

2013 Construction Costs

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Introduction

By completing the activities in this chapter, you will gain an understanding of the office activities involved in construction cost estimating. The following information is taken from the NCARB IDP Guidelines:

Construction Cost

Minimum Construction Cost Experience: 120 Hours

Definition: Involves estimating the probable construction cost of a project.

Tasks

At the completion of your internship, you should be able to:

- Perform value engineering of selected building elements
- Perform life cycle cost analysis of selected building elements

Knowledge Of/Skill In

- Alternative energy systems and technologies
- Building Information Modeling (BIM) technology
- Construction sequencing
- Cost estimating
- Critical thinking (e.g., analysis, synthesis, and evaluation of information)
- Hazardous materials mitigation
- Implications of design decisions (e.g., cost, engineering, schedule)
- Life cycle analysis
- Product evaluation, selection, and availability
- Value engineering

resources

Download the current Intern Development Program (IDP) guidelines at www.ncarb.org/Experience-Through-Internships.aspx.

The American Institute of Architects. Demkin, Joseph A., ed. *The Architect's Handbook of Professional Practice*. 14th ed. Hoboken: John Wiley & Sons, 2008.

- Chapter 13.5 - Construction Cost Management

The American Institute of Architects. Demkin, Joseph A., ed. *The Architect's Handbook of Professional Practice*. 13th ed. New York: John Wiley & Sons, 2001.

- Chapter 14.4 - Construction Cost Management

The American Institute of Architects, *The Architecture Student's Handbook of Professional Practice*. 14th ed. Hoboken: John Wiley & Sons, 2009.

- Chapter 9.4 - Construction Cost Management

Narrative

Managing building costs is a challenging task for the design team as well as for construction managers, contractors, and consultants. Owners demand that their design and construction teams respect the owner's financial and economic objectives and that they control costs during project delivery. This expectation is found in both the public and the private sectors in all client industries, locations, and financial situations.

Owners expect that a budget prepared early in a project will be accurate and that the project will be completed to the required scope, quality, and performance within that budget. Owners invariably place a high priority on cost issues, regardless of the quality or other attributes of the project. They may even judge success or failure exclusively in terms of cost.

During the past decade, professional organizations, educational institutions, government and private entities have supported the development of building cost analysis methodologies and provided seminars and other educational programs on this subject. The success of these efforts has varied, but one issue has become clear: Achieving high-quality design and implementing effective cost analysis and management are not contradictory objectives.

Nearly every decision an architect makes during design and construction affects project costs. Some decisions are straight forward because they affect building quality or performance. Others are more subtle, affecting ease of construction, complexity of building elements, or availability of materials. Some decisions can profoundly affect other disciplines, such as plenum depths that may confine mechanical/electrical services or a building module that influences a structural grid.

Why is it so difficult to control building costs? Quite simply, the design decision-making process is subject to constant upward pressure on scope, quality, and performance and, therefore, on cost. Unless decisions are managed and expectations kept in check, costs may rise beyond budget limits.

Building cost analysis encompasses economics, cost estimating, and cost management, discussed below under the following heads:

- Understanding building economics
- Identifying factors that influence building costs
- Using standard formats
- Applying cost-estimating methods
- Dealing with escalation and contingencies
- Understanding value analysis
- Understanding life-cycle costing

notes

Take brief notes while reading the narrative and list key resources you used to complete the activities. Note discussion outcomes from meetings with your supervisor, mentor, or consultants. When finalizing the activity documentation (PDF), include your notes and the Emerging Professional's Companion activity description.

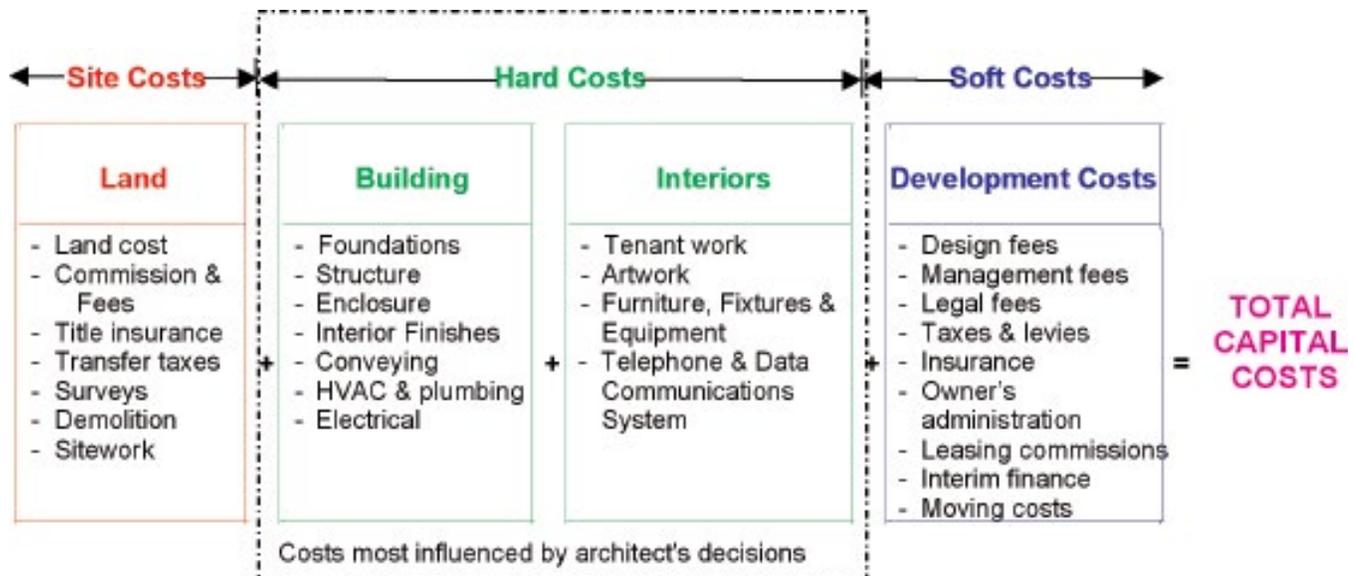
Construction Costs

Understanding Building Economics

What determines how much buildings cost? We all understand the cost of buying a suit, an automobile, or even a house. By experience, we develop a sense for what something should cost. However, unless we fabricate an item from its basic parts, we may not develop a sense of what makes it cost a specific amount. Construction projects are complicated entities. To be able to estimate and manage building cost, an architect must first understand what costs are involved.

Capital Cost Components

Capital costs are normally subdivided into three major categories—site costs, hard costs, and soft costs. The accompanying diagram summarizes each of these categories.



Site Costs

Site costs normally cover the owner's initial land acquisition and development costs for the project.

