b>Reasoning by analogy</b>

Removing biases from the project selection processes requires a conscious set of actions that begin with the recognition that potential biases as a result of heuristic and other processes will exist and that a motivated and conscious effort is required to remove them from the process.

### **Project Portfolio Evaluation Methodology**

Many techniques exist for evaluation of potential project portfolios that will optimally meet an organization's Strategic Business Objectives. We have already discussed the importance of metrics and unbiased evaluation criteria and constraints.

Numerous techniques exist for solving multi-objective project portfolio problems but proper application is dependent on accurately evaluating benefits and constraints and so called “rate and weight” methodologies lend themselves to the bias concerns discussed above and should be avoided.

Project proponent claims, costs, schedule and benefits need to be carefully reviewed and challenged as part of the project selection process and one or more capital allocation methodologies utilized. These capital allocation methodologies include:

- ranking of potential projects by cost benefit ratios
  - independent projects with singular budget constraint
- linear programming
  - multiple constraints especially when extensive project options being considered
- integer programming using “branch and bound” methods
  - most accurate when project options are narrowed
    - there are  $2^N$  potential project portfolios, where N is the number of projects that are either funded or not funded

The standard capital allocation model is derived from work done by Markowitz on Portfolio Theory and may be written as:

$$\text{Maximizing } \sum_{i=1}^N b_i x_i$$

Where  $b_i$  is the benefit associated with the  $i^{\text{th}}$  project; and  $x$  is either zero or one depending if the project is included in the portfolio or not

The above capital allocation model is constrained in such a way that the total cost of all projects in the portfolio does not exceed some maximum capital cost such that:

$$\sum_{i=1}^N c_i x_i \leq C$$

Given that a total budget constraint is typically not as hard as the above formula would suggest, it may be convenient to understand the sensitivity of the portfolio optimization to the maximum capital cost level.



This simple capital allocation model can be extended to address:

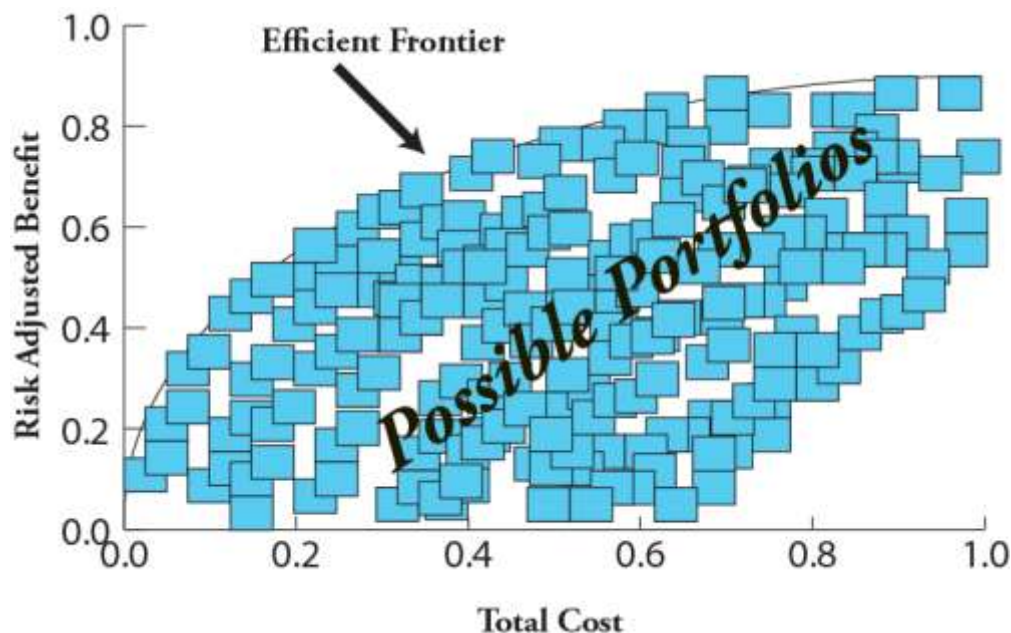
- multiple benefits (associated with multiple evaluation criteria, appropriately weighted)
- benefits spread over time (net present value)
- costs spread over time (net present value)
- future costs associated with implementation of a project (maintenance and operating costs; consumables)
- costs associated with not doing a project
- mutually exclusive projects or project alternatives
- project precedence
- partial project benefit interdependency
- cost, schedule other benefit synergies
- multi-period cost constraints
- sensitivity to delay

### The “Efficient Frontier”

Solving the capital allocation model does not result in a singular solution but rather an extensive solution set that may be considered by looking at:

- *risk adjusted* benefits versus total costs (project portfolio management)
- portfolio returns at various risk levels (portfolio theory)

These potential portfolio solutions may be plotted to create a view of the "efficient frontier."





