

Bucknell Bidding Simulation Tutorial

Note: This document contains the text copied and pasted from the BBS webpage.

Introduction to Construction Bidding

The majority of construction projects are completed using the traditional design-bid-build project delivery method. This method requires that a bidding process be completed to determine the construction firm (typically a “general contractor”) that will assume overall responsibility for completing the project for an owner client. In the bidding process, all construction firms interested in completing the work receive bid packages from the owner or architect/engineer (AE) of the project. These bid packages include plans/drawings, technical specifications, and general conditions that communicate the scope of the project. Each contractor interested in performing the work submits a lump sum bid to the owner or AE. The bid will include the contractor’s anticipated direct costs, overhead costs, bonding costs, and desired profit. (These are explained below.) In general, the firm that submits the lowest bid which meets all the requirements of the owner’s bid package will be awarded the contract. Although alternative bidding strategies exist, mostly on private projects, the method of lump sum competitive bidding described above the most common method of construction procurement.

Introduction to Direct Costs

Direct Costs are the costs associated with the physical construction of a project. Direct costs can be directly associated with a specific physical portion of the completed facility. The three typical subcategories of direct costs are labor, materials, and equipment.

The labor component is the cost to pay the wages of each worker for each hour he/she spends on the project site. A contractor’s bid therefore needs to include an estimate of the total number of hours associated with each wage rate needed to complete the project. The total number of hours of labor hour reflects the labor productivity, which is the amount of work completed per hour of work and reflects the skill and work habits of the workers, specific aspects of the tasks, and aspects of the space where the work is performed.

The materials component is the unit cost of each type of material multiplied by the estimated number of units of that product needed for the project. The number of units of material delivered to the project site is not the same number of units used in the project. This difference is the material waste and it is also a variable that needs to be taken into account in the estimate of a real-world bid. For example, if a stud comes in 96” lengths but only 92” lengths are needed for a wall, the 4” cut from each stud will be discarded.

The equipment cost is the money needed to rent each piece of equipment for the entire time it is on the site. This cost includes a mobilization cost to ship the equipment to the job site as well as time on site when the equipment is not being used.

The previous paragraphs emphasize that a contractor’s bid should reflect the estimated costs for labor, materials and equipment, but it important to note that actual costs can end up much higher than estimated costs for many reasons, including poor estimating, material delays, extreme weather, lower productivity due to site conditions or poor scheduling, etc. (These factors will be discussed further when discussing Impact Factors.) Once a contractor has signed a contract with the owner for that

project, he/she is locked into the contract amount (which is usually the bid amount) and contract completion date. If the contractor's actual costs end up being higher than estimated, the unanticipated direct costs reduce the amount of profit earned on the project. A contractor cannot ask the owner for more money unless he/she can prove there was a change to the contract scope. If, on the other hand, actual costs end up lower than estimated (due to higher productivity, for example), the difference results in a higher project profit than expected.

For the purposes of this simulation, it will be assumed that all bidders have estimated the same direct costs. In the "real world," this never happens. For work being completed by the general contractor's own crews, different bidders will almost certainly assume different productivity values. For work being completed by subcontractors, each general contractor bidder will typically secure bids from different sets of subcontractors and material vendors. And even if a subcontractor gives a bid for a project to competing general contractor bidders, the subcontractor's bids may be different, reflecting their past experiences with each bidder. Each general contractor will ultimately choose the sub or vendor that gives them the best price. However, based on work history on past projects, general contractors have the subs and vendors they prefer to work with and will work for if their pricing is close to enough to their competitors'. This also works the other way: if subs and vendors have good relationships with general contractors in the past, they are likely to give better pricing to them than to their competitors. The end result of their preferential pricing is that general contractors will ultimately come up with different estimated direct costs for the same project scope. But in the BBS, the estimated direct costs will be assumed to be the same for all bidders and will be provided to the user for each bid.

Introduction to Overhead

Overhead is a type of indirect cost associated with every construction project. There are two primary types of overhead: Field and General & Administrative (G&A). Field overhead costs are costs associated with supervising and maintaining the job site but not with a specific unit of installed construction. Examples include the salary of the GC's superintendent and support staff on site, trailer and equipment rental, fencing, waste disposal, cranes and material lifts used by multiple crews, etc. For the purposes of this simulation, all firms will be assumed to have the same field overhead percentage: 10% of the estimated direct costs. Again, in "the real world," this rarely happens because each firm is different and each project is different.