Soft Costs

Soft costs include a variety of costs incurred by the owner to move the project forward. Design fees, management fees, legal fees, taxes, insurance, owner's administration costs, and a variety of financing costs fall into this category. Moving costs and other tenant-related costs may be placed in the soft cost category.

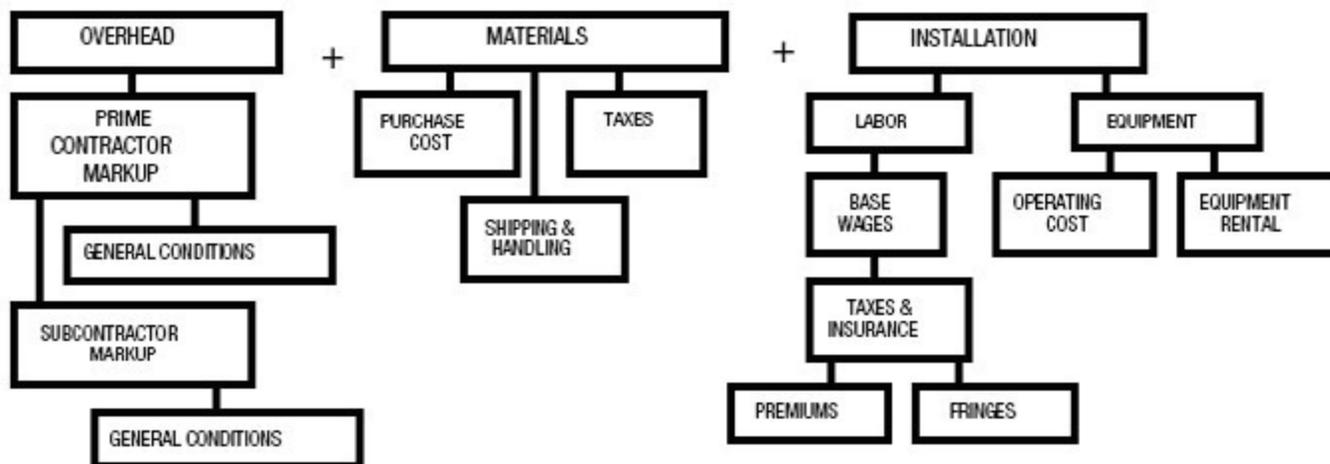
Hard Costs

Hard costs are those most directly affected by decisions of the architect. These include core and shell features, interior enclosures, basic building services, and fit-out costs for finishes and mechanical and electrical services. Major components of hard costs that are usually not incurred under the construction contract include furniture, fixtures, and equipment (FF&E) and specialized mechanical and electrical services. These costs are often incurred directly by the owner.

The breakdown of costs can vary widely according to building type. For instance, a standard office building is typically built for between \$80 per square foot and \$150 per square foot, depending on quality and performance requirements. A laboratory building, on the other hand, may cost from \$150 per square foot to more than \$400 per square foot, again depending on quality and performance requirements. The disparity between costs for these two building types is caused largely by laboratory mechanical costs, which alone can exceed \$150 per square foot, especially when extreme requirements of control, filtration, and cleanliness are required. To control mechanical costs when they are expected to represent 40 to 50 percent of overall project cost, more attention must be given to initial budgeting and ongoing cost management activities for mechanical elements.

Construction Costs

Construction costs are the portion of hard costs normally associated with the construction contract, including the cost of materials and the labor and equipment costs necessary to put those materials in place. Added to this are overhead costs, which include both job site management and the contractor's standard cost of doing business (office, staff, insurance, etc.).



Material Costs

Material costs cover purchase of materials, including local and regional taxes, and shipping and handling costs, which include transportation, warehousing, and in some cases security. In very remote areas or in overseas locations, shipping, handling and other overheads may exceed the cost of the material.

Installation Costs

Installation costs include the price of labor and equipment to put materials in place. Labor costs consists of base wages, taxes, insurance, and benefits, as well as premiums for overtime or for working in remote locations. Equipment costs include the direct cost of the equipment (whether it is a purchase amortization or a rental) and the cost of an equipment operator, which sometimes includes support staff.

Overhead costs associated with construction are usually referred to as general conditions. These costs include those for field supervisory staff, additional professional services staff, engineering consultants, as well as temporary facilities and utilities, small tools, and a variety of safety and security equipment. Also included in this category are bonds, permits, and insurance costs allocated to the project. Contractors and subcontractors also incur general conditions costs.

Additional overhead costs associated with the main office of each contractor include salaries of home office staff, certain insurance costs, various home office overhead costs (job procurement, marketing, advertising, etc.) and profit. Profit is a function of market and risk and may include a contingency for unknown or uncontrollable aspects of the work.

What makes construction costs vary?

The purchase price of building materials is directly affected by their availability and the demand for them in the marketplace. The timing of events on a project can significantly affect cost, especially if short lead times for products and materials challenge availability. Shipping and handling costs, particularly in remote areas, can be expensive. Procurement limitations such as the “Buy American Act” can substantially drive up cost by limiting competition. Sales taxes, import/export duties, and other special fees indirectly affect the cost of materials.

Installation costs are driven by geographic variations in labor costs and productivity. Certain trades, such as demolition, universally carry very high insurance premiums because of the risks associated with the work. The safety record of the contractor further affects insurance premiums. Conditions of the work, particularly for renovation projects, dramatically affect productivity because access, egress, laydown area, staging area, and general space available to conduct business may be restricted.

The nature of a project site, such as a remote location or site with poor access to utility services, also affects general conditions costs. Security for the construction site can be another cost factor. Owner requirements and limitations on site access may indirectly affect cost.

Other potential markups that contribute to a building's cost are a function of market competition and project risk. Risk or the perception of risk is always a significant factor. In times of high competition, allocations for overhead and profit tend to be reduced to increase a firm's competitive edge. When competition is poor, these costs tend to increase. Owner policies intended to reduce the owner's risk can also increase cost. For example, some owners believe that employing extremely onerous bonding and default requirements protect them, but they may be unaware of the cost of such measures.

Identifying Factors That Influence Building Cost

Building costs can only be controlled through effective control of the factors that influence them:

- Scope of work
- Geographic and site factors
- Programmatic factors
- Design factors
- Qualitative and performance factors
- Delivery process, legal, and administrative factors
- Market, competition, and economic influences
- Risk factors

Scope of Work

This is the most basic factor driving building cost. If the scope increases, costs will almost invariably increase accordingly, thus scope management is an important part of cost management. Under extreme circumstances, it may be necessary to program a facility over again rather than rely on the design process to correct a scope problem.

