CONSTRUCTION PROJECT MANAGEMENT:
A Complete Introduction

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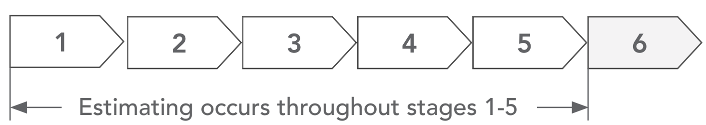
CHAPTER 10

Fundamentals of Estimating



What are estimates and when are they done?

An **estimate** is an educated guess, based on the best available information, of what something is going to cost, usually in dollars or time. Most of us are familiar with getting estimates for repairing the car or painting the house. We make informal estimates ourselves almost daily – how long it will take to drive to Grandma's or how much the utility bill is going to be this month.

In construction, estimates are made to determine the probable real time – and, from that information, the probable cost – of building a project. The contractor's goal is to predict costs accurately and have this estimate low enough to win the job.

Because estimates are done before a project is built, they are, at best, an approximation of what the actual costs are going to be. The true costs of a project will not be known until the project has been completed and all the costs recorded. An estimate done before much design work is complete is very rough; an estimate done after the drawings and specifications are available is far more accurate. Both types of estimates are valuable and serve different purposes at different times during the development of a project.

Both owners and contractors need to know what a project will cost. The owner needs to balance project goals against costs and establish a realistic and workable budget and the contractor needs to establish an amount that the owner will pay for the work. For both parties, the stakes can be high, and an inaccurate or incomplete cost estimate can have serious implications.

Estimates are done throughout the life of a project, beginning at the feasibility phase, continuing throughout the design (during schematics, design development, and final design), before the general contractor is hired, and whenever changes occur during construction. Different types of estimates are done at different phases of a project as the amount of design information is refined. Estimates completed very early in the process are quicker to do but much less accurate than the detailed estimates developed when the drawings and specifications are complete.

Contractor and owner estimates – When we talk about a construction estimate, it's helpful to understand that the owner's project estimate is not the same as the contractor's project estimate. Let's see how they differ.

As we might expect, an owner is involved with, and responsible for, an entire project – from feasibility to occupancy or sale. The costs associated with actually constructing the project are only one piece of the project expenses. The owner is concerned with *all* the costs, which, in addition to the physical construction, might include: purchasing the property, paying for the design work, hiring marketing personnel, paying for attorneys and accountants, interest payments on loans, and other costs. All the anticipated project expenses are estimated and monitored by the owner throughout the process. Estimates are important to an owner because they are the major tools he or she will use to make key determinations about the project: its affordability, its size, and its quality.

The contractor's concern is narrower. The contractor's estimate includes only the expenses involved in the portion of the overall project for which he or she has been hired—typically, the labor, materials, equipment, and supervision necessary to complete the structure and fulfill the contract with the owner. The contractor's detailed estimate provides the basis for the bid price to the owner.

Considerations when developing an estimate

No matter at what stage of a project an estimate is created – whether at the earliest conceptual phase or at the completion of construction documents – there are several factors affecting costs that the estimator takes into account. These factors include the following:

- **Project size and complexity**
- **Quality of building materials**
- **Location of the project**
- **Schedule and time frame**
- **Market conditions**
- **Management**

Let's look at each of these factors.

Project size and complexity

Typically, the bigger the job the more it will cost in terms of materials and labor. But larger projects also provide an economy of scale not present in smaller projects. A larger project provides workers with an opportunity to find their rhythm. And once a contractor has mobilized onto a site – set up his tools and equipment, and prepared the area – it is generally cost effective to be there for a while rather than having to demobilize and move to another project. This is why, for example, painters charge a premium for using different colors: it costs time and money to clean the brushes, and close and open different cans. An additional factor is that repetition increases speed. If a tile setter has 5,000 square feet of floor tile to install, it typically takes longer to lay the first 1,000 square feet than the second 1,000, and so on. As square footage increases, cost per square foot decreases. The estimator must factor in these aspects of size and productivity.

Another characteristic that impacts worker productivity is project complexity. Anytime a structure has complications – a corner, oversized heights, bay windows, odd shapes – productivity goes down and labor costs go up. It is easier for an electrician to put fixtures in an 8-foot-high ceiling than to install them 15 feet up, for example. When complexity requires non-standard sizes, then the price climbs too. Straightforward, simple buildings are easier to build and cost less (that's why so many buildings are so plain!).

Quality of building materials

The quality of products plays a significant role in costs. It costs more to install specially sized wood with jamb extensions than off-the-shelf aluminum windows with drywall returns; Italian marble costs more than standard ceramic tile; 40-ounce nylon carpet costs more than 28-ounce. Some projects just meet code requirements and include very basic finishes; others include fine craftsmanship and superior materials. The estimator reviews the specifications for information regarding the quality requirements of a product.

Location of the project

Location impacts many aspects of an estimate. Labor costs vary from place to place. An inaccessible site (such as a house built in the mountains) means delivery costs are likely to be high, and if the project site is at a distance from the contractor's office, then overhead costs typically rise.

Location can impact the availability and cost of labor. It can also increase the contractor's difficulty in hiring qualified subcontractors who might be operating under different licensing requirements and with different viewpoints and experience. If there is a shortage of local workers, the general contractor might be obligated to bring them in, which can be expensive. Costs vary from area to area too, even when they're within a reasonable proximity to each other. It's more expensive to build something in Boston than in Worchester, Massachusetts, and more expensive in Denver than in Greeley. A contractor working outside his or her normal location adjusts for that in the estimate.

Two other problems associated with location are traffic and parking. Inner-city sites with vehicular and pedestrian traffic increase the costs of access and protection and sites without parking may require making costly alternative arrangements for workers and staff (such as renting spaces). These issues are factored into the estimate.

Schedule and time frame

If a project has an extremely tight time frame, the contractor might be forced to accelerate the work by adding crews or overtime, thus increasing labor and other costs. Extended schedule durations also increase supervision costs, which add indirect costs. Furthermore, if a contractor expects the project to extend over a long period of time, the estimate needs to take into account the likelihood that material prices will fluctuate. The time of year that work will take place also impacts the estimate, as there may be delays due to weather and the necessity for taking measures to protect materials from rain and/or cold.

Market conditions

If the local economy is in a slump and competition for jobs is tough, the estimator sharpens his bid and likely reduces the amount identified as profit. Sometimes a contractor accepts a job even though there's no profit to be had, in fact, simply to keep his crews busy. Conversely, if work is plentiful and it's more difficult to hire experienced crews, this will be reflected in higher bids.

Management

Management considerations include the general tone and effectiveness that might be expected on a project. Is the owner likely to be difficult? Does the architect respond quickly to requests for information? Is there skilled management among all the parties? Also, is the job likely to require additional paperwork such as one typically finds on a federal job? Extra work takes extra time and should be accounted for in the estimate.

