NAC Executive Insights

Pricing Work for a Profit: Developing a Construction Estimate

Key Points

1. Evaluate bid opportunities.
2. Identify what factors effect project cost.
3. Recognize task production impactors.
4. Ascertain possible project risk.

A contractor is a buyer *who wishes to purchase the opportunity to build a project in a marketplace consisting of multiple owners offering a variety of projects. A project owner is a* seller *with a product that has no standard value. It is the contractor who defines the project's value based on its view of the marketplace.*

Introduction

A contractor's cost estimate serves two purposes: 1) it defines the probable cost associated with preforming the required items of work; and 2) it defines the risk of performing the work according to the contract requirements, the specifications.

The probable cost part has two important aspects: one, pricing based on required tasks, scope of work, and task productivity that is two, aligned with the project's specified completion date, which is an execution plan matched to the schedule. Many commercial projects are schedule-driven because of the profit to the owner from the product produced by the constructed facility. Together the cost and risks pieces of information are relied upon for making a decision to bid—that is, either submit an offer to perform the work or decide not to bid.

An estimate/risk analysis seeks to identify significant relationships among the many and variable factors impacting competitive bid prices for a project. Each project is examined based on its own individual cost drivers. There are, however, important production and risk relationships common to most projects. If the decision is to bid, the estimate/risk analysis then serves as the basis for establishing the offered price.

Decision to Bid

Contractors have long recognized the impact of increased competition on successful bidding. With each additional bidder that a project attracts, profit opportunity is diminished. Often a decision to prepare a project estimate and bid is made after considering the number of assumed bidders—in other words, the competition—and the known capability of those bidders.

What contractors appreciate from experience has been proven by industrial management researchers using game theory. Bidding process models demonstrate mathematically how the prospect of earning a profit decreases rapidly at first and then monotonically as the number of bidders increases.

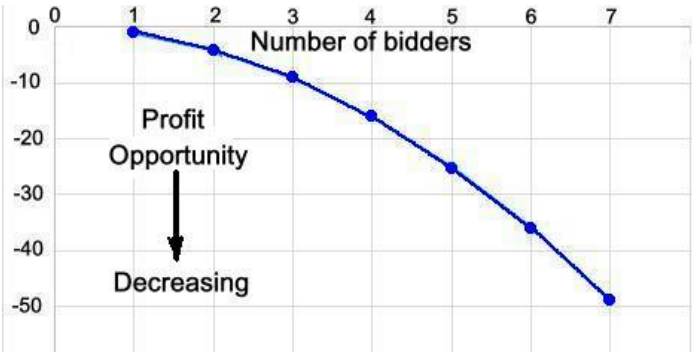

Figure 1. Graph of the monotonically decreasing function, $f(x) = -(x)^2$

Simply stated, profit decreases approximately as the square of the number of bidders, *x* (Figure 1).

The theoretical models assume each bidder has the ability to price work at the same level of estimating accuracy, all have identical cost, each receives the same material prices and pays the same labor rates, and has similar equipment cost. While this is to a large extent true, individual contractors can have advantages in specific cost areas. However, data collected by project owners has also demonstrated the effect that the number of bidders has on project pricing, as illustrated in Figure 2.