Geographic and Site Factors

Site location (e.g., urban vs. rural) affects labor rates, material costs, and a variety of other cost issues. Local climate has a major influence on selection of building materials and even on basic approaches to developing the building. The building site also determines access, egress, and utility provisions. In some instances, particularly large sites such as campuses and military bases, utility lines may need to be extended great distances to reach the building site, possibly resulting in costs that exceed those of the rest of the project.

resources

Dell'Isola, Michael D. *Architect's Essentials of Cost Management*. New York: John Wiley, 2002.

Factors Affecting the Cost of Building Elements

System/Element	Principal Variable	Secondary Variables
Foundations	Footprint area at grade	Soil conditions, site configuration, water table, seismic zone, weight supported, soil disposal, grade slab specs
Basement construction	Volume of basement	Soil conditions, soil disposal, water table and flow, depth of basement, type of soil retention, seismic zone
Superstructure	Area of supported floor & roof	Number of stories, floor-to-floor height, building configuration, loading, span and bay sizes, roof type and openings, seismic zone, M/E/P integration, type of cladding system
Exterior closure	Area of exterior closure	Area and type of fenestration and exterior doors, thermal and sound insulation requirements, seismic zone
Roofing	Area of roof	Roof configuration and type, number and types of openings, thermal and sound insulation requirements, extent of glazing
Interior construction	Gross floor area	Floor-to-ceiling heights, partition/wall density, flexibility required, extent of glazing and special features
Staircases	Number of flights	Floor-to-floor heights, fire regulations, staircase type
Interior finishes	Gross floor area	Floor-to-ceiling height, area of enclosed and finished spaces, type of ceiling, special finish requirements
Conveying	Number of stories	Capacity and speed required, type of drive system, number of stories, building occupancy
Plumbing	Density of fixtures	Building occupancy, story heights, roof area, building configuration, special system requirements
HVAC	Heating/cooling load	Building occupancy and orientation, building area and volume, building configuration, story heights, thermal insulation provided, heat loss and gain, local climate
Fire protection	Area protected	Number of stories and story height, fire and insurance regulations, internal configuration
Electrical	Connected load	Building area, number of stories, building occupancy, standby requirements, lighting levels, power supply and distribution system
Special construction	Building function	Special user requirements
General conditions	Value of construction	Time for construction, temporary utility availability, site access and storage, bonding and insurance requirements, interest rates, market conditions
Sitework	Developed area of site	Site configuration and levels, paved areas, special features, demolition required, soil disposal and compaction, soil conditions, exterior lighting and utilities, extent of landscaping

Site conditions include basic topography, which dictates the amount of earth that must be moved to allow for development and provision of utilities. Environmental factors can affect costs directly if they require a response and indirectly if their mitigation requires adjustment in the project schedule. For example, wetlands mitigation can have major impact on cost and on how much of the site is available for use. The presence of rock or other difficult soils also directly affect site development costs as well as eventual choices for building foundations.

Programmatic Factors

Typical cost drivers related to a building program include space efficiency, security requirements, circulation requirements, ADA requirements, blocking and stacking, adjacency requirements, and the functional mix of spaces.

By far the most significant of these factors is the mix of space types required in a building. For example, laboratory space may cost \$400 per square foot, while standard administrative or office space may cost \$100-150 per square foot. An exact 50-50 program mix in this example would yield a building cost of \$200-220 per square foot. If the same building comprised 70 percent laboratories and 30 percent office space, the building cost would exceed \$300 per square foot.

Space efficiency is also an important cost driver. Achieving the levels of space efficiency defined in the program can be a design challenge. To ensure these efficiencies are achieved, care must be taken to establish realistic targets based on experience in comparable buildings.

Design Factors

The building geometry and degree of articulation in the basic plan affect building cost. For example, from a cost perspective, a perfectly square footprint is the simplest to build and theoretically less expensive. Nonetheless, this geometry may be unacceptable and overly simplistic for most projects.

Plan geometry and exterior articulation are issues that require proper budgeting and oversight during the design process. Shadow lines, notches, and projections all may benefit the building form aesthetically, but their complexity represents additional costs for labor and possibly for materials. This relationship is especially true for buildings with high-quality envelope systems.

Building height and overall scale also influence building cost. For example, the cost of the structural system is likely to increase along with the building height.

Qualitative and Performance Factors

The owner's quality and performance requirements need to be carefully considered in both budgeting and cost management. Owners generally set requirements with a bottom threshold in anticipation that delivered quality will at least meet stated minimums. Designers will almost certainly meet these minimums and often exceed the minimum because of their desire to provide better quality and performance.

resources

Construction Specifications Institute. *The Project Resource Manual: The CSI Manual of Practice*. New York: McGraw-Hill, 2005.

Learn more about Construction Cost Estimating Best Practices via the Architect's Knowledge Resource (AKR): www.aia.org/aiaucmp/groups/ek_members/documents/pdf/aiap016637.pdf

Legal and Administrative Factors

The delivery method chosen by the owner can affect the cost of a project in many ways. Whether the delivery method is design-bid-build, design-build, construction management at risk, or a variety of other construction management approaches, the initial budgeting process and the cost management process should reflect the delivery method chosen and account for any premiums or discounts anticipated, especially as they relate to the schedule.

The timing of a construction contract award is an extremely important consideration. A construction contract can be awarded at almost any point in the procurement process. However, if the contract is negotiated and awarded before the documents are complete, the owner and contractor often agree on a guaranteed maximum price (GMP). A GMP usually includes allowance for work not defined, and the degree and nature of these allowances requires scrutiny on the part of the owner and the architect.

The owner's approach to cost management and cost management policies have a subtle but significant effect on the cost of a building. Brian Bowen, former president of Hanscomb Inc., observed, "Buildings cost what they're allowed to cost." If the owner's attitude toward cost management is lax, it is reasonable to assume costs will increase over time. Conversely, if the owner demonstrates concern for cost then cost tends to be contained over time.

Market and Economic Influences

Market and economic conditions may overwhelm other cost factors. Market conditions tend to follow the overall economy, and in turbulent economic times the market has been known to affect building costs by 10 to 20 percent or more. In times of recession or slow economy, prices tend to drop because demand is down. Conversely, in times of economic boom, prices tend to rise because demand is up.

Competition also affects prices. As the number of bidders increases, the price goes down; when the number of bidders is reduced, the price goes up. Market factors are volatile, and great care must be taken when projecting the effects of competition and inflation. The delivery method chosen may also affect competition, directly through the number of prime contractors who are bidding the project and indirectly through the number of subcontractors included in the bids of the primes.

