PROJECT MONEY MANAGEMENT

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1. Introduction

Managing a project budget isn't too different from managing a personal budget in theory. However, a particular challenge for project budgeting, compared to personal finances, is that projects nearly always incur large "up front" costs, and the profits (for commercial products) or benefits (for public service or military projects) are realized later over time. There is very little immediate gratification in project management. Planning and forethought are absolutely essential for the best utilization of resources. While there are always unknowns in determining the project budget, "fortune favors the prepared mind."[1] The better you think through your project, the better you will be able to create an accurate budget, which will take a lot of the pain out of your project work.

2. Money Estimate Types

2.1 The Ballpark Estimate

This is the type of estimate that is used in the early planning process of a project. It is used to assess whether or not the project should even be considered, or for choosing between project alternatives, and should not be the subject of a large time investment. To make the ballpark estimate, the project manager relies on comparison to prior projects, and perhaps some brief web searches to get an estimate for the most expensive pieces of equipment or materials that might be necessary, add a conservative (i.e. pessimistic) estimate for labor costs, and an additional 10-20% margin for materials and supplies. It is better to err on the conservative (pessimistic) side when making a ballpark estimate, as your clients will remember that ballpark figure if you progress with the project. Clients are likely to object to a significant increase in cost over the initial estimate but will rarely object to a decrease.

2.2 The Budget Estimate

The budget estimate represents the next level of accuracy in cost estimation. The purpose of the budget estimate is to allocate resources for the organization and some care should be taken in its calculation. Costs should be estimated accurately—using some of the techniques in the next section. Approximations are still used at this stage to keep the task manageable and to accommodate uncertainties. For example, at USNA an informal rule of thumb that many professors use for budgeting travel is that attendance at a conference in the continental U.S. will cost $2K/person, and attendance at an international conference will cost $3K/person. The goal with a budget estimate is to be within about 20% of your final project cost.

2.3 The Definitive Estimate

The definitive estimate requires the highest level of accuracy. For definitive estimates, formal quotes, which are legally binding contracts on the agreed price, are sought for the major pieces of equipment in the project. For some items—particularly lower cost items--only informal quotes might be available. An informal quote is something like the price you see on-line for a

[1] Louis Pasteur, in a lecture at the University of Lille in 1854. http://en.wikiquote.org/wiki/Louis_Pasteur, accessed 12 October 2012.

book on Amazon.com. That is an accurate representation of the purchase price at that moment but there is no guarantee that the Amazon price will stay fixed at that value. Such informal quotes can cause problems when there is a significant time delay between your identification of the desired part and the actual purchase, which is often the case in large organizations. Therefore, for expensive items you should seek a formal quote—most companies can provide formal quotes if contacted directly. Definitive estimates should always be used when you provide paperwork for purchasing. You also should provide specific part numbers and as much descriptive detail as you can fit on the form.

3. Cost Estimation

Project budgets include the costs for labor, equipment, materials, and support expenses. In situations where there is uncertainty in costs, models are used for best estimation. Finally, break-even analysis is often used in commercial projects to set the price point or to determine what can be tolerated in terms of costs.

3.1 Cost Categories

Labor is usually the dominant cost of any activity. In addition to the take home wage of the employee, the employer must also pay for related taxes and benefits. Estimates of overhead vary widely, but it's safe to assume that the labor cost to the employer is at least 20% greater than the before-tax wage of the employee, for an employee with the typical benefits of health insurance and some sort of retirement plan. The rates that we are using for labor costs in our capstone course ($10/hour for students and $50/hour for faculty) are an underestimate of labor expenses, particularly considering labor overhead.

Equipment and supplies are often confused, but they are in fact very distinct categories. Equipment connotes apparatus that is generally more expensive but also is expected to be used for a long time. Businesses are expected to track and maintain equipment, and the purchase cost for equipment is typically "amortized" or spread over a longer time period. Supplies on the other hand are typically less expensive and don't require maintenance. For example, if you accounted for your personal finances like a business, your car would count as equipment (and often is purchased over a long period of time via a loan), and your textbooks would count as supplies (just because they don't require maintenance doesn't mean they don't require use).

