Title: Cost Estimate: What's the Price

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COST ESTIMATE: WHAT'S THE PRICE?

BY

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INTRODUCTION

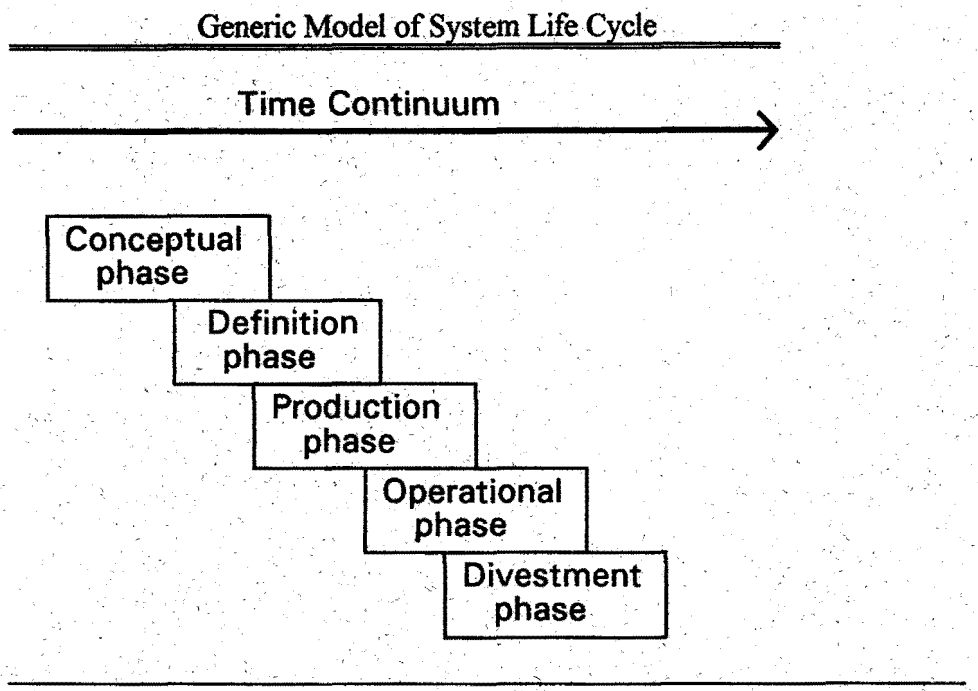
Doing accurate cost estimating can be a positive influence on an engineering manager's career, as well as a company. Bad cost estimating in the long run can hinder an engineering manager's career. An inaccurate cost estimate can even bankrupt some small companies if they have large cost overruns. With these reasons you would think that engineers, engineering managers and companies would spend a good deal of time and money getting the best cost estimate possible. Literature shows that companies doing public projects do not spend enough time and money on cost estimating. The average cost overruns on public projects run 104%, and have gone as high as 700%. Just how much time and effort a company should put into calculating the cost of a project (product) falls under the topic of the "Value of perfect information". This paper will explore these ideas of cost estimating.

CHAPTER 1

COST ESTIMATING

There are a vast array of different methods to do cost estimating, many of these methods are project dependent. The largest set of methods has been developed for the public sector. The reason for all the large selection of methods in the public sector is that the projects are normally very large with very long life spans, and are open to public bidding. If a company does not calculate the bid correctly, it could bid too high and not

get the project or too low, in which case the company will have cost overruns and could get a reputation for fiscal irresponsibility.



(Cleland)

Cost estimating is done fairly early in the life cycle of a project. A rough draft of the cost estimate is done in the conceptual phase. The conceptual phase of a project examine the environment, forecasts are prepared, objectives and alternatives are evaluated, and the first examination of the objective, cost and schedule aspects of the system's development is performed. It is also during this phase that basic strategy, organization, and resource requirements are conceived. The fundamental purpose of the conceptual phase is to conduct a feasibility study of the requirements in order to provide a basis for further detailed evaluation (Cleland).

When doing a cost estimate during the conceptual phase a set of cost categories needs to be examined. Some of the possible cost categories are listed below, this is not an all inclusive list (Murtaza pp 20).

- Construction management:
- Site preparation:
- Transportation and lifting:
- Field indirect:
- Direct labor:
- Owner Cost:
- Project Management:
- Engineering and design:
- Major equipment:
- Bulk commodities:

After the conceptual phase the project goes through more scrutinizing in the definition phase. This phase is to determine, as soon and as accurately as possible, cost, schedule, performance, and resource requirements as well as whether all elements, work packages, and subsystems will fit together economically and technically (Cleland).

This phase is where the cost of cost estimating really comes into play. By the definition the costs, schedules and resources must be done as accurately as possible in the shortest period of time. In many cases the company is not given enough time to do a thorough cost estimate so they make many assumptions and work off historical information. If a company specializes in a certain type of project they will have a better chance of coming closer to the actual cost. Another thing that happens during this phase to cause cost overruns is that the government agency has not completely defined the project. Without complete design specification it is very hard to make accurate cost estimates.