Risk Factors

Projects with more risk are likely to cost more, thus formalized risk-estimating methods may be appropriate in certain circumstances. Preparation of a risk-based cost estimate places more attention on major cost components when risk is a significant issue and variances in these components can be consequential. In some circumstances, it may be appropriate to consider alternate design choices that may have the benefit of minimizing some aspect of risk on a project. For example, a facility could be relocated to a different area of the site to minimize the chance of disturbing contaminated soils, or materials could be selected that are known to be readily available rather than materials that are in short supply.

notes

Using Standard Formats

Use of a standard framework for classifying and managing information is essential for accurate building cost analysis. The most common framework in the construction industry today is the 16-division MasterFormat developed and managed by the Construction Specifications Institute (CSI). MasterFormat is extensively used throughout the industry as a format for project manuals, specifications, and other project data. Since the MasterFormat structure resembles the basic way projects are procured (subtrades and contract packages), it is often used as a framework for cost control, scheduling, and estimating.

UNIFORMAT is a classification system based on physical building elements, originally developed by the American Institute of Architects (AIA) and the U.S. General Services Administration (GSA) in the 1970s. The most recent version, UNIFORMAT II, refines certain aspects of the original system and has been designated ASTM Standard E1557-96. UNIFORMAT is best applied to conceptual and schematic estimating, while MasterFormat is more effectively used for detailed estimating and bidding. It is not difficult to cross reference the two systems.

Applying Cost-Estimating Methods

Any cost-estimating method used should be consistent with the level of information available and the time available to prepare the estimate. Cost estimating methods tend to fall into four major categories:

1. **Single-unit Rate Methods (SUR)**
2. **Parametric/Cost Modeling**
3. **System/Elemental Cost Analysis**
4. **Quantity Survey**

The figure on the opposite page shows when these estimating methods generally can be applied to overall delivery of a project.

Single-unit rate methods tend to be appropriate in the planning and programming phases of a project. Parametric and cost model estimates are generally used during schematic design and early design development. Systems and elemental estimates are best during design development and early construction documentation. Estimates based on a quantity survey can be used almost any time but are generally most appropriate when documents are reasonably detailed, such as during design development, construction documentation, and bidding and construction. At any time, these techniques may be used to cross-check overall costs.

1. Single-Unit Rate (SUR) Estimating Methods

Single-unit rate estimating methods are subdivided into four major categories:

- Accommodation method
- Cubic foot method
- Square foot method
- Functional area method

resources

For more discussion of using MasterFormat and UNIFORMAT as a structure for cost-estimating review topic 13.5 Construction Cost Management in *The Architect's Handbook of Professional Practice, 14th Edition*.

Pre-Design	Schematic	Design Development	Construction Documents	Bidding	Construction
SUR					
	Parametric/Cost Modeling				
		System/Element			
			Quantity Survey		

Accommodation Method

For this method, an estimate of overall construction cost is calculated using the cost of selected units of the facility as a baseline. For example, parking garages can be measured per parking stall. Apartment buildings might be measured on cost per apartment. Performing arts facilities and auditoriums can be measured on cost per seat. Hospitals may be measured on cost per bed. The accommodation method is often used to provide very preliminary estimates or to provide a quick check and assessment of a current project estimate.

Cubic Foot Method

This method of analysis is not generally used in the United States except for volume-dependent facilities such as warehouses. Although it can be effective, the cubic foot method tends to be awkward for use in most facility types. Nonetheless, certain European countries, especially Germany, routinely use cubic measures as a means of budgeting facilities.

Square Foot Method

This is the most commonly used initial budgeting mechanism in the United States. It can be effective, but care must be taken to ensure the programmatic basis of each is comparable when costs of different facilities are considered. In addition, the method of measuring must be consistent for project comparisons to be valid. A number of published sources provide square foot costs. A commonly referenced one is the R. S. Means Company's Building Construction Cost Data.

Functional Area Method

This approach to estimating is based on functional space types. A functional space type is defined as an area in a building that has a distinct functional purpose, for example, classrooms, a cafeteria, or a gymnasium in a school. The advantage of determining cost by functional area rather than pure square footage is that variations in space types and program can be considered in the basic estimate. Using the school example, classrooms might cost \$100 per square foot to build, while the gymnasium might cost \$200 per square foot. Overall proportions in a typical program of classrooms and gymnasium can be accommodated. The functional area method allows for sensitivity to program elements.

The functional area method can be applied in two ways, either by pure space type or by core and shell plus the functional space build-out. The first option assumes equal sharing of the core and shell costs among space types. The second derives the core and shell costs separately and then assesses the build out costs of each space type.

2. Parametric/Cost Modeling Method

These cost estimating methods use predetermined models based on statistical analyses used to predict facility costs. The process is most effective for repetitive facilities that have consistent programs, such as those with industrial applications. Statistics are gathered from in-place construction and can be used

to predict costs, especially for complicated systems that involve piping, manufacturing, and processing components. These approaches have less application in building construction.

Cost models can be prepared with computer models that project the form, shape, and composition of building types. In the last several years, computer based systems have been developed to help designers model form and shape and determine building size. These systems can also be used as a front-end device for cost modeling.

3. Systems/Elemental Cost Analysis

This approach to cost estimating provides a bridge between the conceptual estimating methods described above and estimates based on full, detailed quantity surveys, which are described below. The concept behind this approach is subdivision of a facility into its elemental components, generally using UNIFORMAT as a basis. The level of detail included is a function of the amount of design detail available when the cost estimate is prepared.

When very limited design information is available, a set of assumptions must be made from which to estimate costs. It is possible to base these estimates on historical information from similar facilities or historical information about building components and elements. At an early stage of design, before details have been defined, it may be desirable to develop what are generally referred to as “assemblies” — composite systems usually drawn from standard design details. These assemblies can be accurately priced and are especially useful for comparative purposes. Historical cost is an appropriate basis for estimates when facility types and programmatic components are similar. Adjustments to the historical cost information can be made if necessary.

Published sources of information can be used to prepare estimates and to cross-check estimates prepared using other methods. The R. S. Means Company produces a publication that contains cost models of various building types, including selections of walls, finishes, mechanical systems, etc.

A potentially more accurate estimate is one produced using an elemental format that represents specific conditions of the developing design. This approach requires a combination of pricing mechanisms, which could include historical costs, costs of systems and assemblies, and detail cost analysis for selected items.

4. Quantity Surveys

The quantity survey method of cost estimating is usually employed when detailed design information is available on the entire project or at least major components thereof. The actual pricing approach may include only total unit prices or labor, materials, and equipment. The level of detail in the estimate is intended to reflect individual units of work in the way it will be carried out.

resources

As you research and look for more information on topics presented in the *Emerging Professional's Companion*, remember that a quick internet search of keywords can be incredibly useful to completing your Activities.