Identifying and understanding the efficient frontier allows us to identify the best project portfolios at a given budget level and to assess the lost benefits or added costs associated with other than optimal portfolio selection.

As cost constraints are relaxed, additional or larger projects can be considered providing lower incremental returns. This is reflected in the flattening observed in the efficient frontier and closely mirrors Pareto’s 80/20 rule where 80% of all value available from all projects may be achieved from doing just 20% of the projects. This provides the program manager with a convenient tool for management prioritization and the development of critical controls for the program.

### **Characteristics of Successful Project Portfolios**

Successful project portfolios:

- assure projects are aligned with an organization’s strategic direction
- are based on a sound portfolio decision process
- comprise projects that are resilient to the effects of uncertainties embedded in the project selection process
- recognize the shift in constraints as one moves from a project to program context

<b>Constraints Shift Under Program Management</b>	
<b>Project</b>	<b>Program</b>
<b>Scope</b>	<b>Alignment with Strategic Business Objectives</b>
<b>Schedule</b>	<b>Required Resources</b>
<b>Cost</b>	<b>Benefits</b>

Successful project portfolios address key questions related to:

- resources required for program implementation
- critical resource limitations that the program will face
- prioritization of objectives
- identification of critical controls
- projects critical to individual SBO achievement
- consideration of uncertainty and risk
- project interdependencies
- key portfolio risk areas

Successful project portfolios recognize that the critical aspect of the project selection process is represented by the quality of the decisions made.

## **Conclusion**

Objective driven, bias free project portfolio analysis and selection provides the program manager with another tool to:

- build organizational alignment
- understand program sensitivities to changes in acceptable risk levels and profile
- understand the influence of budget and other constraints on benefit maximization
- identify project priorities, sequencing and effects of interdependencies and synergies
- establish an appropriate set of critical controls.

## **References:**

1. Markowitz, H.M. (March 1952). "Portfolio Selection". *The Journal of Finance* 7 (1): 77–91. doi:10.2307/2975974. <http://jstor.org/stable/2975974>.
2. *Strategic Program Management*; published by the Construction Management Association of America (CMAA); ISBN 978-0-9815612-1-9; July 24, 2008
3. *Topics in Strategic Program Management*; ISBN 978-0-557-52887-5; July 2010



## About the Author



### **Bob Prieto**

*Senior Vice President  
Fluor*

Princeton, NJ, USA

**Bob Prieto** is a senior vice president of Fluor, one of the largest, publicly traded engineering and construction companies in the world. He is responsible for strategy for the firm's Industrial & Infrastructure Group on the development and delivery of large, complex projects worldwide. The group encompasses three major business lines including Infrastructure, with an emphasis on Public Private Partnerships; Mining; and Industrial Services. Bob consults with owners of large engineering & construction capital construction programs across all market sectors in the development of programmatic delivery strategies encompassing planning, engineering, procurement, construction and financing. He is author of "Strategic Program Management", "The Giga Factor: Program Management in the Engineering and Construction Industry" and "Application of Life Cycle Analysis in the Capital Assets Industry" published by the Construction Management Association of America (CMAA) and "Topics in Strategic Program Management" as well as over 450 other papers and presentations.

Bob is a member of the ASCE Industry Leaders Council, National Academy of Construction and a Fellow of the Construction Management Association of America. Bob served until 2006 as one of three U.S. presidential appointees to the Asia Pacific Economic Cooperation (APEC) Business Advisory Council (ABAC), working with U.S. and Asia-Pacific business leaders to shape the framework for trade and economic growth and had previously served as both as Chairman of the Engineering and Construction Governors of the World Economic Forum and co-chair of the infrastructure task force formed after September 11th by the New York City Chamber of Commerce. Previously, he served as Chairman at Parsons Brinckerhoff (PB), one of the world's leading engineering companies. Bob Prieto can be contacted at [Bob.Prieto@fluor.com](mailto:Bob.Prieto@fluor.com).