G&A overhead, also called home office overhead, are the costs associated with running the company and are not specific to a project. Examples include the costs for the company office and utilities, salaries and wages for executives, estimating, procurement, accounting, and human resources staff, and legal, marketing and advertising expenses. These costs are "paid for" by applying a percentage mark up to each set of direct costs. Because different firms pay different costs for home offices, executive salaries, etc., G&A overhead rates varies between companies. Larger firms typically have greater G&A overhead rates because large firms typically have larger offices, full-time estimators, procurement staff, human resource staff, accountants, etc. In small firms, managers and other employers often perform more than one function and little is spent on marketing and advertising.

The G&A overhead values in this simulation will be pre-set dollar amounts, which will be different for each firm depending on its characteristics. The G&A values will remain constant throughout the simulation and will be applied to each firm at the end of each fiscal year. To cover this annual charge, each firm will have the option on each bid to put a dollar amount towards covering their annual G&A. While this will increase the total bid value, therefore decreasing the chances of winning the bid, a firm that practices this will ensure with each bid they win that their home office

expenses will be covered and that they will have a chance of making a net profit. If a firm does not include enough G&A in their winning bids, the unpaid G&A costs will be deducted from the firm's net income from projects when calculating the firm's net income for the year. (This is explained further when discussing the Income Statement.)

Introduction to Profit

Profit is the amount of money earned above the sum of all costs; That is, profit equals the total amount paid to the contractor by the owner (typically the contract amount) less the total amount of costs incurred by the contractor in completing the project. While the actual profit earned on a project cannot be calculated until after the project is over and all the bills are paid, a bidder must select the profit percentage that he/she wants to include in the bid and enter this number in the simulation to provide adequate funds to maintain the health of the business. This profit percentage entered is a percentage of the estimated direct costs only.

It is important to recognize that the profit included in a bid is not money that can be distributed to the owners of the contracting company as soon as the project ends. The profit amount included in a bid may be needed to pay for higher than estimated direct costs. If direct costs end up higher than estimated due to reasons discussed in the "Impact Factors" section, the actual profit earned on a project ends up less than the bid profit percentage. A no-profit bid leaves zero margin for error. Even if actual direct costs end up below estimated direct costs, the profit earned on a project is typically retained within the company and used for working capital needs (i.e., to pay labor and material bills for active projects before the owner pays for the work).

Project profits are also typically retained to pay for G&A overhead costs when a firm does not have enough active projects going to cover G&A costs. This situation explains why it actually might make sense to submit a bid that includes zero or a negative profit. If a firm hasn't won any new work in a while, there will be no incoming revenue to pay for G&A overhead. In desperate times, a project that brings in ANY revenues that exceed the sum of direct costs and field overhead is better than having no project at all because the project will contribute at least a little towards G&A costs. But be careful. If the actual direct costs significantly exceed estimated direct costs on a project bid with low or negative profit, a firm could quickly find itself heading towards bankruptcy!

Introduction to Performance Bonding and Bonding Capacity

A construction performance bond is a document that provides a third party guarantee (like insurance) that the contractor will perform the work in accordance with the contract documents. (There are also payment bonds and bid bonds, but these are not addressed in the simulation.) A bond is purchased by the GC from a surety (bonding company) who will pay the owner (or pay another contractor to finish the work) if the GC fails to complete the work. Bond cost is the cost associated with obtaining a performance bond for a project and is a function of the financial strength of a company. The better your financial health, the lower your bond rate. The bond cost will be a percentage of the estimated direct costs (typically 1-3%) and will be automatically calculated and applied to each bidder's bid.

The surety pays close attention to the financial state of the GC at the time of bidding, especially noting how much work a GC is already engaged in, the GC's ability to do work for which a bond is sought, and the GC's overall financial health. The more projects underway that a contractor has, the greater the risk that the contractor will not be able to pay all of its bills before getting paid by the owner. Indeed, if a contractor severely underestimated direct costs, it may not be able to pay all of its bills even after getting paid the contract amounts by project clients. If a contractor doesn't pay its

subcontractors and material vendors, these firms stop doing business with the firm, which forces the firm to cease operations. As such, if a GC already has several projects underway, a surety will be far more cautious about providing bonds to back up any more projects and will charge the GC a higher bond percentage. The point at which the surety will greatly increase a GC's rate is called the GC's bonding capacity. The bonding capacity of each GC varies and depends on the size and financial health of the company. Larger reputable companies have larger bonding capacities than smaller firms. This means that smaller firms can take on less work before their bonding rates jump.