Categories of Costs

In order to understand how a cost estimate is created, it's important to understand the different ways that job costs are categorized. To be sure that all costs are included and to organize the hundreds of costs associated with a project so that they can be tracked, costs are customarily identified as being in one of two categories:

- Direct project costs
- Indirect project costs

Every expense on a job is classified as one of these categories and assigned a cost code to enable it to be tracked and managed. In addition there is a third category of costs which include those that are not directly linked to specific projects but are necessary to maintain the contractor's business: indirect business costs. Let's take a look at all three of these types of costs.

Direct project costs

Direct project costs are the materials, labor, and equipment expenses directly associated with the items that become part of the physical structure. *Direct project costs are billable to a specific task and/or subcontractor*. Examples of direct project expenses include the cost of excavating for foundations, pouring concrete, building walls, supplying and laying kitchen tile, and installing the landscaping.

Let's look at how the estimator calculates direct costs.

Direct costs: materials

Materials are the easiest direct costs to calculate because they don't vary much from contractor to contractor (although suppliers can, and do, give variable price quotes to different contractors based on their history with the contractor and the contractor's ability to pay by specified discount dates).

The first step in pricing materials is to calculate how much is needed. The quantity of materials in a project is determined from the drawings. Each sheet of the drawings must be analyzed, with the materials identified and total amounts calculated.

The process of measuring plans to quantify materials is called doing the **take-off**. This process is completed in the same sequence as the building is built – from the ground up – to reduce the chance of missing something. Completing an accurate take-off is important because other costs are calculated based on quantities. For example, if the estimator calculates (through measurement) that 10,850 square feet (SF) of drywall is going to be required, when labor costs are assigned to the task of hanging the drywall, the numbers are based on an estimate of how many labor hours it is expected to take to hang 10,850 square feet. If the estimator has miscalculated the quantity of drywall, then the labor hours as well as the material costs will be wrong.

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Knowing just the quantity of materials isn't sufficient, however; the estimator also needs to know exactly what the product quality requirements are. The specifications provide the information necessary to price the correct product. In our drywall example, the quantity of drywall needed doesn't tell the estimator what grade of drywall the architect wants. For example, is it fire or water or mold resistant? The specifications provide this information.

Once the quantity and quality of the material has been determined, the cost can be calculated by multiplying the quantity of the materials times the **unit cost**. For example, a contractor is estimating the cost of an addition on a house. The take-off indicates that 2,050 linear feet (LF) of 2ft by 6ft redwood decking will be required. A quote from the supplier indicates that it will cost $2.15 per LF (a linear foot is the unit cost) for the decking. The total estimated cost for the lumber is therefore 2,050 LF x $2.15/LF = $4,407 (plus applicable taxes).

Direct costs: labor

Estimating labor costs is more difficult because these costs can vary substantially from contractor to contractor. Labor costs are calculated by multiplying an hourly **wage rate** (which includes costs such as social security, unemployment taxes, and health benefits in addition to the worker's direct pay) by **productivity** (how much a worker can accomplish in a given period of time). For example, let's assume a $40/hour wage rate for a drywaller who is likely to be on a two-person crew with a productivity rate of 2,000 square feet per 8-hour day. If the contractor's take-off indicates that there are 11,850 square feet of drywall, how much will the labor cost? The calculation is quite simple:

11,850 SF (total units of drywall) ÷ 2,000 SF (units installed per 8 hours) = 5.9 days (we'll round up to 6 days)

Each worker's wage rate is $40/HR, therefore the cost is $80/HR x 8 HR/day = $640/day x 6 days = $3,840 total labor cost

Determining labor costs isn't always so straightforward, however, because these costs are highly variable. As we've said, the productivity rate identifies the number of units of work (such as the square feet of drywall) a person is able to install in a specified period of time (usually hourly or daily). But productivity rates can vary greatly from contractor to contractor, and they are impacted by the skill and experience of the worker as well as the conditions in the field: Is there sufficient coordination and supervision? Is all necessary equipment in

The Davis-Bacon Act – Congress enacted the Davis-Bacon Act in 1931 to assure workers a fair wage, provide local contractors an equal opportunity to compete for local government contracts, and preserve the government's ability to distribute employment and federal money equitably through public works projects. Among other things, the law states that labor on federal projects or federally assisted projects must pay workers no less than the local prevailing wages and benefits. This ensures that contractors bidding on public works projects will not lower wages in order to achieve a lower bid.

Some organizations, including the Republican Party, have long tried to repeal the Davis-Bacon Act on the grounds that the regulations are outdated, expensive, and bureaucratic. There have also been several times when the act was temporarily suspended. After Hurricane Katrina, for example, President George W. Bush suspended the act *indefinitely* in designated areas along the Gulf Coast. After pressure from both Democrats and Republicans, Bush rescinded his emergency order and restored the prevailing wage requirement. For the most part, the Davis-Bacon Act continues to enjoy local support across the nation.

place? Is the job especially complicated or does it require working in less than optimal conditions? Are there efficiencies of scale in the work? All of these can impact a worker's productivity.

In addition, hourly labor rates are variable among the trades; electricians and plumbers are generally more highly paid than painters, for example. The "going rate" for a particular trade and worker is a function of whether the rate is based on prevailing wage rates, union rates, or on open shop rates. A **prevailing wage** is the hourly wage, plus benefits and overtime, paid to the majority of workers in the local area. Most workers on publicly funded jobs are paid a prevailing wage

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because of the Davis-Bacon Act. This act requires that most federal construction projects pay workers the local area's prevailing wage. **Union rates** are paid to workers who are members of a labor union and are paid a wage rate established by the union and a project's management, and workers who are not in a union are paid **open shop wages**. Open shop wage rates are agreed to by the individual worker and his employer. The estimator needs to understand how wages for each trade, on each job, have to be calculated.

Direct costs: equipment

Equipment can be rented or purchased; the contractor may or may not own it. If a contractor owns her equipment, the usual practice is to charge an hourly rate for its use. The cost for equipment includes the rental cost for the piece of equipment plus the operating cost (gas, set-up, maintenance, etc.) Equipment operators may or may not be rolled into base equipment costs; typically, when the equipment is owned by the contractor and rented to the job, the cost for operators is included under labor costs.

Direct costs: subcontractors

Subcontracted work is a direct project cost to the general contractor. All the labor, material, equipment, taxes, overhead, and profit are included as part of the subcontractors' bids to the GC. Typically, the general contractor itemizes the costs for subcontracted work and adds a markup to those costs.

The estimator has now calculated the costs of materials, labor, equipment, and subcontractors – the direct costs. Once these costs are known, the indirect project costs are calculated.

Indirect project costs

The second category of job cost is **indirect project costs** (also called general requirements or general conditions costs). These are the job expenses that are directly linked to the cost of the work as a whole but *not to a specific task or subcontract*. Indirect project costs include such items as the general contractor's job supervision, setting up a jobsite office (typically a trailer), temporary water and power for the job, scaffolding, cleaning the site, the costs incurred in organizing meetings, and much more. Some of these costs are required by the terms of the contract (an example would be a requirement that a full-time superintendent be at the jobsite), some are required by law (such as certain testing requirements), and some are the result of good construction practice (such as keeping the site clean). Indirect project costs are not physically incorporated into the structure.