Dealing With Escalation and Contingencies

Escalation and contingencies are cost factors that have not yet been identified when an estimate is prepared. All estimates, as estimates, potentially include escalation and contingency. These terms can be defined as follows:

Escalation is the inflationary cost growth anticipated between the time an estimate is prepared and the project bid is accepted. Pricing represents known costs at the time the estimate is prepared, and escalation is added to move the cost forward in time. This can be done in three ways:

1. Escalation that occurs during construction: For simplicity, 50 percent of the work is assumed to take place before the midpoint of construction and 50 percent after. Therefore, the cost estimate for construction is escalated to the midpoint to show what a potential bid might be. This is called a bid estimate.
2. Escalation that occurs from the time the estimate is calculated to a projected bid date: In order for an estimate to reflect a future bid date, the bid estimate would be escalated for the amount of time between the date of the bid estimate and the bid date.
3. Escalation calculated by the contractor and presented in a bid: Subcontractors preparing bids to submit to general contractors usually include escalation in their numbers and guarantee the numbers for a limited time. A contractor preparing a bid to present to the owner does the same.

Contingency is an allowance for work that is not completely defined when the construction estimate is made but is anticipated to be part of the project scope. Contingencies tend to be added as a single factor made up of several components:

- Design contingencies depend on the degree of completeness of the design when estimates are prepared and the degree of confidence the estimator has that the design will not change significantly.
- Estimating contingencies reflect the estimator's confidence in the estimate. They can depend on the extent of design development at the time the estimate is prepared, but other factors may also affect the estimate, such as availability of materials, issues of site access/egress, and conditions of the work. The design and estimating contingencies are usually included together and generally approach zero as the documents are completed.
- Construction contingencies are intended to reflect cost increases that will occur after the construction contract has been awarded. These contingencies are meant to cover unknown site conditions, weather, and uncontrollable delays, as well as change orders due to inconsistencies/incompleteness in the construction documents.
- Owner's contingencies are intended to cover the construction contingency but include an allowance for scope increases and owner-elected changes.

What are reasonable allowances for contingencies? There are no absolute standards, but experience teaches what figures are sensible. For example, a major architecture/engineering firm advocates using the following design/estimating contingencies:

- Program estimates: 10-15%
- Schematic cost estimates: 7.5-12.5%
- Design development estimates: 5-10%
- Construction documents estimates: 2-5%
- Pre-bid estimates: 0%

Understanding Value Analysis/Value Engineering

Value analysis (VA) is a cost optimization process that has been applied in numerous ways in the construction industry for more than 30 years, mostly under the term value engineering. The concept is also a problem-solving process, and when applied correctly to a problem can have excellent results. It is this aspect of the process that has led to use of the term value analysis rather than value engineering. Unfortunately, VA has often been employed instead as a last minute cost reduction process, resulting in significantly reduced value for the owner.

The application of VA is not difficult but does require patience, concentration, and a certain amount of discipline. For best results, all parties involved must agree on the objectives and be willing to work toward common goals. When properly used, VA can be a useful tool for general problem-solving, cost optimization, and value enhancement.

Understanding Life-Cycle Costing

Life-cycle costing (LCC) is an economic assessment expressed in terms of equivalent costs. It is used to evaluate the significant costs of ownership over the life of a product, assembly, system, or facility and to compare the costs of various options.

Life-Cycle Costing Principles

In LCC analyses, both present and future costs need to be taken into account and related to one another. Today's dollar is not equal to tomorrow's dollar. Money invested in any form earns, or has the capacity to earn, interest. For example, \$100 invested at 10 percent annual interest, compounded annually, will grow to \$673 in 20 years. In other words, it can be said that \$100 today is equivalent to \$673 in 20 years time, providing the money is invested at the rate of 10 percent per year

The terms "interest rate" and "discount rate" are generally used synonymously, and refer to the annual growth rate for the time value of money. The discount rate can be derived from the minimum acceptable rate of return for the client for investment purposes or from the current prime borrowing rate of interest.

Inflation also affects an economic analysis because its ability to reduce purchasing power over time must be factored in. This effect, more correctly termed "deflation," means that more currency in the future will be required to purchase the same goods. Some costs may exceed inflation. For example, energy costs have tended to increase at a rate 1-2 percent above inflation over the last 10 years. Thus, future energy costs need to be inflated differentially (above the general inflation rate) by 1-2 percent. This is referred to in life-cycle cost analyses as escalation.

Life-Cycle Cost Analysis Period

The period used in comparing design alternatives is an important consideration. Generally, 25 to 40 years is long enough to predict future costs for economic purposes and to capture most significant costs, since 90 percent of the total equivalent cost is consumed in the first 25 years

resources

More information about value analysis can be found in topic 12.11 Value Analysis in *The Architect's Handbook of Professional Practice, 14th Edition*.

Dell'Isola, Alphonse J., and Stephen J. Kirk. *Life Cycle Costing for Facilities: Economic Analysis for Owners and Professionals in Planning, Programming, and Real Estate Development : Designing, Specifying, and Construction, Maintenance, Operations, and Procurement*. Kingston, MA: Reed Construction Data, 2003.

(at a 10 percent discount rate). Consideration of periods longer than 40 years generally add no significant benefit to the analysis.

A time frame must also be assigned to each system under analysis. The useful life of each system, component, or item under study may be its physical, technological, or economic life. The useful life of any item depends on such things as the frequency with which it is used, its age when acquired, the policy for repairs and replacements, and the climate in which it is used. Component replacement may be scheduled several times in an overall facility cycle.

Categories of Cost

Typical facility costs for the owner over the life of a building can be subdivided as follows:

1. Initial costs
 - Construction
 - Fees
 - Other initial costs
2. Future facility one-time costs
 - Replacements
 - Alterations
 - Salvage
 - Other one-time costs
3. Future facility annual costs
 - Operations
 - Maintenance
 - Financing
 - Taxes
 - Insurance
 - Security
 - Other annual costs
4. Functional use costs
 - Staffing
 - Materials
 - Denial of use
 - Other functional use costs

Life-Cycle Costing Methods

Life-cycle costing requires adjustment of costs to a common point of time. Generally, one of two economic methods can be used. Costs may be converted into today's cost by the present worth method, or they may be converted to an annual series of payments by the annualized method. Either approach will allow accurate comparison of construction alternatives.

notes

Present Worth Method

The present worth method requires conversion of all present and future expenditures to a baseline of today's cost. Initial (present) costs are already expressed in present worth. Future costs are converted to present value by applying the factors presented previously.