In this simulation, every time a company wins a bid, the contract amount for the project (as given on the bid tab) will be subtracted from the company's bonding capacity. There are unique upper and lower bonding limits for each firm. If the lower limit is exceeded, there will be a slight increase in the bonding rate of the firm but this will not be a great hindrance to that company in future bids. It is essentially a warning by the surety to watch how much bonding capacity remains. The upper bonding limit is the firm's bonding capacity. If it is exceeded, there will be a major jump in the bonding rate for that company if it is exceeded. This jump will all but prevent the company from winning future bids.

In this simulation, the bidding process has been greatly simplified. The direct costs have been estimated for you and will be identified for each Invitation to Bid (IFB). Your company's bond costs and field overhead percentage will be automatically applied to the direct costs. The user need only enter the percentages of direct costs that he/she wants to include in the bid for profit and the percentage of annual G&A costs to include in the bid.

Direct Cost Impact Factors

An impact factor is a percentage increase or decrease in the direct costs of a project which reflects the fact that the direct costs for labor, materials and equipment included in bids are only estimates. Once a project has started, things happen that cause the actual project direct costs to be different from the estimated project direct costs. There are three sets of impact factors in this simulation: owner class, project size, project type. The three impact factor percentages for each project will be chosen through a semi-random process explained below.

Each of the impact factor types has four possible impact percentages it can apply to the project's estimated direct costs, ranging from an 8% increase to a 2% decrease. Let's use as an example the possible impact factor for the Owner Type. (Note that the table below are not the actual percentages used in the game).

Owner Type	25% chance	25% chance	25% chance	25% chance
A	-6%	-3%	No increase	+1%
B	-2%	No increase	No increase	+2%
C	2%	4%	6%	8%

Each of the percentages in the table columns above has a 25% chance of being chosen by the simulation. For example, if the project has an Owner Type A, there is a 25% chance that your firm's

direct costs will end up 6% lower than estimated, 25% chance that direct costs will end up 3% lower, 25% chance they will be the same as estimated, and 25% chance they will be 1% higher than estimated. (The percentages for the lower two rows are not relevant for a project with an Owner Type A.) For each impact type for each project, the simulation will determine which scenario is applicable and will then randomly choose one of the four impact percentages. The sum of the impact percentages chosen by the simulation will then be applied to the estimated direct costs. This new value, post impact, will be called the “Actual Direct Costs.” You will not know the “Actual Direct Costs” value or the impact percentages when you submit your bid, but you should consider possible impact factors when you choose the G&A and Profit percentages to include in your bid.

Owner Characteristics: How They affect Direct Costs

Not all owners are created equal. Some will be incredibly helpful and be a resource in the completion of a project. Some will seemingly fight you every step of the way and do all they can to impede your running of the project. For example, “bad” owners will unreasonably limit a contractor’s working hours, utility outages, site access, and site layout, all of which can drastically hurt labor productivity. “Bad” owners can also constantly demand minor changes in scope or delay or accelerate portions of the work that individually are not significant to warrant a change order but collectively hurt productivity.

In this simulation, the quality of the owner is reflected in the “Owner Class” and “Impact Factor” features. The “Owner Class” of the owner for each project being bid will be listed on the Invitation to Bid along with the direct costs. There are three possible classes: A, B, and C. A “Class A” owner is a competent and professional client who will cooperate to maximize the project productivity and progress. A “Class C” owner is incompetent and/or uncooperative and will unintentionally significantly hurt productivity and progress. A “Class B” owner is somewhere between the two but will ultimately have little impact on the project’s ultimate success for your company.

The Owner Class impact factor reflects the general effect the owner’s assistance/resistance will have on the project’s costs during its construction. In general, a “Class A” owner will likely decrease the direct costs of the project. A “Class B” owner could increase, decrease, or not affect the direct costs. A “Class C” owner will likely increase the direct costs of the project.

Just as a contractor often will know the reputation of the owner of a project but not know exactly how the owner’s actions will affect the productivity in the field, in the simulation you will know the owner class for each bid but will not know the impact factor until after the project is underway. However, attention should be paid to the owner class when bidding, especially when bidding a low profit percentage. An undesirable owner could increase your direct costs and make you lose money on the project.