The cost of the superintendent is an example of why a cost might be categorized as an indirect project cost rather than a direct cost. The general contractor's superintendent on a project is on the jobsite full-time, managing and coordinating the work. He works with *all* the subcontractors, facilitates meetings, updates the schedule, helps track costs, and works closely with both the contractor's project manager and the architect. The superintendent is involved with most, if not all, aspects of the work; the cost for his salary and benefits is therefore not billable to any one specific task. The superintendent is an indirect project cost. Compare this to the supervisory staff for the electrical subcontractor on the job. All *his* time is focused on the specific tasks involved with the electrical work and can be billed against this cost. This supervision is *not* an indirect project cost. Indirect project costs are typically, although not always, incurred only by the general contractor.

There is a direct time/cost relationship between indirect project costs and how long the work continues: the longer the job the higher the indirect project costs. Once the construction is over, the jobsite trailer is removed, the portable toilets are returned, and the general contractor's superintendent goes on to another job; the work is done and so are all indirect project costs.

Indirect business costs (overhead)

There is a second category of indirect costs that are critical to the success of a contractor's business but are not classified as job costs: **indirect business costs,** more commonly referred to as **overhead**. These are the costs associated with running the contractor's business and *have no direct relationship with any specific job*. Overhead expenses include the cost of staffing the home office, telephone and fax machines, office rent, and so on.

Although overhead costs occur away from the jobsite, they are critical contractor expenses and must be paid for with proceeds from each job. How they are calculated is highly variable and depends on the contractor's fixed costs (such as rent and home office staff), the number of projects the office is working on, and other factors. Sometimes contractors pro-rate overhead according to their volume of work; sometimes they charge a set percentage on all jobs. Typically, indirect business costs are simply added to the total estimated direct and indirect project costs. All the contractors and subcontractors have overhead expenses that are at least partially funded through individual jobs.

Let's look at a simple comparison of how different costs might be classified as either direct, indirect project, or overhead costs.

Expense	Direct project cost	Indirect project cost	Overhead
Roofing	√		
Superintendent		√	
Home office			√
Telephone at jobsite		√	
Telephone at homeoffice			√
Contractor's attorney			√
Site excavation	√		
Solar panels on the new building	√		
Solar panels on the home office			√
Drinking water at the jobsite		√	
Meeting minutes		√	

Figure 10.1. Comparison of costs

Now that we understand in general terms how estimates are created, let's look at where contractors get their numbers and what makes a good estimate.

Where does the estimator get the numbers?

We know the types of costs the estimator needs to calculate, but where, exactly, does he or she get the numbers? There are three basic sources:

- In-house data from previous jobs (field-generated data)
- Purchased cost data
- Subcontractors and suppliers

The data a contractor gets from his own experience, called in-house data, are the best way to estimate costs. These are a contractor's tested, real costs, using known crews. This historical data – how much the same task for a similar project cost the contractor in the past – are the best way for the contractor or his estimator to price labor costs accurately.

There are sometimes items in an estimate for which the contractor does not have adequate data. Several companies specialize in compiling and publishing cost data. Although not as reliable as a contractor's own field data, purchased data can be accurate, as costs may be adjusted for project conditions and location. One commonly used source of published data is RSMeans, a division of Reed Construction Data. RSMeans is one of North America's leading suppliers of construction cost information and publishes estimating guides for all sectors of the industry and for different types of projects – residential, industrial, commercial, and institutional. They publish several dozen cost estimating and reference books that are readily available. We'll examine some of the Means data in the next chapter.

Finally, estimators can get pricing help from subcontractors and suppliers. Companies that supply materials, called vendors, gladly provide material and equipment costs to the estimator, as do potential subcontractors.

What makes a good estimate?

Sometimes it doesn't matter too much if an estimate is not absolutely accurate. For example, if you are adding a bathroom in your house, miscalculate the plumbing costs, and end up spending more than you had planned, it could be expensive, but the loss may not make a substantial difference in your life. But if you're a subcontractor for all the plumbing in a 500,000-square-foot skyscraper and you make a mistake on your estimate, it could have catastrophic implications for your business, with lost reputation, litigation, and, in extreme cases, bankruptcy.

The goal of the estimate is to include *everything*, and for everything to be priced *accurately* so that the estimated cost is as close as possible to the final, actual costs for the work. Because the contractor typically bears any cost overruns caused by errors or omissions in the estimate, it is crucial that the bid estimate be both accurate and complete. To ensure this, the estimator asks the following questions:

1. Has everything been accounted for and priced?
2. Are labor costs and material prices based on accurate data that reflect local conditions?
3. Are the quantity, quality, model numbers, and color of all products correct?
4. Does the price of materials and equipment include taxes and delivery?
5. Will the owner pay for materials that need to be stored before they're installed or used? (Note: Sometimes an owner will only pay for materials once they have become part of the structure.)
6. Do the manufacturer's warranties match what is required by the specifications? If not, the contractor will need to purchase an extended warranty.

7. Does the supplier offer a price discount for speedy payment? If the contractor can pay promptly for materials, many suppliers offer price breaks.
8. Have risks been carefully analyzed and does the estimate reflect this? (An example of a risk is escalating material costs for projects with a long construction time.)
9. Is there adequate overhead and sufficient profit?

Value engineering – The increasing cost of materials, labor, overhead, and maintenance is making it necessary to get the most value out of our construction, and reducing costs is increasingly important. Many projects – from small houses to large industrial and commercial buildings – may be "value engineered" to minimize overall costs. Value engineering (VE) is not the same as "cost cutting" but is a methodical analysis of ways to reduce the costs of a project or structure over its entire life. Value engineering can be done at any time but is best done during the design phase when it's easier to make design adjustments. VE is a systematic process of analyzing specific building components and systems to find ways to perform the same function(s) at a lower life cycle cost without sacrificing reliability, performance, and design goals. It is possible that the initial cost for something (an expensive geothermal cooling system, for example) will be higher than a conventional system but will save costs over the life of the project. Value engineering must balance the up-front costs with the long-term cost savings – and the budget and vision of the owner.

Now that we have a basic understanding of the components of and reasons for estimating, we're ready, in the next chapter, to take a look at different types of estimates.

Chapter Vocabulary

Davis-Bacon Act – a law stating that labor on federal projects or federally assisted projects must pay workers no less than the local prevailing wages and benefits.

Direct project costs – the labor, materials, and equipment expenses directly associated with the items that will become part of a physical structure.

Estimate – an educated guess, based on the best available information, of what something is going to cost, usually in dollars or time.

Fee – the amount paid as remuneration for services. In construction, the fee is typically overhead plus profit.

General conditions costs (general requirements costs, indirect project costs) – expenses that are directly linked to the cost of the work but not to a specific task or subcontract.