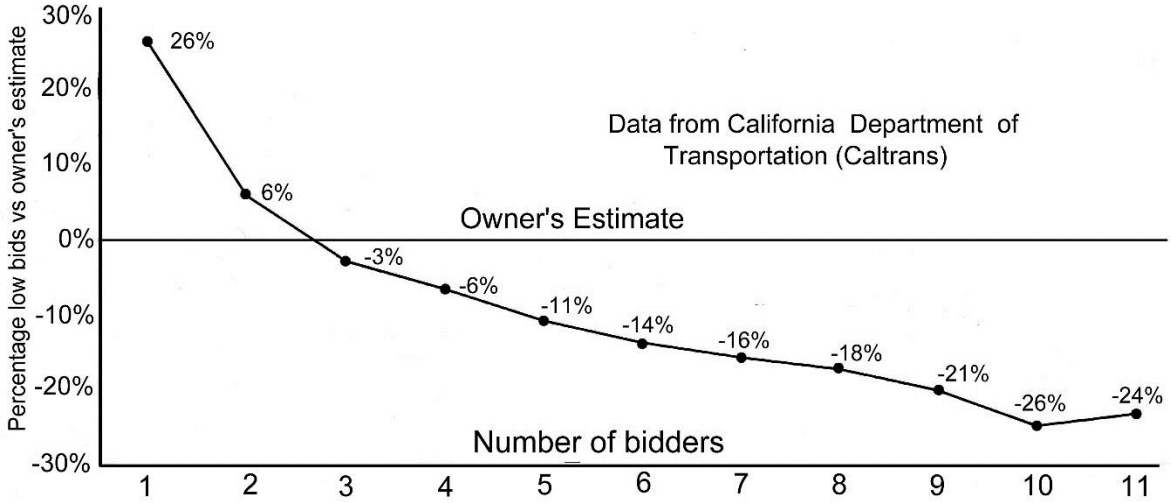

Figure 2. Comparison of the Low Bids vs. the Owner's Estimate Based on Number of Bidders.

Similarly, there is a risk to the owner when a project attracts a large number of bidders. Intense competition results in a lower initial bid price, but such pricing can lead to multiple change order requests and claims. As a result the final completed project cost is much greater than the initial bid price.

Resources vs Opportunity

Bidding is a competitive exercise and contractors do not expect to be the successful bidder on every project bid. While the foundation of successful bidding is an accurate estimate of project cost, estimate preparation requires an expenditure of resources. Therefore, contractors seek opportunities and recognize it is a waste of resources to estimate projects that are drawing a large number of bidders.

A Contractor's Approach

Project estimating is much more than quantity take-off and material pricing. The pricing of work is a question of risk and opportunity. Does the company have experience with the type of work, are the right people available to manage the work, can an advantage be identified—equipment, material sources—and, is there a more productive sequence of work activities?

The creation of a good construction estimate requires thinking and visualization of the work task environment together with careful consideration of the risk applicable to the tasks.

Attention to Detail

The estimator's attention must follow the Pareto 80/20 Principle. Appling the principle to construction, the estimator should seek to identify and concentrate attention on the significant 20 percent of the tasks that drive 80 percent of the project cost and risk.

Tasks are seldom spelled out in the contract documents, but are necessary for evaluating work requirements and developing project cost.

At the detail level, each task is usually related to and performed by a crew. The estimator develops task descriptions by defining the type of effort required to construct an item of work. On a unit-price job, an owner may pay for concrete work under only one or two bid items such as concrete by volume and reinforcement steel by weight. Therefore, the estimator will need to create tasks for: 1) formwork (contact surface area), 2) reinforcing steel (weight), 3) concrete (volume by mix type), 4) embedded items (number), and 5) cure areas (surface area).

The sequencing of the estimate tasks must be supported by a robust project schedule. Together, the estimate and the schedule confirm whether the project can be delivered on the date specified in the contract documents. The cost estimate and the schedule complement one another and provide a complete visual of how the project will be constructed.

Bottom-Up Estimate

Contractors typically price the cost of performing work using a bottom-up estimating methodology. Bottom-up estimating takes time because the estimator must carefully review the project documents and plans to identify the specified details of task performance. This detailed study leads to a better understanding of the work and greater estimate accuracy. The time required to create a bottom-up estimate is the primary disadvantage of the method. Compared to other estimating methods, such as historical bid based estimates, it takes much more time to complete a bottom-up estimate.

The bottom-up approach is applicable to a design-bid-build situation, where a complete set of project drawings and specifications has been developed by the project owner and are available to the contractor. Bottom-up estimating requires the creation of crews by the estimator for each task, and the calculation and assessment of crew production rates, material costing, and data on the ownership and operating (O&O) cost of construction equipment. Costs for labor burdens and benefits, as applicable, are generally included in the hourly labor rates, and contractor job and company "home office" overhead plus markup is added to the total estimated direct cost. This approach provides a wealth of detailed information upon which to evaluate cost and schedule risk.

Alternate Contracting Methods

While the bottom-up estimate approach is the standard approach for design-bid-build work, it may not be appropriate for projects that are let using alternate contracting methods. Projects that will include variations of design-build and construction manager/general contractor or construction management-at-risk usually include contractor involvement in design after a price has been offered and accepted by the project owner. Therefore, at the time of pricing, design details, even material quantities, are not completely defined and changes can be expected.

Documentation

The basic premises and assumptions supporting the estimate must be carefully documented. Estimate support data would include project work narratives, backup calculations, drawings or references to drawings, and sketches. Collectively, this information is the basis for establishing the probable costs of tasks and developing the associated project schedule. Consistency between task production rates used in an estimate and the schedule demonstrate an ability to complete the project within the allocated contract duration. Finally, the estimate submitted to company management must include a comprehensive risk assessment so appropriate estimate and schedule contingency can be determined.

