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# Project Cost & Feasibility

# Project Cost & Feasibility

## Introduction

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

**Project Cost and Feasibility**
Minimum Project Cost and Feasibility Experience: 40 Hours
Definition: Analyze and/or establish project costs relative to project conditions and owner's budget.

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

- Perform or review a feasibility study to determine the cost and/or technical advisability of a proposed project
- Establish preliminary project scope, budget, and schedule

**Knowledge Of/Skill In**

- Project financing and funding
- Project delivery methods
- Construction sequencing
- Cost estimating
- Value engineering
- Life cycle analysis
- Project budget management
- Critical thinking (e.g., analysis, synthesis, and evaluation of information)

## 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



AIA NCARB

## 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
- Integrating building cost analysis into the design process

# 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.*

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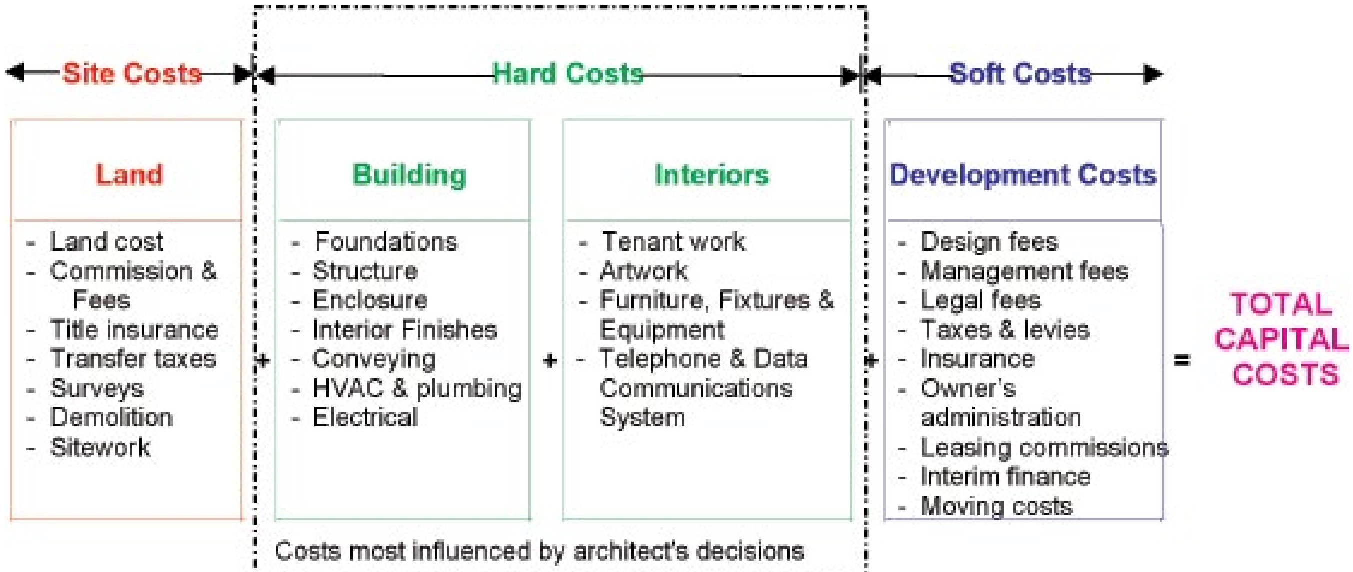
## Understanding Building Economics

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.

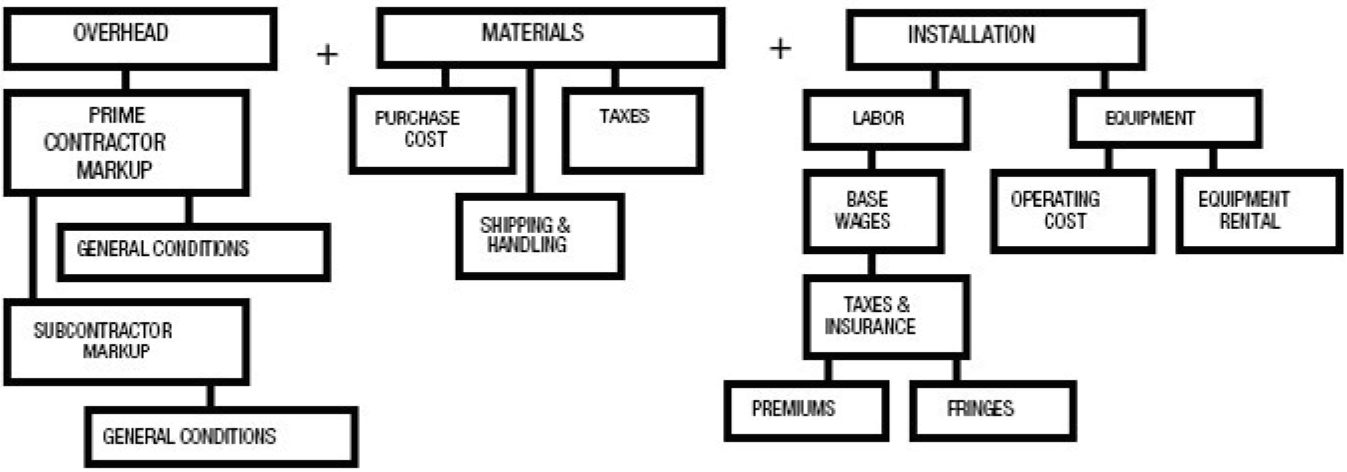
**Hard Costs**

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.