General requirements costs (general conditions costs, indirect project costs) – expenses that are directly linked to the cost of the work but not to a specific task or subcontract.

Indirect business costs (overhead) – costs associated with running the contractor's business and not directly billable to any specific job expense.

Indirect project costs – see General conditions costs.

Open shop wage rate – wages paid to workers who are not in a union or on a federal project, and as agreed to by the individual worker and his or her employer.

Overhead (indirect business costs) – costs associated with running the contractor's business and not directly billable to any specific job expense.

Prevailing wage – pay rates set by the Department of Labor based on wages in a specific locality.

Productivity – how much a worker can accomplish in a given period of time.

RSMeans – a product line of Reed Construction Data, and a primary supplier of construction cost data.

Take-off ("doing the take-off") – the process of measuring construction drawings in order to quantify materials.

Union rates – wages paid to workers who are members of a labor union and whose pay rate is established by the union and a project's management.

Unit cost – the cost of materials based on a typical unit for that product such as tons, square feet, linear feet, or cubic yards.

Value engineering – a methodical analysis of ways to reduce the costs of a project or structure over its entire life.

Wage rate – rate (typically, by the hour) for labor, including costs such as social security, unemployment taxes, and health benefits in addition to the worker's direct pay.

Test Yourself

1. What is a cost estimate?
2. Why are estimates done at different phases of a project?
3. Name three examples of direct costs.
4. Name three examples of indirect project costs.
5. Why would a superintendent be categorized as an indirect project cost and not a direct cost?
6. What is a take-off and when is it used?
7. Explain how project complexity can impact a cost estimate.
8. Why does an estimate have to be complete and accurate?
9. Why are labor costs more difficult to calculate than material costs?
10. A contractor who is putting an estimate together is inexperienced with doing foundation work and therefore has no in-house cost data. What other two ways might she use to get cost figures for this portion of the job?


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CHAPTER 11

Creating Estimates

Estimates are based on design information. When the design of a project is incomplete, it is still possible to estimate what it will cost to build, but the estimate will, of course, be approximate. In the last chapter, we defined an estimate as an educated guess. As the owner and architect move ahead in the planning and design of a project, progressively more detailed estimates are generated and the educated guess becomes increasingly accurate. These early estimates are tools for the owner and architect to make adjustments in the program while it's still relatively easy. It is always cheaper and less stressful to make changes during the design process than to find out, after contractors' bids come in, that the project is unaffordable and needs to be changed.

Types of estimates

There are three basic types of estimates: two are developed before the design is 100 percent complete, and one is a very detailed estimate based on complete design information. Each of these exhibits a different level of accuracy and completeness.

- **Conceptual estimates** are based on very little design information and use gross unit pricing to determine the project cost. Estimates using gross unit costs might quote a cost per room (for a hotel), a cost per pupil (for a school), a cost per bed (for a hospital), and so on. These estimates are used during the early phase of a project when there are no drawings; they assist the owner in making program choices. A common conceptual estimate is called a rough-order-of-magnitude (ROM) estimate.

- **Preliminary estimates** are developed after some design is known and decisions are still being made. There are several types of preliminary estimates; in this text, we'll look at square foot estimates in which costs are projected based on area. These estimates are more accurate than ROM estimates.
- **Detailed estimates** (also called **final, bid**, or **unit price** estimates) are based on the most detailed design information and are developed by the contractor (or bidding contractors) after the design drawings and specifications are completed. A detailed bid estimate is prepared by determining the price of labor, materials, and equipment necessary for the work and includes subcontracts, overhead costs, taxes, and the contractor's profit. The contractor prepares the detailed estimate prior to submission of the bid to the owner.

Conceptual and preliminary estimates can be sufficiently accurate for the owner to evaluate design alternatives (for example, the project size and configuration) and to provide initial cost data. But they are insufficient for the very detailed cost estimate that a contractor develops at the completion of design, which forms the basis for the amount the contractor will be paid for the work.

Let's look at rough-order-of-magnitude, square foot, and detailed estimating in a bit more detail.

Conceptual/rough-order-of-magnitude estimates

A rough-order-of-magnitude estimate is completed early in the planning phase (typically during feasibility) by the owner to determine if the project is affordable and to help define the scope of work. As noted, this type of estimate is done before many details are known; the estimate can be completed very quickly. But because conceptual estimates are based only on broad design projections before many specific decisions have been made, they are, by necessity, very rough. A ROM estimate is useful primarily as a planning tool.

How might the owner develop a ROM estimate? If the owner is familiar with the type of project being estimated, she will use her own in-house data to complete the conceptual estimate. Otherwise, she must rely on a consulting estimator or on published data. Once the cost per unit is known, this number is multiplied by the anticipated quantity.

Let's say an owner is interested in developing a 42-room hotel and wants to get a rough idea of the financial feasibility of the project. She determines that the unit cost is $84,000 per room (including all costs except those to purchase the site). The total ROM estimate can be as simple as the following:

Number of rooms x cost per room = total cost
42 rooms x $84,000/room = $3,528,000 total cost

Added to this figure are adjustments that might be made such as non-standard room sizes, unusual building configuration, location, or expected construction date.

The conceptual estimate can be completed quickly and without drawings. Although a conceptual estimate is very rough, with limited accuracy, it can serve an important function. Conceptual estimates provide an owner with early data regarding project budgets and programs and can be used to set broad development goals and cost projections.

What does an owner do when the conceptual estimate is too high? Take our hotel as an example: The owner has experience with similar projects and makes a rough projection that a 42-room hotel will cost in the range of $3,530,000. She is going to depend on bank financing for the project and doesn't think she can get loans for more than $3 million, however. What might she do? She has four options: 1) abandon the idea; 2) cut back the size of the proposed project to lower the overall cost; 3) reduce the quality of the work, thereby lowering the square-foot cost and meeting the lower budget; or 4) some combination of 2 and 3. Although the final actual costs for the hotel will be different, the conceptual estimate should be close enough to enable the owner to make a reasonable decision regarding how to proceed.

Preliminary/square foot estimates

A **square foot estimate**, which is completed after some design detail is available but before the entire design is complete, uses a cost per square foot to calculate totals (size in square feet x cost per SF = total cost). The cost *per unit* includes labor, equipment, material, overhead, and profit but does not calculate these numbers separately. This type of estimate is therefore more detailed and hence more accurate than the rough-order-of-magnitude estimate. The square foot estimate is used to define the project budget further; depending on the amount of detail available, square foot estimates are significantly more accurate than conceptual estimates.

Square foot estimates are typically completed by contractors or architects using the estimator's own experience or published data such as the cost data guides printed by the RSMeans Company (introduced in the last chapter). Let's look at how a contractor might use an RSMeans guide to price a private residence that has not yet been completely designed but about which major decisions regarding layout, materials, and amenities have been determined. (In addition to residential projects, the RSMeans guide also has data for industrial, commercial, and institutional structures. Here we'll focus on residential work, however.)