Annualized Method

The annualized method converts initial, recurring, and nonrecurring costs to an annual series of payments and may be used to express all life-cycle costs as an annual expenditure. Home mortgage payments are an example of this procedure; that is, a buyer opts to purchase a home for \$1,050 a month (360 equal monthly payments at 10 percent yearly interest) rather than paying \$150,000 all at once.

Other Economic Analysis Methods

Other methods of economic analysis can be used in a life-cycle study, depending on the client's requirements and special needs. With additional rules and mechanics, it is possible to perform a sensitivity analysis, determine the payback period, establish a break-even point between alternatives, determine the rate of return and extra-investment and rate-of-return alternatives, perform a cash flow analysis, and review the benefits and costs of using different products, materials, and assemblies.

All life-cycle costing methods, correctly applied, will yield results pointing to the same conclusion— selection of the alternative with superior economic performance. Since the construction industry is capital cost intensive, however, the present worth method is recommended. In addition, this method tends to be easier to use and to produce easily understood results.

Integrating Building Cost Analysis Into The Design Process

Detailed cost estimating, value analysis, and life-cycle costing are all useful tools and are all services beyond the basic requirements specified in AIA Document B101™. Building cost analysis is the application of these tools within the overall design process. The objective of building cost analysis is to maintain balance and alignment between scope, user/owner expectations, and budget, both from the outset and over time in a way that makes clear the cost consequences of decisions.

The building cost analysis process has several key steps:

- 1. Prepare a realistic budget.** Prepare a budget that properly reflects scope and expectations. This is the first and perhaps most important step in the process. The budget can be prepared using an estimating technique appropriate to the information available but, at the least, it should have budgets for each discipline. In this way, the budget becomes a “cost model” for the facility. Adequate reserves for escalation, contingencies, and risk must also be included.
- 2. Subject decision-making to ongoing cost input.** Design decisions should be reviewed for cost implications as decisions are made. This requires provision of cost input on an ongoing basis.

resources

Fatzinger, James A. S. *Basic Estimating for Construction*. Upper Saddle River, NJ: Prentice Hall, 2004.

Civitello, Andrew M., William D. Locher, and Andrew M. Civitello. *Contractor's Guide to Change Orders: [how to Resolve Disputes and Get Paid]*. [Anaheim, Calif.]: BNI Pub., 2002.

3. **Prepare comprehensive milestone estimates.** Periodic cost estimates, at a minimum, should be prepared at the conclusion of each major phase of the project and reviewed by all disciplines to ensure completeness and proper consideration of competition and market costs. Historical cost analysis and benchmarking can provide an additional measure of justification for the estimates.
4. **Focus on cost drivers.** Details are important, but focus on the key cost drivers associated with each discipline. The effort involves a balancing process and the recognition that to achieve overall cost targets trade-offs and adjustments between disciplines will be necessary.
5. **Revise design/objectives as necessary to maintain budget.** If the estimate, as well as a reasoned analysis of it, indicates budget problems, it will be necessary to revise the design itself and possibly the design objectives to maintain the budget. After any necessary adjustments have been made, the “cost model” should be revised to reflect redistribution and reassessment of the budget assigned to each discipline along with revised contingencies. This process continues to the next milestone and becomes progressively more detailed in each phase of design.
6. **Use value analysis as a cost management tool.** VA can be used as an optimization tool and a means of balancing competing design issues without compromising critical aspects of the design. VA focus should narrow as the design develops, adjusting from conceptual issues to details, materials, and systems.
7. **Maintain sensitivity to life-cycle costs and sustainability.** Life-cycle costing is a recognized method for objectively comparing alternatives during design development and is an important component of ongoing cost advice. Issues of energy efficiency, sustainability, and reliability require an organized approach and a proper economics-based analysis tool that can inform project decision-making.
8. **Learn from the process.** Last but not least, learn from the process. Gather and maintain information from past projects to use as input for current projects, and learn from the experience of others.

Written by Michael D. Dell'Isola, PE, CVS, FRICS

Michael D. Dell'Isola is a senior vice president of the Orlando, Florida, office of Faithful+Gould. He has 30 years of experience in cost control, value engineering, technical facilitation and partnering, life-cycle costing, and project management.

notes

Reconciling Estimates

Supplemental Experience for eight (8) Core IDP Hours

In this scenario, the estimator consultant on your project, a 35,000 SF medical clinic has prepared an estimate at design development that indicates you are approximately 1 percent under budget. The client, a group of doctors, has indicated that their funding is finite and the project must remain within budget or it will not be financially viable. The doctors have also made it clear that several other projects will follow if this one is successful.

Activity - Core

As an added precaution your firm commissions an additional independent estimate by another firm. The second estimate comes in at 12 percent over budget (a difference of 13% between estimates). You review both estimates and note the following significant differences:

- The first estimator has a contingency of 5%, while the second estimate has a contingency of 10%.
- General contractor overhead and profit (OH&P) is 15% for the first estimator and 18% for the second
- Both estimators are using a projected bid date about one year from the estimate date and a construction time at 12 months. This means the mid-point of construction is 18 months out. However, the first estimator is adding 6% escalation and the second 8%.
- Mechanical/Electrical costs are about 15% higher in the second estimate (adding about 5% to the total cost)
- Other differences are not individually significant
- Both firms have excellent reputations.

Based on the estimates outlined above, prepare a client report advising that your initial estimate is reasonable, or suggesting adjustments to the project contingency, schedule or escalation.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Life-Cycle Costing for a Project

Supplemental Experience for eight (8) Core IDP Hours

With advice from your supervisor or mentor, find a project underway in your community for which you can access detailed project information. Choosing a project in your firm will be simpler, but if your firm has no ongoing local project you can use a project from another firm.

Begin by reviewing the information in the narrative on life-cycle costing. Meet with the client and building manager (if available) to determine their parameters for the economic success of the building.

Specifically, work with the client to understand and learn:

- Their initial cost budget
- Projected building life (25, 30 or 40 years)
- Their discount (interest) rate to establish a time value for money (at least 6% and as much as 15%)
- Expectations for energy performance
- Expectations for maintainability
- Expectations for system/component life
- Special feature of the building that contributes to the owner's product or service

Activity - Core

Select a building system and compare two construction alternatives for that system and project. Prepare a life cycle cost analysis using the present worth approach comparing the two alternatives.

Address the following life-cycle costing questions:

- Determine the useful life of the materials specified in each alternative. Consider factors such as the frequency with which the material is used, the climate, and maintenance requirements.
- Prepare a spreadsheet with each of the following categories of cost, filling in information as you find it in your research: Initial costs, Future facility one-time costs (replacement and alteration), Future facility annual costs (energy, maintenance, and other applicable costs), Functional use costs (if appropriate)
- Consider non-economic impacts of the two alternatives that could affect a final choice.

