Fundamental Principles of Project Prioritization

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This document describes four basic valuation concepts that underlie the Project Prioritization methodology. Project Prioritization is designed to solve a specific capital budgeting problem – that of identifying the set of projects (in current and future years) that maximize the net present value of the portfolio subject to budget constraints in each year. Project Prioritization is based on state-of-art multi-attribute decision theory. In order to apply the theory, practical implementation issues must be solved. This paper describes four such issues.

1 Value Provided By A Project

The value provided by a project is based on the incremental benefit the project provides compared with not doing the project, the so-called *Do-Nothing* alternative. The attribute levels associated with doing nothing are specified over time. The attribute levels associated with the project are specified over time.

The value of doing a project is defined by equation (1) below. The terms in equation (1) are:

$u_j(x_j)$	scaled value of attribute j when it is observed to be at measured level x_j.
w_j	weight placed on attribute j.
$x_{j,dn}(t)$	level of attribute j at time t if the project is not done.
$x_{j,p}(t)$	level of attribute j at time t if the project is done.
r	discount factor applied to future benefits.

The net present worth of a project done in the first year of the analysis period is

$$NPW_p = \sum_t r^t \sum_j w_j \left\{ u_j \left[x_{j,p}(t) \right] - u_j \left[x_{j,dn}(t) \right] \right\} \tag{1}$$

There are several things worth noting about equation (1).

- The time horizon over which benefits are added is left unspecified. This will be discussed below (see point 2, below), but in theory the summation must extend over the infinite horizon.

- If the attribute level provided by a project is unchanged if the project were not undertaken, then the contribution of that attribute to the net present worth of the project is zero, because the term in brackets vanishes.
- Benefits are discounted as if they were measured in dollars.
- In words, the benefit provided by a project is the net present worth of the changes in attribute levels that the project creates.
- Doing nothing has zero net present worth.

Main conclusion: report values for only those attributes whose levels are changed by a project.

2 Time Horizon

The time horizon in equation (1) is not specified. The practical question is over how many periods denoted by t will a project provide value? In this methodology, the net benefits provided by a project can be measured as far as the foreseeable future extends; indeed, that takes the summation out to infinity. Practically, however, one recognizes that even if the Do-Nothing alternative were selected, there will come a time when *something* will be done to address the situation that the project under consideration addresses. Therefore, at some future time, the incremental benefits provided by a project, given by the term $\{u_j\,[x_{j,p}(t)] - u_j\,[x_{j,dn}(t)]\}$, as in (1), will vanish. In this methodology, it is assumed that such a time exists, and that the future attribute levels are virtually identical from that time onward.

Put another way, there is a time associated with a project such that the project provides incremental benefits compared with the Do-Nothing alternative. Beyond that time, the attribute levels are the same and the project provides no net benefits. This time is denoted T_p and it is important to note that this time can vary by project (hence the subscript p).

Finally, another way to express this idea is that delaying the attribute changes provided by the project indefinitely cannot happen and that somehow doing nothing "catches up" to the project – after some point the project can no longer be deferred and a project must be done.

A typical project report will contain the following:

- The attribute levels provided by the project for the five years for which budgets are provided, $x_{j,p}(t), t = 1, 2, 3, 4, 5$.
- The attribute levels provided if the project were not undertaken for five years for which budgets are provided, $x_{j,dn}(t), t = 1, 2, 3, 4, 5$.
- The time beyond the budget period during which the project provides incremental benefit, the collection of times $\{t : 6 \leq t \leq T_p\}$, assuming that budgets are specified for the first five years in the planning period.
- A simple description of the incremental benefits provided by the project compared with doing nothing from $t = 6$ to $t = T_p$.

Main conclusion: report incremental value provided by a project only until the time it takes for doing nothing to catch up.

3 Project Portfolio Selection

Projects are selected so that the total net benefit provided by the selected projects is greatest, subject to not exceeding the budget constraints. The decision variables in this problem are actually *when* to begin a project. Any project can be started in any year of the planning period, so each project has associated with it an initialization year, which can be 1,2,3,4,5, or never.

In this methodology, we formulate and solve the optimization problem of selecting the best starting time for each project. The net present worth of each project, given by (1), modified appropriately for delayed projects—no incremental benefits exist during the years the project is delayed. The starting times are specified so that the sum of the benefits is greatest without exceeding any of the constraints.

Main conclusion: the decision variable in this methodology is <u>when</u> to do a project. If a project is delayed more than five years, it is as if it is never done.

4 Deferred or Avoided Costs

The question of how to treat deferred project costs—costs not paid when a project is deferred—has arisen. In this project prioritization methodology, costs are constrained so there is no benefit for deferring a project or avoiding a cost of a planned project. To claim such a benefit would be (a) double counting and (b) a violation of the meaning of a constraint.

However, a planned expense associated with the Do-Nothing alternative can be treated as a benefit if the project defers the expense. For example, if a planned substation improvement is delayed four years because a project is selected, the cash flow associated with that deferral can be expressed as a benefit of undertaking the project.

The question of how to treat deferred project costs may arise because of familiarity with an approach to project evaluation that characterizes each project by its own Net Present Value, NPV. In that approach, the net present value of a project is:

$$NPV = PV(Value) - PV(Costs) \tag{2}$$

where PV means discounted present value. The first term on the right-hand side of (2) is the present value of the benefits provided by a project. The second term is the present value of the costs. The decision whether to defer a single project T years can be based on maximizing the NPV of these two alternatives, using (2), thus, in part, comparing the present value of the costs associated with doing the project immediately or deferring it. In this approach, the deferred costs provide a benefit. Using the obvious notation, one compares

$$NPV_{now} = PV_{now}(Value) - PV_{now}(Costs) \tag{2a}$$

with the deferred project's net present value

$$NPV_{defer\ T} = PV_{defer\ T}(Value) - PV_{defer\ T}(Costs) \tag{2b}$$

and selects the alternative with greater net present value. However, these considerations do not apply when one determines the constrained optimal portfolio of projects. As noted above, for the portfolio problem, the objective is to identify the portfolio of projects (in current and future years) that maximize the net present value of the *portfolio* subject to budget constraints in each year. The equations for this optimization problem are somewhat complex and are not included here. We hope that the words are sufficient to communicate the concept.

The main difference between the project-oriented approach as described by equations (2, 2a, 2b) and the project prioritization methodology is that deferred cost is part of the *objective* in equations (2, 2a, 2b), but deferring a cost contributes only to the *constraints* in the project prioritization methodology.

Note that in the project prioritization methodology, when a project is deferred from any current year to the next year, that deferral frees constrained budget dollars so as to allow the selection of one or more additional projects in the current year. For the deferred project, it is certainly true that its being deferred changes both the present value of the benefits it provides and the present value of its costs. But in identifying the set of projects that maximize value, the value calculation employed in the project prioritization method does not include costs. This is so because costs are accounted for in the budget constraint only.

Main conclusion: so-called avoided project costs, avoided because of deferral, do not count. The opportunity provided by deferral is not monetary; it is instead the opportunity to do something else.