Problem to solve

What is the estimated cost of a 1,400 SF one-story house in Tampa, Florida, with one and a half baths, a one-car detached garage, and textured ceilings? Assume the exterior wall system is stucco over wood frame and that the quality of the structure is average.

Price is linked to quality: the higher the quality the higher the price. So, in order to maximize pricing accuracy, the estimator needs to understand what quality is anticipated. RSMeans addresses this through their classes of residential construction: from economy to average, custom, and, finally, luxury. Each classification has specific characteristics. In our problem, we are pricing a house of "average" quality, which, according to Means, is a house with a simple design built from standard plans. Features include one bathroom, asphalt roofing, and no garage; there are some distinctive features to the house, and the workmanship typically exceeds minimum code requirements. (Our house is slightly different from the "average" identified by Means because of the extra half-bath and the garage. There will be an opportunity later to take these facts into account.)

Pricing is also affected by the number of stories a house has. Means provides cost breakdowns for seven different *categories* of housing defined by the number of stories. The estimator needs to select the cost data sheet that matches the *quality* of the project (economy, average, custom, or luxury) plus the residential *category*. For our problem we have been asked to price an average one-story house. Figure 11.1 is therefore the appropriate RSMeans Cost Data Sheet.

RESIDENTIAL | Average | 1 Story

- Simple design from standard plans
- Single family — 1 full bath, 1 kitchen
- No basement
- Asphalt shingles on roof
- Hot air heat
- Gypsum wallboard interior finishes
- Materials and workmanship are average
- Detail specifications on p. 27

Note: The illustration shown may contain some optional components (for example: garages and/or fireplaces) whose costs are shown in the modifications, adjustments, & alternatives below or at the end of the square foot section.

Base cost per square foot of living area

	Living Area										
Exterior Wall	600	800	1000	1200	1400	1600	1800	2000	2400	2800	3200
Wood Siding - Wood Frame	135.60	122.45	112.70	104.85	98.30	94.05	91.75	88.85	83.15	78.95	76.10
Brick Veneer - Wood Frame	152.80	138.85	128.50	120.05	112.95	108.35	105.95	102.75	96.70	92.20	89.10
Stucco on Wood Frame	141.80	129.05	119.55	112.00	105.65	101.50	99.35	96.50	91.05	86.95	84.20
Solid Masonry	166.85	151.40	139.85	130.30	122.25	117.10	114.35	110.65	103.95	98.90	95.30
Finished Basement, Add	33.95	32.80	31.25	29.85	28.75	27.95	27.60	27.00	26.10	25.50	24.90
Unfinished Basement, Add	13.90	12.50	11.55	10.65	9.95	9.50	9.20	8.85	8.30	7.90	7.60

Modifications

Add to the total cost

Upgrade Kitchen Cabinets	$ + 3521
Solid Surface Countertops (Included)	
Full Bath - including plumbing, wall and floor finishes	+ 5993
Half Bath - including plumbing, wall and floor finishes	+ 3570
One Car Attached Garage	+ 12,676
One Car Detached Garage	+ 16,871
Fireplace & Chimney	+ 5234

Adjustments

For multi family - add to total cost

Additional Kitchen	$ + 6796
Additional Bath	+ 5993
Additional Entry & Exit	+ 1640
Separate Heating	+ 1409
Separate Electric	+ 1915

For Townhouse/Rowhouse - Multiply cost per square foot by

Inner Unit	+ .92
End Unit	+ .96

Alternatives

Add to or deduct from the cost per square foot of living area

Cedar Shake Roof	+ 3.85
Clay Tile Roof	+ 4.55
Slate Roof	+ 6.65
Upgrade Walls to Skim Coat Plaster	+ .41
Upgrade Ceilings to Textured Finish	+ .48
Air Conditioning, in Heating Ductwork	+ 4.19
In Separate Ductwork	+ 8.02
Heating Systems, Hot Water	+ 2.16
Heat Pump	+ 2.66
Electric Heat	− 1.01
Not Heated	− 3.80

Additional upgrades or components

28 **Important: See the Reference Section for Location Factors (to adjust for your city) and Estimating Forms**

Figure 11.1. Square foot cost data

The RSMeans data sheet shows national average costs *per square foot* depending on the exterior wall system and the size of the house. For residential projects, there are four possible exterior wall systems (wood, brick, stucco, and masonry; see the vertical column on the left side of the chart) and a range of sizes from 1,000 to 3,800 square feet. Basements may also be added and the estimator can adjust costs for various modifications such as extra bathrooms, garages, and upgraded materials and systems such as tile roofing and air conditioning.

To determine the cost for our house, the estimator locates the house's exterior wall system; in our case, this is stucco over wood frame. Next, we read across to the square footage that matches the proposed building size; in our problem, it is 1,400 square feet. Reading down at the intersection of exterior wall and building square footage shows a cost of $105.65 per square foot. (Interpolation is necessary if the square footage is different from what is presented in the cost sheet. For example, if the building is 1,500 square feet, the cost per square foot is ($105.65 + $101.50) ÷ 2 = $103.58.)

The base square foot cost represents a national average cost and can be increased, or reduced, depending on the complexity of the building, whether it has a basement, and if there are any features that deviate from the average house.

To find the total base cost for our house, we multiply the square footage of the building by the cost per square foot as shown in the data sheet.

1400 SF x $105.65/SF = $147,910

To get our estimate as close as possible to what the building will cost, we need to add in the upgrades. The upper left of the cost sheet indicates what is included in the average house. Our house has upgrades of an extra half-bath, a garage, and textured ceilings. If we refer to Figure 11.1 we can see that the following costs need to be added to the base cost:

½ bath..Add $ 3,570
One-car detached garage..Add $16,871
Upgrade ceilings to textured finish ($.48/SF x 1,400 SF)..............Add $ 672
Total modifications = ...$21,113

To get the total estimated project cost, we add the upgrades to the base price:

$147,910 + $21,113 = $169,023 adjusted base cost

But we're not quite done.

The Means cost sheets are all based on *average national* costs so an additional adjustment must be made to take into account that the house will be built in Tampa, Florida. Location adjustments are done by multiplying the project cost by a *city location factor* (Figure 11.2). The location factor assumes that the *average* city cost is 100, and costs in Tampa (and elsewhere) are expressed as a percentage of this average.