Many different criteria are used to evaluate the worth of a project after the cost estimate is completed. In the public sector benifit:cost ratio is used in about every case. To

have a project approved the benifit:cost ratio must be greater than one. As discussed in the handout from class this benifit:cost ratio has many drawbacks (Deckro).

- Oversimplification of complex inputs
- Susceptibility to misinterpretation
- Potential for misuse.
- Social relevance.
- Size of project .

Benefits are very hard to define in most public sector projects. What is the value of a human life or the value of sending a man to the moon? So the benifit:cost ratio could be less than one just because there are so many intangible benefits that are under valued. It is common for benefits for public sector projects to be under stated. If the benefits are understated then the cost must also be understated inorder for the project to be approved.

CHAPTER 2

COST OVERRUNS

In today's market a cost overrun can cause a projects to be canceled before the project reaches completion (Shash). If there are large payments outstanding after the cancellation of a project, the cash flow for a company could be put into dire straits. Cost overruns can be a large stains on a company's cash flow to point where it could drive the company into bankruptcy.

Public sector projects are carefully scrutinized by the public for any cost overruns. In recent news, the super collider to be built in Texas was canceled after cost overrunning as high as 100%. Other public and military projects are on the cutting block because of cost overruns. Though the benifit:cost ratio for these projects may still be greater than 1, all the public sees is it as miss use of public funds.

Cost overruns on projects are common (Segelod). By definition a cost overrun is the amount of money that a project costs over the bid. The bid on a project is directly related to the cost estimate prepared by an engineering manager. The bid is normally a factor (mark up) greater than the cost estimate. If the engineering manger is working under a deficiency in information or time the cost estimate and subsequently the bid, will be incorrect leading to cost overruns. If the engineering manager doing the cost estimate is not given enough resources (time, money, and staffing) to spend on doing a proper cost estimate the bid will be incorrect (Remer).

What is enough resources? That is the question this paper is trying to address. In the following two sections this paper will examine two different methods to answer the question "what is enough resources?" The first chapter will give a method from an

academic point of view. The method discussed is the Value of Perfect Information. The second chapter will give a method developed for one set of public sector projects. The method was developed by two engineering manager at the Jet Propulsion Laboratory of California Institute of Technology.

CHAPTER 3

VALUE OF PERFECT INFORMATION

In decision theory ideas there is a section on the value of perfect information. Decision theory deals with determining the optimal strategies to use when a decision maker is faced with several different decision alternatives and several different future conditions or states. (Cleland, Deckro). At any decision node where more information can be gathered an engineering manager must decide whether more information is needed or to continue on with the current set of information. At these decision nodes the engineering manager must decide the value of perfect (more) information. There may be hundreds of these information decision nodes in a decision tree. Each of these nodes has to be examined individually to get the optimal cost estimate.

The value of this decision point value must be compared to the cost of the new information and the value of the decision point if the information was received. The cost and change in the value of the node are compared and if the change in the value is greater then the cost the information is worth receiving. There can be many different factors in this decision of what information to pursue. These factors include time, resources, capital, and probability of receiving the project.

For example, an engineering manager is calculating the cost estimate for the Tri-Met Westside rail project tunnel though the west hills and arrives at a decision point of drilling more wells to test the soil and the level of ground water, or going ahead with the information that Tri-met had given. Which way does the engineering manager go? If the information given by Tri-met is wrong it will cost the company an extra $1 million dollars. The wells will cost a total of $200,000 to drill and test and delay the cost estimate by one

month. The engineering manager believes the information from Tri-Met is fairly good but, there could be errors. If it was early enough in the cost estimate process, the engineering manager may have the month needed and call for the wells to be drilled. However, if the engineer manager does not have the month then he/she is stuck going on without new information.

The value of information it not all cut and dried and the engineering manager must calculate all possibilities to the end to use this decision analysis. In the real world an engineering manager uses this decision analysis for part of the process of cost estimating and relies on gut feeling for the rest. This method is also time consuming and you could not answer your boss' question: "What is your idea on the cost to submit a bid to a new public works project?" The boss want the answer in the meeting. The next case looks at quick method that the engineering manager can use on the spot, allowing him/herself time later to go back to his/her office and use the decision method for more accurate estimate.

CHAPTER 4

JET PROPULSION LABORATORY SPACECRAFT PROJECT : THE COST OF DOING A COST ESTIMATE

The jet propulsion laboratory (JPL) spacecraft project for US NASA was having a small (comparatively) overruns of 46%. In today's environment every penny that the federal government spends is under close scrutiny, any cost overrun is seen as an irresponsible use of public funds.