Read the Contract Documents and Study the Plans

There are risks imbedded in the contract documents: 1) how work items are bid; and 2) how the contractor will be paid for work performed. Partially resolved uncertainty does not serve to reduce a contractor's risk. A perception of risk has a significant effect on the willingness of a contractor to bid. To mitigate perceived risk, contractors increase item bid prices. The estimate presented to company management, however, is created "clean," that is, without the extra costs of risks. This approach is followed so that risk costs effects are not applied twice. The estimator documents all risks in relation to how they might affect task cost, but the risk adjustment to a bid is a management decision.

For a contractor, the quality of the bid documents, particularly the plans, can serve as a risk indicator. The construction estimator, using the provided plans and specifications, must be able to define accurately the work tasks and delivery requirements. During preparation of the estimate, all discrepancies and conflicts are carefully documented.

The estimator identifies and quantifies the areas of uncertainty related to:

- project knowns and unknowns.
- potential risks elements associated with these knowns and unknowns.
- conflicts between the plans and specifications.

Conflicts

Conflicts between statements in documents are indicators of future disagreements during execution of the project work. The three examples in Table 1 are from actual projects and, while all are minor, they are indicators of a designer's lack of attention to accurate calculation of quantities or conflicting guidance from the owner.

Table 1. Conflicts found in construction project bid documents.

➢ Rock excavation bid quantity was 100 cubic yards, but only 20 cubic yards were indicated in the specifications for payment.
➢ Bid quantity for granular material was 324 tons, yet the plan sheet indicated a quantity of 191 tons.
➢ The excavation quantity did not match the granular backfield material quantity.

When conflicts such as these are found by the estimator, they serve as a warning that the estimator needs to be vigilant in reviewing the plan sheets, project specifications, and the bidding documents. Correspondingly, conflicts will often cause management to increase item pricing.

Bid Items—Will I Get Paid?

The risk component of a bid is increased when there are no bid/pay items to accommodate work quantity variation. A lump-sum item reduces design and contract administration costs for the owner because there is no calculation, verification, or measurement of the individual components included in the item. The contractor submits a single, fixed price to complete the item with an undetermined number of components. Transportation agencies often have the contractor bid traffic control lump sum instead of paying for each sign, barrel, or device used.

The wording of contract documents can also effectively create a lump-sum situation by asserting a quantity and then stating there will be no pay adjustment of quantity increase: "The owner reserves the right to increase or decrease the quantities without compensating the contractor." Therefore, the estimator needs to carefully review how the project owner will pay for accomplished work. A careful examination of project documents often identifies situations where multiple types of materials and work tasks are paid for under a single bid/pay item. Such bid items represent a quantity overrun risk to the contractor, even if the work is well defined. As a result, the item demands a higher mark-up to cover possible additional cost. Similar to conflicting statements or conflicts between drawings and specifications, lack of bid items is an indicator of future problems during performance of the work.

Labor Task Production Rates

How many people are required to perform a specific task efficiently? Construction tasks can be labor-intensive, and the most unpredictable element of a construction estimate is typically labor productivity.

To meet the required project delivery date, it also may be necessary to estimate some tasks using overtime labor rates. Knowledgeable contractors tend to avoid bidding projects when the labor component of total project cost is greater than 30 percent. They also know that if a bid is submitted, it likely will carry a higher mark-up.

A Labor Productivity Number

Before settling on a production rate for a crew, many things must be considered. Two, however, may have significant impact: one, management skill, and two, weather. Interpersonal relationships are an important factor bearing on the production rate used to estimate task cost. Management skill, i.e. leadership, is a core ingredient for achieving improved crew productivity. The estimator must consider the caliber of the management team that the company will assign to the project if the bid is successful.

Likewise, weather can affect production rates assigned to a task in several ways. Heat causes a need for more rest breaks or breaks for water. Both low and high temperatures impact concrete placement as well as many other construction activities. Rain will limit earthwork activities. High winds restrict crane usage. All of these environmental factors must be considered when developing the project schedule as they impact the total time—work time plus down weather time—to complete a task. A major portion of project overhead cost is incurred even when crews are not working.

While it varies by project type and the work tasks, nearly 50 percent of chargeable labor time is often spent attending to nonproduction activities. These may include: sequence of work, material/equipment logistics, tool/equipment availability, set-up time, and waiting for inspections/testing. An estimator should assign a production rate for a crew to preform a task only after carefully considering each of these factors and other project-specific factors.