Prepare a client report, outlining your conclusions and explaining recommended alternatives. Review findings with your supervisor. If possible, share the report with the client. Catalog research of each material alternative in the report's appendix.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Conduct a Value Analysis Workshop

Supplemental Experience for eight (8) Core IDP Hours

In this activity, you will conduct a “mini” value analysis (VA) workshop on a project active in your office. The “mini” workshop will be a condensed form of a full VA workshop.

Activity - Core

Select an active project in your office or mentor’s office, preferably one recently completed schematic design or in early design development, with a cost estimate available. The objective is to assemble a team and conduct an independent VA workshop on the project to identify potential changes in the design that could improve value. Value can be improved by maintaining function and reducing cost or by spending more but with a proportionally larger improvement in function.

Preliminary efforts (two to three calendar days):

- Sit down with the current design team to review the program, design documents and cost estimate and discuss what they consider key objectives, issues and limitations.
- Select a multi-discipline team of your colleagues not associated with the design to be the peer review VA team. The team should be 3-5 people.
- Prepare a brief (one page or less) summary of the project and an agenda for the workshop, following the steps below.
- Distribute the agenda and report to your team. Make available a copy of the project documentation to your team to review ahead of time.

VA Workshop (1/2 Day):

- Schedule a meeting for your team to spend ½ day in the workshop. Secure a meeting space.
- Invite the project principal or manager provide a brief project overview (20 minutes) and, if possible, participate as an observer for the session.
- Conduct the workshop.
- Spend 30 minutes discussing the objectives of the workshop and identifying two or three key functional study areas. Because of the time limit, it is important to focus on a limited number of opportunities.
- Spend 45 minutes brainstorming changes to improve value through reduced cost or improved function. Record the ideas.
- After brainstorming, spend about 45 minutes evaluating ideas and consider the most promising for further review. Select 5-7 ideas and assign ideas to team members to complete an analysis.
- Spend the balance of the time developing the ideas assigned to each team member including advantages/disadvantages, a cost assessment and a recommended approach.
- Allow team members one or two days to complete their work and submit to team leader.

Prepare a report that summarizes the impacts, benefits and overall economic consequences of the ideas. Each idea developed should be captured as an exhibit. Review your recommendations with the design team and record their feedback.

Ask to observe upcoming project meetings. You can help by taking notes or the meeting minutes.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Gather Historical Project Costs

Supplemental Experience for eight (8) Elective IDP Hours

In this activity, you will gather and examine historical construction cost information on completed projects. To do this, request access to files and have conversations with the project's manager. If possible, talk with the cost consultant who prepared the estimate and the building contractor.

Activity - Elective

Review two completed projects to determine the history of cost estimates prepared during the project and the final actual bid/offer price for the project. Examine the accuracy and completeness of the estimates and develop a rationale for any significant difference from the bid/offer. Interview at least one project manager and one cost consultant.

- Locate project files and obtain copies (digital preferred) of estimates prepared at project milestones.
- Examine format, content and level of detail. Was the date of the estimate and the schedule for the project clearly stated? Were inflation/escalation, markups and overhead and profit assumptions documented? Document the history of the estimates. Did any changes to project scope or quality result?
- Examine bid/offer information. If not available, follow-up with the project manager, cost consultant and/or construction contractor may be necessary. Once obtained, compare the bid/offer with the final estimate. What was the general result?
- Obtain a Schedule of Values (SV) for the project. This may also require follow-up if not available in the files. Compare the SV with the bid/offer and the final estimate. Can you determine where in building components or trades variations occurred?
- Write a brief 2-3 page report documenting your observations and conclusions.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Assessing the Current Status of a Budget

Supplemental Experience for eight (8) Elective IDP Hours

In this activity, you will review a current project active in your office and review and assess its status.

Activity - Elective

In consultation with your IDP supervisor or mentor, select an active project in your office or a mentor's. Carry out the following steps:

1. Verify the budget for the project and assess its current status—within budget or over budget.
2. Gather information, if available, on a current cost estimate being prepared and review previous estimates prepared for the project. Review previous actions taken to keep the project in budget.
3. Whether the project is over or under budget, prepare a summary based on the following parameters:
 - Areas of the project that have exceeded, met, and come in under the client's budget
 - Decisions that added costs to the project and who made them
 - Other external factors that may be adding costs to the project
 - Steps that can bring the project back within budget

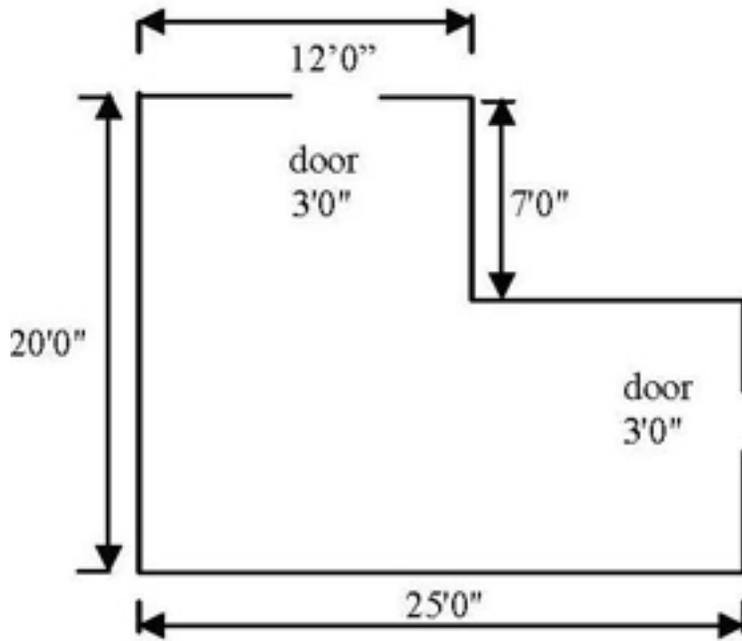
Present your findings to your supervisor/mentor and the project manager for this project. Discuss what lessons can be learned to ensure that the project remains within budget and future projects can stay within their budget.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Time and Materials Estimate

Supplemental Experience for eight (8) Elective IDP Hours

Prepare an estimate of the cost of laying 6" x 6" x 1/2" quarry tile flooring and a 6" covered base in the room illustrated below.



2C

Activity - Elective

Research the unit and labor costs listed in [Exhibit 2C-1](#) by consulting [RSMeans](#) or by calling a local supplier. Once all costs are known, prepare your cost estimate by using the accompanying form, [Exhibit 2C-2](#).