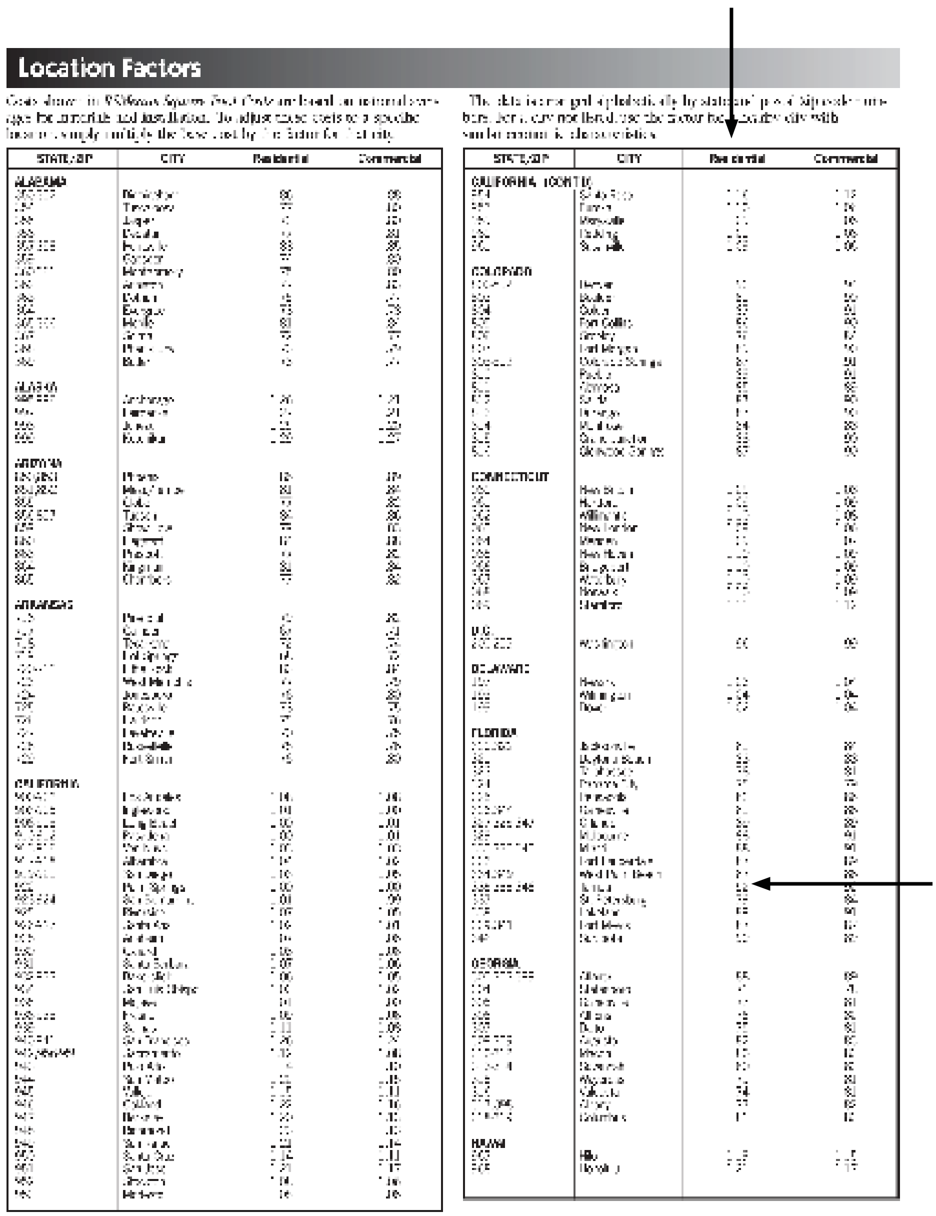


Figure 11.2. Location factors

On the location factor sheet, find Tampa and go across to the residential column. We can see that Tampa is valued at .92 of the national average. This means it's cheaper to build in Tampa than it is in the average American city.

Multiplication of the adjusted project cost by the location factor for Tampa gives us the total estimate for building our house:

$169,023 (base costs plus additives) x .92 (location factor) = $155,501 total cost

If we compare the cost of building the house in Tampa ($155,501) with the national average for the same building ($169,023), we can see that Tampa is less costly.

What if we were to build the same building in San Francisco? How would *that* cost compare to the national average and to the cost in Tampa? To determine this, we do exactly what we did for Tampa: calculate an adjusted base cost and multiply by the location factor for San Francisco (1.26):

$169,023 x 1.26 = $212,968

So it appears that the cost to build our house in San Francisco is a lot higher than both the national average ($169,023) and the cost in Tampa ($155,501).

The final adjustment that might have to be made is for time. We computed our examples based on the 2010 Means data indices. A project set to begin sometime in the future needs to be adjusted for expected increases in labor and material. This can be accomplished by using an anticipated inflation figure or by referring to *Means Historical Data*, which suggests an escalation rate for future years.

As already discussed, conceptual and square foot estimating are approximate estimates completed before the design is complete. For the most accurate and detailed estimating, the owner looks to the detailed estimate developed by the contractor at the completion of design and before the bid submission. Not surprisingly, these estimates are far more difficult and time-consuming to complete and their accuracy is more critical.

Detailed/bid estimates

Bid estimates (also called **final estimates** or unit **price estimates**) are prepared at the end of design to finalize the construction budget. They are developed by bidding contractors attempting to be hired for the work. (Subcontractors also develop detailed estimates to put *their* bids together for the general contractors.) These estimates are accurate because they are based on complete design information. Unlike conceptual and preliminary estimates, the detailed estimates put together by bidding contractors break down all the separate costs for construction – direct and indirect project costs (including subcontractor costs), overhead, and profit.

What steps does the contractor take to generate all the detailed price data for a bid estimate? Estimating is a systematic process that mimics the sequence of construction: the estimator begins at the foundation and works his or her way up to the roof. The first thing the estimator does is quantify every work item through a measurement process called a take-off (discussed in the previous chapter). The take-off generates a list of products and materials and the quantity of each (the number of windows, square feet of roofing materials, tons of gravel, cubic yards of concrete, board feet of decking, etc.). For a detailed estimate, most costs are separated into units of labor, material, and equipment and the contractor calculates a cost for each. Let's generate a detailed estimate for a small task as an example of how this process might work.

Problem to solve

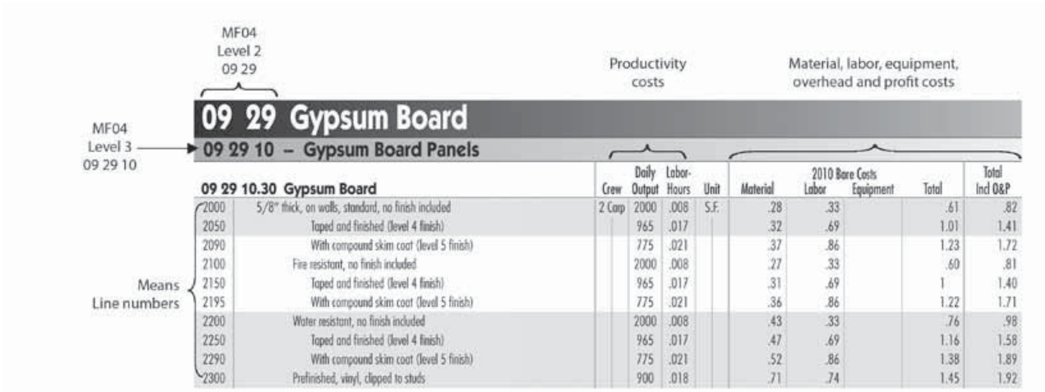
What is the total cost for 5/8" fire resistant gypsum board on both sides of four 15' high x 32' long partitions, with no openings and no finish?