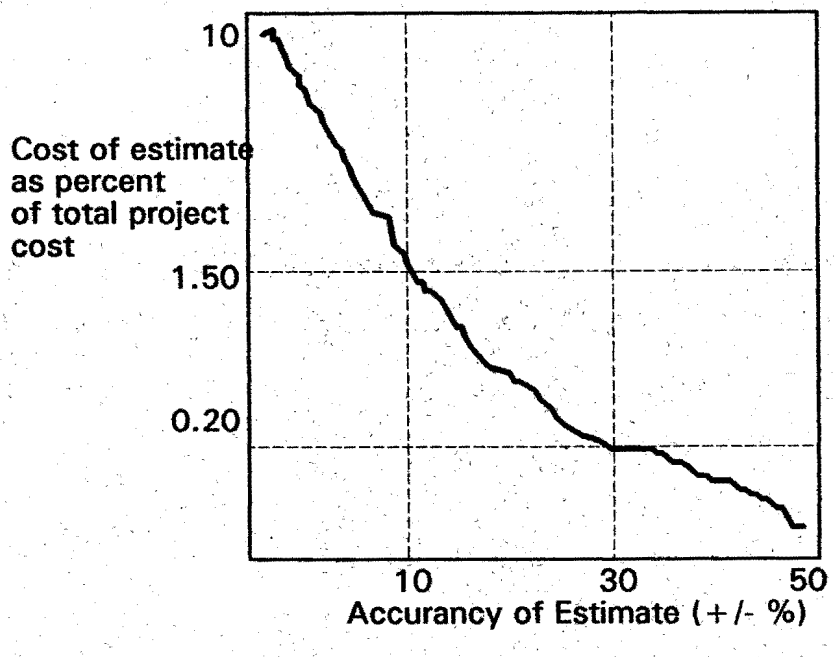
There are many reasons for cost overruns, but one of the key factors is the lack of resources (time, money, and staffing) spent to do proper up-front cost estimating. Many companies and government agencies typically under allocate resources for producing a cost estimate and, as a result, do not take the time to include all the necessary cost elements. This leads to cost overruns and/or de-scoping of the functional requirements of projects (Remer). Donald S. Remer and Harry R. Bushanan, both of the JPL, had a goal to come up with some guidelines for calculating the amount to spend on cost estimating to get within tolerable accuracy. Accuracy ranges from being definitive (-5 to +15%) to an order of magnitude (-30 to +50%). Remer and Bushanan considered anything greater than ±50% not worth talking about. Why worry about the analysis on a project with a range of $0.1 to $100 million dollars if you cannot get within 50%?

They approach the cost of cost estimating as a percentage of the total expected cost of the project.

Cost of a cost estimate (%) = $C_E / C_P \times 100\%$

C_E = Cost of the estimate

C_P = Total cost of project



This graph represents a $3 million dollar project in the chemical process industry. With this formula an engineering manager could get an estimate that is accurate enough to be within ±30 percent and would cost 0.2 percent or $6K, whereas an estimate accurate to within ±10 percent would cost 1.5 percent of $45K of the total project cost

For a much larger project the following formula was devised:

$$C_E = KC_P^R$$

Where

C_E = Cost of the cost estimate in thousands of dollars ($K).

C_P = Cost of the project being estimated in millions of dollars ($MM)

K = Constant depending on the accuracy of the estimate

R = Slope of the line.

K and R are project style dependent. Remer and Bushanan calculate these values for the Deep Space Network (DSN) project set. Each style of project requires that the past project be examined to calculate the correct K and R values. In the DSN project R = 0.35

and K is 24 for an order of magnitude estimate, 60 for a budget estimate and 115 for a definitive estimate.

This method would be useful in the conceptual phase of a project life cycle to estimate the cost of the cost estimate. A company must decide early if it wants to put in a bid for a project and understand what the sunken cost will be if they do decide to enter a bid.

CONCLUSION

With this renewed importance of reducing cost overruns on public project, this area of study will get new attention. Each company has their own idea on how much they will spend on a cost estimate. We may need to in the future standardize this amount to cut down on the number of cost overruns.

The government may also look into other ways to choose a company to do a project other than merely awarding it to the lowest bidder. Other factors that need to be considered are:

- Has the company done these types of project before?
- Cost estimating accuracy in the past
- Amount of time and resources put into doing the cost estimate.

The public agency needs to also take more accountability for monitoring the process of a project. The following are some ideas that may help avoid or minimize the overrun (Lederer).

1. Assign the initial estimating task to the final developers.
2. Anticipate and control user changes.
3. Monitor the progress of the proposed project.
4. Use the estimate to evaluate projects personnel.
5. Do not rely on cost-estimating software for an accurate estimate.

The way bids are submitted needs to be examined. To have a company commit a large sum of money on the gamble that they will get the bid does sound like a good

investment from the company point of view. The public agency may want to do the cost estimate themselves or contract out for this. The public agency would still open up the bidding for the project but the criteria would be based on the company meeting the cost estimate prepared by the public agency. More work and study needs to be done in the area of cost estimating for public sector projects, inorder to cut down on the size and number of cost overruns that occur.

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