Find:

- Total cost
- Total cost per square foot (based on the tile area).
- Consider alternate tile sizes or types that come under total cost of the original.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Construction Costs

Working with a Schedule of Values

Supplemental Experience for eight (8) Elective IDP Hours

Exhibit 2C-3 is an excerpt of a Schedule of Values from a high school. The excerpt includes MasterFormat Divisions 3 - Concrete, 4 - Masonry and 7 - Thermal and Moisture Protection.

Activity - Elective

Your task is to extract the cost of those items associated with Exterior Closure. In the column provided in Exhibit 2C-3, indicate which items apply to Exterior Closure. If a partial amount is appropriate indicate why in the comments. Calculate a total cost for all three divisions.

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

2C

Storm Windows and LEED Points

Supplemental Experience for eight (8) Elective IDP Hours

In this scenario, your firm is designing a renovation to a historic building on a college campus nearby in Northern New York State. Part of the expectations for the project involves attaining a LEED Silver rating and doing so is proving difficult, especially in conjunction with maintaining the historic character of the building.

Your area of responsibility is the building's exterior closure including the original windows that have been deemed historic. Currently the building is extremely energy intensive due in part to extensive infiltration of outside air through the windows. The owner wants to retain the windows if possible and replacing the windows is prohibitively expensive. You propose adding exterior storm windows designed in such a way as to not obscure the historic windows. You are also applying for LEED points based on energy savings.

Your client favors the approach and wants to reduce the energy consumption in the building but is concerned about initial cost. He has asked you to help justify the added cost of the storm windows.

The following provides cost/economic information on the project:

- Added cost of Storm Windows \$227,000
- Mechanical Equipment Saved \$156,500
- Annual Energy Savings \$12,570
- Discount Rate = 8%
- Life Cycle = 30 Years
- Present value of annual cost factor = 15.631

Activity - Elective

Calculate the simple payback period for the added initial investment. Calculate the net present value of the savings in energy. Compare the savings to the added initial investment.

Are these results desirable to the owner and if so, how would you convince the owner to proceed with your recommended design? What would you present to a local Architecture Review Board or Historic District Review Board?

Share your work with your IDP supervisor or mentor and make suggested changes. Document the final version as a PDF.

Construction Costs

Exhibit 2C-1

Project Data:

6" x 6" x 1/2" quarry tile	\$ ____ per carton of 100
6" x 6" quarry tile base (straight).....	\$ ____ each
6" x 6" quarry tile base (angles/corners)	\$ ____ each
Cement setting mix (3 bags required per 100 SF).....	\$ ____ per bag
Tax on all materials	5%
Allow for waste on tile	5%
Allow for waste on base	2%
Tile setter (setting 120 SF or 100 linear ft. of base per 8-hr. day).....	\$ ____ per Hour
Helper (one for each setter).....	\$ ____ per hour
Burden/fringe benefits	35% on labor Cost
Job overhead	5% on labor and Materials
Head office overhead	2% on labor, materials, and job overhead
Profit.....	10% on labor, materials, and job overhead

[Back to "Time and Materials Estimate"](#)

2C

Estimate:

a) Materials:

6" x 6" x 1/2" quarry tile	no. at \$	\$	
6" x 6" base (straight)	no. at \$	\$	
6" x 6" base (angles/corners)	no. at \$	\$	
Cement setting mix	bags at \$	\$	

		\$	
Tax	%	\$ _____	\$

b) Labor:

Tile setter	hours at	\$	
Helper	hours at	\$	

		\$	
Burden	%	\$ _____	\$ _____

Labor and Materials: \$ _____

c) Job overhead: % _____ \$ _____
\$ _____

d) Head office overhead: % _____
Profit % _____
_____ % \$ _____

Total Estimated Cost: \$ _____

Area of Room _____ SF

Cost per SF \$ _____

Construction Costs

Exhibit 2C-3

3.01	Concrete Work		Exterior Closure	Comment
3.02	Reinforcing Steel	\$ 84,591		
3.03	Footing Excav. & Backfill	\$ 178,414		
3.04	Wall Footings	\$ 146,770		
3.05	Column Footings	\$ 44,647		
3.06	Column Plans	\$ 98,875		
3.07	Pour in Place Walls	\$ 417,964		
3.08	Slab on Grade	\$ 465,413		
3.09	Slab on Deck	\$ 111,179		
3.10	Structural Elevated Slabs	\$ 12,578		
3.11	Stair Plan Fill	\$ 4,576		
3.12	Stair Treads & Risers	\$ 28,982		
3.13	Locker Bases	\$ 13,812		
4.01	Masonry			
4.02	Ext CMU Area A	\$ 93,353		
4.03	Ext CMU Area B	\$ 76,538		
4.04	Ext CMU Area C	\$ 81,703		
4.05	Ext CMU Area D	\$ 37,275		
4.06	Ext CMU Area E	\$ 11,068		
4.07	Ext CMU Area F	\$ 82,208		
4.08	Ext CMU Area G	\$ 41,813		
4.09	Ext CMU Area H	\$ 32,959		
4.10	Ext CMU Canopy	\$ 16,952		
4.11	Ext CMU Outbuilding	\$ 44,305		
4.12	Int CMU Area A	\$ 218,719		
4.13	Int CMU Area B	\$ 249,480		
4.14	Int CMU Area C	\$ 221,656		
4.15	Int CMU Area D	\$ 101,193		
4.16	Int CMU Area E	\$ 384,400		
4.17	Int CMU Area F	\$ 307,097		
4.18	Int CMU Area G	\$ 205,612		
4.19	Int CMU Area H	\$ 149,914		
4.20	Int CMU Outbuilding	\$ 26,879		
4.22	Brick Area A	\$ 117,624		
4.23	Brick Area B	\$ 96,437		
4.24	Brick Area C	\$ 102,949		
4.25	Brick Area D	\$ 46,967		
4.26	Brick Area E	\$ 13,946		
4.27	Brick Area F	\$ 103,582		
4.28	Brick Area G	\$ 55,754		
4.29	Brick Area H	\$ 41,528		
4.30	Brick Canopy	\$ 21,360		
4.31	Brick Outbuilding	\$ 54,599		
7.01	Moisture Protection			
7.02	Dampproofing & Waterproofing	\$ 15,157		
7.03	Fireproofing	\$ 111,669		
7.04	Roofing	\$ 680,932		
7.05	Caulking	\$ 87,514		
7.06	Ext Insulation Finish System	\$ 52,406		

Total \$ 5,593,349

Back to "Working with a Schedule of Values"

notes

Take brief notes while reading the narrative and list key resources you used to complete the activities. Note discussion outcomes from meetings with your supervisor, mentor, or consultants. When finalizing the activity documentation (PDF), include your notes and the Emerging Professional's Companion activity description.

2C

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