How are the costs for the gypsum board calculated? The estimator's take-off determines that there are 3,840 square feet of drywall (the common name for gypsum board) used on the partition.

15'H x 32'L x 2 (sides) x 4 (partitions) = 3,840 SF

Once the quantity of material is known the estimator determines the cost for the materials plus installation labor. Typically, the estimator uses in-house historical data along with square foot cost data from suppliers to complete the calculation. We will use published data from RSMeans to assist us, as we did with the residential calculations. Because in this problem we have a greater amount of design information, the appropriate Means reference will be the *Cost Construction Data*, which breaks down costs more completely than does the square foot price data sheets.

The *Cost Construction Data* index provides the page location for gypsum board. A detail from that page is shown in Figure 11.3. Let's see how the data is presented.



09 29 Gypsum Board

09 29 10 – Gypsum Board Panels

09 29 10.30 Gypsum Board		Crew	Daily Output	Labor-Hours	Unit	2010 Bare Costs Material	Labor	Equipment	Total	Total Incl O&P
2000	5/8" thick, on walls, standard, no finish included	2 Carp	2000	.008	S.F.	.28	.33		.61	.82
2050	Taped and finished (level 4 finish)		965	.017		.32	.69		1.01	1.41
2090	With compound skim coat (level 5 finish)		775	.021		.37	.86		1.23	1.72
2100	Fire resistant, no finish included		2000	.008		.27	.33		.60	.81
2150	Taped and finished (level 4 finish)		965	.017		.31	.69		1	1.40
2195	With compound skim coat (level 5 finish)		775	.021		.36	.86		1.22	1.71
2200	Water resistant, no finish included		2000	.008		.43	.33		.76	.98
2250	Taped and finished (level 4 finish)		965	.017		.47	.69		1.16	1.58
2290	With compound skim coat (level 5 finish)		775	.021		.52	.86		1.38	1.89
2300	Prefinished, vinyl, clipped to studs		900	.018		.71	.74		1.45	1.92

Figure 11.3. Construction cost data gypsum board (excerpt)

RSMeans uses a system called MasterFormat (MF04) developed by the Construction Specifications Institute (CSI) to organize information in a hierarchy from very broad (called divisions or level 1 information) to very detailed, represented by Means' 12-digit line number. (We'll look at this in more detail in Chapter 16.) For each line item, specific price data is provided (reading from left to right): a coded standard crew size (in the case of gypsum board, 2 Carp = two carpenters); crew productivity (the quantity a crew can install in an eight-hour day and called Daily Output); labor productivity (how long it takes a single worker to install a single unit); unit (the standard unit measurement for the item, in our case, square feet); and bare material, labor, and equipment costs per unit (bare costs do not include overhead and profit). For the total cost per square foot, we'll move to the far right column (identified as Total Incl O&P).

In our problem, we've been asked to price 3,840 square feet of 5/8" fire resistant gypsum board. We can solve the problem by referring to the page detailed in Figure 11.4 – Gypsum Board. Let's see how the estimator might proceed.

We find the product we're pricing on line 2100 and, moving along from left to right, the costs for materials and labor (there are no equipment costs associated with this product). All the costs shown are per unit (in our case, this is square feet). The productivity rate for a single crew is 2,000 square feet per day. (The daily output is based on normal conditions: an eight-hour day, in daylight, with moderate temperatures.) On the far right, we get a total cost, including overhead and profit of $.81 per square foot. Our total cost is therefore:

3,840 SF x $.81/SF = $3,110

09 29 Gypsum Board

09 29 10 – Gypsum Board Panels

	09 29 10.30 Gypsum Board	Crew	Daily Output	Labor-Hours	Unit	2010 Bare Costs Material	Labor	Equipment	Total	Total Incl O&P
2000	5/8" thick, on walls, standard, no finish included	2 Carp	2000	.008	S.F.	.28	.33		.61	.82
2050	Taped and finished (level 4 finish)		965	.017		.32	.69		1.01	1.41
2090	With compound skim coat (level 5 finish)		775	.021		.37	.86		1.23	1.72
2100	Fire resistant, no finish included		2000	.008		.27	.33		.60	.81
2150	Taped and finished (level 4 finish)		965	.017		.31	.69		1	1.40
2195	With compound skim coat (level 5 finish)		775	.021		.36	.86		1.22	1.71
2200	Water resistant, no finish included		2000	.008		.43	.33		.76	.98
2250	Taped and finished (level 4 finish)		965	.017		.47	.69		1.16	1.58
2290	With compound skim coat (level 5 finish)		775	.021		.52	.86		1.38	1.89
2300	Prefinished, vinyl, clipped to studs		900	.018		.71	.74		1.45	1.92

Figure 11.4. Construction cost data gypsum board (excerpt)

If the estimator wants only the cost for the materials or for labor, he multiplies the square footage by their respective costs ($.27/SF and $.33/SF). As with our residential problem, these cost figures reflect a national average. If asked to price the partitions for a particular location, we need to make a location adjustment.

If the estimator wants to know how long it will take to hang 3,840 square feet of drywall, he or she divides this area by the total daily output of a typical two-person crew:

3,840 SF ÷ 2,000 SF per day = 1.92 days (rounded up to 2 days)

The data sheet provides another handy cost figure. The vertical column titled "Labor Hours" represents the number of labor hours it takes to install one unit of whatever the product is. This figure can be used if the contractor anticipates a crew size different from the standard. Under the Labor Hours column for our 5/8" drywall, we see that it takes .008 hours (for one person) to install one square foot (units are identified in the column directly to the right). So here's how we determine how long our 3,840 square-foot job would take one worker to complete:

3,840 SF x .008 hours = 30.72 hours total for one worker

30.72 hours = 3.84 work days (rounded up to 4 days) for one worker

The estimate summary

Once the contractor has completed the estimate – quantities have been calculated, prices confirmed, and indirect project costs determined – he or she summarizes the data on an estimate summary sheet such as that shown in Figure 11.5 and, assuming costs have been calculated using in-house data and do not yet include overhead and profit, adds these costs plus applicable sale taxes and labor burden.

On a competitively bid job, the contractor submits the final number (in figure 11.5 summary, $1,795,979) as the bid estimate. (This is also called the quote.) For a fixed price project, the owner sees only the bid amount; for projects that reimburse the contractor for actual costs, the owner has access to all these numbers.