Project Characteristics: How They Affect Direct Costs

Just as not all owners are created equal, neither are all projects. Each project has several different variables that dictate which type of contractor would be best suited to complete it. Some of these on a real world project would include: type of project (ex. new commercial building vs. rehabilitating a commercial building vs. new high end residential building), location size of the project, and location of the project.

For simplification, this simulation will only consider the size and type of the project as variables in the bidding process. The project size is reflected in this simulation by the quantity of the direct cost and will be classified into three sizes. Type 1 projects are small projects and have estimated direct

costs below \$750,000. Type 2 projects are mid sized projects with estimated direct costs between \$750,000 and \$1,000,000. Type 3 projects are large projects with estimated direct costs greater than \$1,000,000. The project type for each bid will be pre-determined and given on the bid sheet. This simulation considers three categories of project type: high end residential (Type 1), new commercial (Type 2), and rehab commercial industrial (Type 3). An example of a Type 1 project is an expensive condominium project within a trendy part of the city. A Type 2 example is a new office building for an accounting firm. A type 3 example is renovating an existing office building for an accounting firm.

When bidding on a project, it is important to consider how the characteristics of the project being bid should play into your bidding strategy. Not all companies are equally suited to complete all sized or all types of projects. To reflect this, two impact factors, one for project size and one for project type, will be applied to the estimated directs for each project won by a firm. The numerical application of these impact factors works identically to the owner class impact factor application: semi-random selection by the simulation of one of four potential impact percentages, each with a 25% chance of being applied to the estimated direct costs.

The main difference is that the scenario is not determined solely by the characteristic of the project, but by the match between the characteristics of the project and your company. When you choose your firm, you will receive information about it, including its size (small = 1, large = 3) and specialty project type. When bidding on a project that closely matches your company's size and technical specialty, the direct costs will likely not be affected greatly. Your estimating staff have historical company records on similar projects that allow you to reasonably accurately estimate direct costs and your office and field management staff have experience with similar projects and a general pool of subcontractors that allow the project to be managed properly.

However, when there is a mismatch between either size or type, your company has less relevant experience to draw from and the direct costs of the project are more likely to be higher than your estimated direct costs. The greater the difference in your company's abilities and the project's demands, the greater likely the increase in the direct costs. This means, for example, that a small company (type 1) attempting to complete a large project (type 3) will be at greater risk to increase their directs costs than the same small company attempting to complete a mid-sized (type 2) project.

Another important thing to think about with regard to project size is the time each project will take to complete. The time to complete the project will be given on the bid tab under the title "Project Pay Cycle." This quantity indicates how many quarters the project will take to complete. During these quarters the quantities on the bid tab (direct cost, overhead, bond cost, and profit) will be distributed evenly. Of these values, the most important to keep track of is bond cost. Even if you win bids for projects in different quarters, their deductions from your bonding capacity will sum in the quarters in which they overlap. This also means that even if you win a job in Year 1, it could carry over and affect your Year 2 bonding capacity if its Project Pay Cycle is long enough. The next section provides more details on this.

Income Statement

Income statements are the primary means through which companies keep track of their earnings. While Balance Sheets provide information about a company's financial health (namely, the relative amounts and types of assets and liabilities) at one moment in time, an income statement indicates how well a company performed during a specified period. The most important number in an income statement (the "bottom line") is the net income, which can be considered profit. Ignoring accounting items such as depreciation, net income is equal to gross income (i.e., revenues) less expenses.

In this simulation, the income statement is a much simplified version of something a bookkeeper or accountant would prepare. The simulation income statement only indicates real-time information about direct costs, G&A overhead contribution and profit for each project that was active during that period and the firm's overall net income. These values are only entered into the Income Statement when a bid is won; a lost bid does not change the income statement in any way.

The Income Statement is an important document to monitor at the end of each year because it indicates the firm's net income to date (over the simulation), which is what determines the "winner" of the BBS. But keep in mind there are two important numbers that are not shown the Income Statement but should be monitored. The first is your firm's "Remaining Bonding Capacity." This number is an indication of how much work your firm can still take on in the current fiscal year before your bonding cost rates significantly increase. You can monitor your firm's bonding capacity using the Active Projects report (but will not know your competitors' bonding capacities because that is confidential information). The second value is the "Amount of Annual G&A Overhead Remaining." This number tracks how much of your G&A overhead you have paid off in this fiscal year through the contracts you have won. If you have not included enough G&A in your bids on projects you have won, the remaining G&A will be subtracted from your firm's project profits when calculating the firm's net income for the year.