Sequence of work. Work task stoppages and restarts cause loss of crew momentum. The estimator must ask: Can the project task be accomplished in a continuous and orderly manner without interruptions or is there the need to jump between tasks before they are completed because of project constraints (inspections, testing, accommodating traffic through a highway project)? This factor is important in renovation and reconstruction projects, because the work is chopped into individually. This also means tools and equipment must be shuffled from place to place around the jobsite.

Logistics. The site layout impacts crew productivity. Can equipment and material be delivered directly to point of need or will it have to be re-handled? Will a steady stream of ready-mix trucks for a concrete placement restrict delivery of other materials? Also, distant materials storage locations may necessitate extra travel time.

Timely delivery of equipment and material is necessary to keep crews working. Is there space available for storage of permanent equipment and other materials? Are there limitations on the closure of local streets when necessary to accommodate material delivery?

In Washington, D.C., for the construction of the Ronald Regan Building, the contractor placed a concrete plant in the basement area of the building during construction. This was done because street traffic would have effected delivery of concrete from local plants. Aggregates and cement were delivered to the onsite plant at night when traffic was minimal.

Tool/equipment availability. Will all necessary tools be available immediately or is there a need to store at a distant location? Is equipment being shared between tasks? Crane hook time is often an issue when required for multiple lifting tasks. To avoid hindering crew productivity, the contractor must have a good system for scheduling all necessary support equipment. Scrimping on the number of man-lifts or fork-lifts may reduce direct cost, but also may reduce the production rate of a crew.

Setting-Up. Task set-up time should be carefully analyzed. It may be more advantageous to pay overtime and thus gain continuous periods of productive time. The impact of set-up time depends on the amount of work produced per set-up. If it takes one hour to set-up for an eight-hour shift, the effect is a 13 percent loss in production time. If tasks have to be broken into small incremental parts, however, and only one hour of production time results from the set-up, then it amounts to a 50 percent loss of productive time. The estimator must carefully analyze the effect of set-up time for reconstruction and rehabilitation projects.

Inspections/Testing. The specifications often require inspections of partial task work before the task can be completed. The requirement for inspectors to check the placement of the reinforcing bars before the concrete is placed in the forms is a common requirement. Testing is a similar type requirement. Often each lift of a soil embankment must be tested for density before placement of the next lift. These requirements can disrupt task work and cause non-productive wait time.

Control of Water

Control of water involves both precipitation and seepage flow. When it is necessary to excavate, the impact of encountering groundwater must be considered. Control of water can be a major non-bid item cost. When the contractor must perform work in a pit, rain pattern frequency must be carefully studied and the cost of water control included in the estimate. Project work that is performed in the wet season because of project schedule will make control of water a much higher risk premium.

An excavation into sand and gravel material close to a body of water often will experience a flow of water if some method is not adopted to intercept and remove the water. Dewatering is then necessary. When planning a dewatering activity, it should be understood that groundwater levels change from season to season as a result of many factors. The contract documents should be studied carefully to determine how the project owner will pay for dewatering.

Review

All construction cost estimates should be given an independent review for the validity of their basis. The formality and depth of the review, however, will vary depending on the type of project and its complexity. In the case of a construction company, the estimate is usually reviewed by management and other estimators in the firm. To be of value, the reviewers must closely examine the assumptions that form the basis of the estimate.

When reviewing an estimate, *total cost* is a necessary piece of information, but because experienced estimators usually have a feel for what certain work task costs on a unit-price basis, it is good practice to display *unit costs* also. It then becomes easier to notice an unreasonable unit-cost number and to use it as a starting point for checking an item in detail.

The Bid

The bid amount and how overhead and profit are spread across bid items is a management decision. The estimator presents the probable cost of the project's bid items and a summary of the risk associated with each part of the estimate. Important project risks include cost of environmental compliance, cost of material (market conditions), quantity variations, design changes, and unanticipated site conditions.

Small, non-connected parts. Instead of being able to schedule electrical work or paving in an uninterrupted sequence, small non-connected parts must be completed. Based on the estimator's careful discernment of necessary work tasks, the factors controlling the production rates assigned to the crews performing the tasks, and accounting for the project's inherent risk, management must access the

company's ability to perform the work at the estimated cost and make a profit. This is the bottom line: can the company make a profit?

About the Author

Cliff Schexnayder has been an NAC member since 2012. He is a construction engineer with over 45 years of practical experience, working with major heavy/highway construction contractors as field engineer, estimator, and corporate chief engineer.