3.2 Cost Models

As you will realize when you ponder your own project budgets, there is a lot of uncertainty in the estimation of costs. Cost estimates are usually based on past experience and expert opinion. When estimates vary widely, an averaging function is often used such as[2]:

$$cost = \frac{cost_a + cost_m + cost_b}{6}$$

where $cost_a$ is the most optimistic cost estimate, $cost_b$ is the most pessimistic cost estimate and $cost_m$ is the most likely cost estimate.

[2] Ford & Coulston, Design for Electrical and Computer Engineers, McGraw-Hill Higher Education, New York, NY, 2005, pp. 205-207.

Labor estimates are often done in terms of man-hours (or other variations of people-time). One man-hour implies one person working for an hour on an activity. So, for example, 10 man-hours could involve five people working for two hours each, ten people working for one hour each, or one person working for ten hours. If all of these workers were paid the same hourly wage, then the budgeting would be the same. A similar unit, somewhat unique to programming and computer engineering project management, is the unit of KLOC (pronounced "kayloc") for 1000 lines of code. IBM models the amount of worker-months for its projects through this unit. For example, from past experience, IBM determined that the number of worker months for the development of a new software project was given by:

$$Effort = a\left(KLOC\right)^{b}$$

where a = 5.2 worker-months and b = 0.91.[3] This formula is then applied to develop the budgets upcoming projects by first estimating the number of lines of code, then using that to calculate the effort required, and then using the wage rate to determine cost.

The bigger the budgets, the more care must be taken with cost models. As you can imagine, there are experts who make their living from these models.

3.3 Break-Even Analysis

For a commercial project, break-even analysis describes the relationship between sale price, costs, and product volume. Costs can be divided into two broad categories: "fixed costs" that are constant regardless of production volume, and "variable costs" which depend on the number of items being produced. For the "Visual Aid" examples of fixed costs are research and project development costs, and things like re-tooling a factory for production. Examples of variable costs are the materials, sensors, actuators, and microcontrollers that go into each visual aid unit. The equation for the break-even point, where *n* is the number of units you need to sell for your sales income to equal your total costs, is given by:

$$n \times \frac{sale\$}{unit} = cost_{fixed} + n \times \frac{cost_{\text{var}}}{unit}$$

For example, for the "Visual Aid" let's assume that the R&D and other fixed costs amount to $20,000. In mass production, assuming some economies of scale such as volume discounts on sensors, the cost per unit is projected to be $400. Suppose that our market experts have projected our sales volume at 500 units/year. What should be the sales price if we wish to break even after 2 years?

$$\frac{sale\$}{unit} = \frac{20000 + (2*500) \times 400}{(2*500)} = \$420$$

4. Capstone Project Budgets

The cost estimate that you put into your proposal should be at the "budget estimate" level of accuracy. You should include a budget for labor (at the rate of $10/hour for students and

[3] Ford & Coulston, pp. 206.

$50/hour for faculty and staff) but keep those numbers distinct from the other costs. Besides labor, you should only include the cost of equipment and supplies that you truly expect to purchase for your project. Do not include materials and equipment that are already available at USNA. The reason for this is that the Capstone Coordinator is going to use your budget estimates to plan for resource allocation in the department. Also, if your project has a source of funding besides department operating funds, please indicate that as well. Here is an example of the budget for the "Visual Aid" project:

Item	Unit	Unit Price	Quant.	Sub-Total
Labor				
Students	Hour	$10	1000	$10000
Faculty	Hour	$50	64	$3200
Labor Total				**$13200**
Materials				
Ultrasonic Sensors	Ea	$30.00	10	$300
Infrared Sensors	Ea	$15.00	5	$75
PIC Microcontroller	Ea	$1.00	10	$10
Vibration Motors	Ea	$2.00	20	$40
Batteries	Ea	$12	5	$60
Battery Mount	Ea	$3.75	4	$15
Fabric/ sewing notions for vest	--	--	--	$10
Materials Total				**$510**
Project Cost Estimate				**$13710**