The Four Firms in this Simulation

This simulation features four different construction general contracting firms, named "The Sojka Corporation," "O'Brien Building Group," "Watts Contracting Company," and "Zeller Construction." Each of these firms represents a different type of real-world construction firm with different values for Lower Bonding Limit, Bond Capacity, and other characteristics important in this simulation.

One of these four firms is representative of a real-world small construction firm. It has a relatively low bond capacity and bonding rates. However, it also has low G&A overhead costs.

Two of these firms are representative of mid-sized companies. They have average bonding capacity and G&A costs. Although these two firms are more similar to each other than they are to either of the extremes, one of these two firms is better suited for smaller projects and the other is better suited for larger projects.

The fourth firm represents a large construction firm. It has a large bonding capacity, but must also overcome its high G&A costs.

Using the BBS

When the simulation begins you will have the opportunity to choose the company you feel gives you the best chance for success. You may not change your company characteristics once a simulation has begun. You are encouraged to perform several rounds of practice simulations as different contractors in order to help you choose the best company to select in the lab simulation.

Once you have selected your firm identity and the simulation is ready to begin, the bid tab for the first project will appear on your screen. The estimated direct cost of the project, the Pay Cycle Factor, the Owner Class, and Project Type will be identified. The next two lines will be 10% (of direct costs) Field Overhead and Bond Cost, both of which will be calculated for you. The final two rows are G&A Contribution and Profit. The G&A (1 year) box reminds you of your firm's annual G&A expenses. In the G&A % box, you need to the percentages of this value that you want included

in the bid. In the Profit % box, you need to enter the percentage of the project direct costs you want included in your bid.

Once you have selected and entered your G&A and Profit percentages and clicked “Submit Bid,” the simulation will display the project bid tabulation, that is, show the bid submitted by each competitor and will indicate which firm won the bid. Once you close this bid tab, you will be taken to the next IFB. This process will continue until the lab period is complete. Once all bids have been completed, the simulator will determine the winner of the simulation, which is the team that finished with the greatest net income.

There are several reports that you can access at any time to help you analyze the dynamics of the bidding environment and your firm’s success to date. The Historical Bids button pulls up a table showing the bid submitted by each firm for each IFB. The Active Projects button pulls up a table showing the contract amounts for all of the active projects being completed by each firm. The bottom row is the total for each firm, which may give you insights into how desperate a firm may be to win a project or whether a particular firm may be bumping up against its bonding capacity. The Income Statement tab was explained in its own section above.

Bidding Strategy and Simulation Dynamics

There is no pre-determined ideal bidding strategy for each firm; rather, the best bidding strategy for each IFB will reflect how many projects you have active already and your competitor’s anticipated bids. Several key principles should be kept in mind

- 1) You will likely not end up as the firm with the highest net profit if you don’t win many bids. (The exception would be if all of your competitors submitted excessively aggressive bids on projects that didn’t match well with their company characteristics.)
- 2) You will not end up with the highest net profit if you win bids simply by not including enough of your G&A overhead costs. Unlike Field Overhead, your GA& costs are fixed costs in that they must be paid regardless of whether you win bids or not. So include enough G&A in most bids such that you will likely cover all of your G&A costs by the end of the year, but do not include so much G&A in any one bid that you stand no chance of winning the project.
- 3) For any bid, you want to leave as little “money on the table” as possible. That is, you want to have your bid only slightly lower than the next lowest bidder.
- 4) It is important to monitor your competitors’ bid amounts and bidding successes. Firms that have not won a project lately are likely to submit an aggressive bid to get monies that will cover at least part of their G&A costs. Firms that already have several active projects may be bumping up against their bonding capacity. You will occasionally be prompted during the simulation to answer a question about why the bidding results turned out the way they did. This is to get you to reflect on what is actually happening in the bidding process.
- 5) It is important to consider the owner class, project type and project size of each project in your bid because your actual direct costs could end up significantly higher than your estimated direct costs. Remember that your firm’s sweetspot in terms of project type and size will not match well with all IFBs. As such, it is appropriate for you to identify a project now and then that you probably do not mind not winning.