Division	Work	Materials	Labor	Equipment	Subcontracts	Total
1	Gen'l Conditions	$72,340.00	$46,560.00	$2,040.00	$0.00	**$120,940.00**
2	Site work	$4,320.00	$3,675.00	$2,200.00	$162,500.00	**$172,695.00**
3	Concrete	$76,540.00	$66,800.00	$4,323.00	$0.00	**$147,663.00**
4	Masonry	$0.00	$0.00	$0.00	$56,400.00	**$56,400.00**
5	Metals	$4,300.00	$3,200.00	$0.00	$0.00	**$7,500.00**
6	Wood & Plastics	$234,000.00	$176,000.00	$0.00	$0.00	**$410,000.00**
7	Thermal &	$0.00	$0.00	$0.00	$76,000.00	**$76,000.00**
	Moisture protection					
8	Doors & Windows	$34,566.00	$22,311.00	$0.00	$2,211.00	**$59,088.00**
9	Finishes	$0.00	$0.00	$0.00	$220,000.00	**$220,000.00**
10	Specialties	$6,400.00	$5,430.00	$0.00	$0.00	**$11,830.00**
11	Equipment	$0.00	$0.00	$0.00	$0.00	**$0.00**
12	Furnishings	$0.00	$0.00	$0.00	$0.00	**$0.00**
13	Special Const.	$1,240.00	$765.00	$1,200.00	$0.00	**$3,205.00**
14	Conveying Systems	$0.00	$0.00	$0.00	$52,000.00	**$52,000.00**
15	Mechanical	$0.00	$0.00	$0.00	$78,000.00	**$78,000.00**
16	Electrical	$0.00	$0.00	$0.00	$86,775.00	**$86,775.00**
	SUBTOTALS	**$433,706.00**	**$324,741.00**	**$9,763.00**	**$733,886.00**	**$1,502,096.00**
	Sales tax @ 7.75%	**$33,612.21**	$0.00	$0.00	$0.00	**$33,612.21**
	Payroll tax @36%	$0.00	**$116,906.76**	$0.00	$0.00	**$116,906.76**
	SUBTOTALS	**$467,318.21**	**$441,647.76**	**$9,763.00**	**$733,886.00**	**$1,652,614.97**
	Overhead @ 5%					**$82,630.74**
	SUBTOTAL					**$1,735,245.71**
	Profit @ 3.5%					**$60,733.57**
	TOTAL ESTIMATE					**$1,795,979.28**

Figure 11.5. An estimate summary

The contractor identifies each broad scope of work by number (again, often following the MasterFormat divisions) and these are listed along the left vertical column. To the right are columns for material, labor, and equipment costs incurred by the general contractor. In our example, costs for subcontracts are identified as a separate column. (Remember, the general contractor is responsible for the costs for his own crews *plus* the costs for subcontracted crews.)

To see how to read the summary, let's look at item 3 – Concrete. In the columns to the right, we see that there are costs identified for materials, labor, and equipment but zero for subcontracts. This means that the GC's crews will do 100 percent of the concrete work. Conversely, under Masonry (item 4), there are zero costs identified for materials, labor, and equipment but $56,400 for subcontractor costs. The general contractor will do *none* of the masonry work using his or her own crews. Costs along the horizontal are added and the total cost for the item is on the far right. The total estimate for item 3 = $147,663 and the total for item 4 = $56,400.

Once the indirect project costs and direct costs are subtotaled, the estimator adds in applicable sales and payroll taxes. This last number is not actually a tax (or much of it isn't) but includes everything included in fringe benefits (such as vacation and health) as well as social security and other taxes. Sometimes this figure is called the **labor burden**. The total payroll tax, expressed as a percentage, varies from company to company and location to location. In our example, the sales tax (on materials only) is 7.75 percent. The payroll tax (on labor only) is 36 percent.

After adding in the taxes, the estimator adds a percentage to cover business overhead. As we've learned, this number is also variable. In our example, we've added 5 percent ($82,630).

The final number added to the estimate is profit. The profit is the amount of money left over after all expenses have been paid. The contractor's profit is paid as a fixed dollar amount or a percentage of the construction cost. As noted earlier, in jobs with fixed price contracts, the profit is included in the bid estimate. In jobs with reimbursable contracts, such as a cost plus contract, the profit is added to the overhead and is called the **fee**.

The amount of profit (or fee) the contractor can charge depends on many factors, including the amount of risk the contractor feels the project carries (higher risk jobs should have higher profit) and the volume of work the contractor does. Contractors who do high volumes of work can have a smaller profit per job. The competitiveness of the current construction environment can affect the profit a contractor can charge and still get the job. Profits are typically lower when jobs are scarce and there is a lot of competition than they are when there is less competition.

There is no clear answer to what the profit should be; it can range from zero percent when a contractor hasn't enough work and wants to keep crews busy, up to whatever the market will bear. Typically, the larger a job is the lower the profit percentage. Conversely, small jobs often carry a higher profit relative to the overall cost of the job. In our example, we use 3.5 percent ($60,733).

With all the figures totaled, the estimator now has a total project cost: $1,795,979. This is the number presented to the owner as the bid.

The contractor will make every effort to "bring the project in" on budget, in other words, to meet the estimated costs. A major role for the contractor is to manage the job to ensure that this occurs.

Chapter Vocabulary

Bid estimate (final, detailed, unit price estimate) – a cost estimate based on the most detailed design information developed by the contractor (or bidding contractors) after the design drawings and specifications are completed.

City location factor – used to adjust the national average costs of materials and installation shown in RSMeans cost data publications to those at specific locations.

Conceptual estimate – a cost estimate based on very little design information and using gross unit pricing to determine the project cost.

Detailed estimate (bid, final, or unit price estimate) – a cost estimate based on the most detailed design information developed by the contractor (or bidding contractors) after the design drawings and specifications are completed.

Detailed estimate (bid, final, or unit price estimate) – a cost estimate based on the most detailed design information developed by the contractor (or bidding contractors) after the design drawings and specifications are completed.

Estimate summary – a summation of final project costs prepared by a contractor prior to submitting a bid.

Final estimate (bid, detailed, or unit price estimate) – a cost estimate based on the most detailed design information developed by the contractor (or bidding contractors) after the design drawings and specifications are completed.

Labor burden – costs that are added to the direct wage of a worker, including fringe benefits (such as vacation and health) as well as social security and other taxes.

Preliminary estimate – a cost estimate developed after some design is known and decisions are still being made.

Rough-order-of-magnitude (ROM) estimate – a conceptual cost estimate that is completed early in the planning phase by the owner to determine if the project is affordable and to help define the scope of work.

Square foot estimate – an estimate that uses floor area to calculate costs after some design detail is available.

Unit price estimate (bid, final, or detailed estimate) – a cost estimate based on the most detailed design information developed by the contractor (or bidding contractors) after the design drawings and specifications are completed.

Test Yourself

1. What is the value to an owner of a rough estimate?
2. When are square foot estimates completed?
3. What is the most common source of published cost data?
4. What are the square foot costs for a 1,200-SF, two-story residential project with wood siding over wood frame? Refer to figure 11.1.
5. Why is a location factor used?
6. Refer to Figure 11.2: Is it more costly to build in Los Angeles or in Washington DC? What is the cost difference?
7. What are three types of estimating systems and write a sentence about each.
8. What sort of estimate is developed for a bid proposal?
9. The owner develops the bid estimate. True or false?
10. Refer to Figure 11.5: Which is the most expensive subcontract for this project? How much were the costs for the general contractor's crews for item 4?