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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

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

**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.

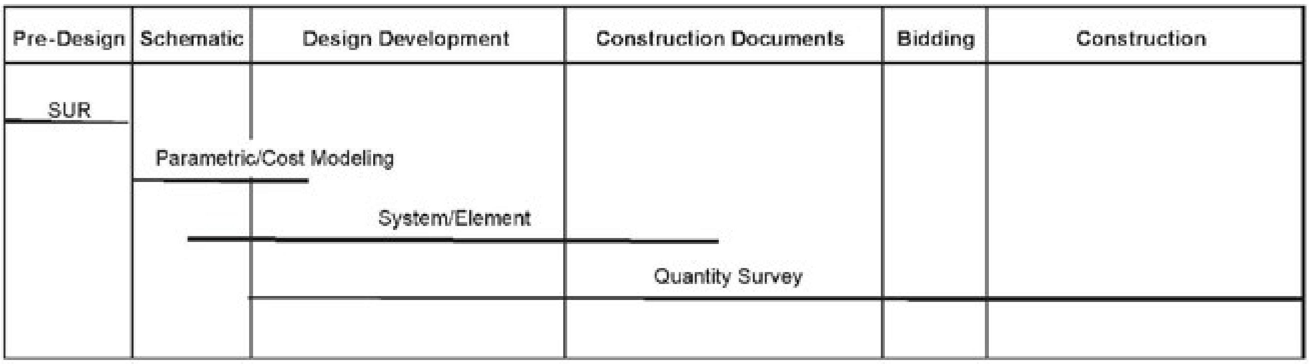
Single-unit rate methods tend to be appropriate in the planning and programming phases of a project. Parametric and cost model estimates are generally used during schematic design and early design development. Systems and elemental estimates are best during design development and early construction documentation. 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.*




**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 RSMeans, 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. RSMeans 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%

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## 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

## Differences in the Cost of One-Story Versus Two-Story Schools

***Supplemental Experience for eight (8) Core IDP Hours***

1C

In this scenario, your firm is experienced in designing elementary and middle schools. A key client from a local school system asks for help preparing for an upcoming school board meeting. There are several new elementary schools planned and their approach has always been based on a single story design. However, one of the school board members who is a developer of apartment buildings claims that two-story construction could save money. Your client asks you for assistance in clarifying the costs of one-story versus two-story construction for elementary schools.

# Activity - Core

Solicit assistance from mentors or those in your firm experienced with school construction. Review the potential differences between one-story and two-story construction for the following:

- Site and site work
- Foundation
- Structural
- Roof construction and roofing
- Circulation square footage
- Vertical transportation
- Plumbing piping
- Air distribution
- Emergency power/backup
- Building security
- Building operations
- Child safety

Prepare a brief report that addresses the issues and compares the relative cost of two-story and one-story construction.

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

## Preparing a Market Survey

***Supplemental Experience for eight (8) Elective IDP Hours***

For this activity, prepare a market survey of the local area.

A market survey explores the factors influencing construction costs in a location. Pertinent data can be gathered by interviewing local firms having knowledge of the construction activity in your area.

It will be necessary to contact firms/organizations in your area. Possible sources include: general and subcontractors, contractors and builders associations, local government officials, other architectural and engineering firms, builders' exchange and construction-reporting firms, and bankers and commercial mortgage firms. Talk with your IDP supervisor or mentor about contacts they can provide to you.

# Activity - Elective

Conduct a (partial) market survey. Select from the following list and address two or three categories:

- Availability of major materials to be in the project
- Capability of local fabricators, precast yards, concrete plants, etc.
- Availability of labor crafts necessary for the project
- Availability of special erection equipment
- Anticipated capacity of local contractors during bidding period
- Special conditions that might influence bidding
- Local escalation experience
- Site accessibility

Prepare a written report that includes:

- Who was contacted.
- Where they are located.
- When contact was made.
- Why they were contacted.
- What information was obtained.
- A summary assessment with specific recommendations.

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

## Corporate Headquarters Building Options

***Supplemental Experience for eight (8) Elective IDP Hours***

In this scenario, your firm is designing a headquarters for a company with 400 employees. The company's master plan called for two, two-story buildings: each 50,000 GSF at a construction cost of $12,500,000.

1C

## Activity - Elective

The owner's facility department is recommending the buildings be combined into one. Write a brief narrative answering the following questions:

- Will the single building be larger or smaller in total gross area?
- Will the single building be more or less costly?
- Are there other impacts on the building's function?

The owner's facility staff based their construction budget ($25,000,000 total) on expectations of a competitive market with 6-8 prime bidders and 3-4 subcontractors per trade. It is now apparent that the marketplace is much less competitive with 2-3 prime bidders and maybe, 1-2 subcontractors per trade. What is your suggestion for a revised construction budget considering this level of competition?

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

## Initial Budget for a High School

***Supplemental Experience for eight (8) Elective IDP Hours***

Your firm has been selected to design a new high school. The school system has not constructed a new high school in many years and has requested that you prepare a preliminary budget.

They provided following program:

| Program | |
|---|---|
| Classrooms | 50,000 SF |
| Laboratories | 8,000 SF |
| Gymnasium | 12,000 SF |
| Auditorium | 11,000 SF |

The following provides a basis of budgeting (benchmark current year) using program spaces and overall building core and shell.

| Space Type | | | | Unit Cost |
|---|---|---|---|---|
| SF | of | Core & Shell | x | $ |
| SF | of | Classrooms | x | $ |
| SF | of | Laboratories | x | $ |
| SF | of | Gymnasium | x | $ |
| SF | of | Auditorium | x | $ |

# Activity - Elective

Please reference the following source:

- RSMeans, Reed Construciton Data, Inc.

Research the cost per square foot listed above by consulting RSMeans. Once all costs are known, prepare a draft budget using the revised unit costs.

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

1C

## The Price of Sustainable Design

***Supplemental Experience for eight (8) Elective IDP Hours***

In this activity, you will assess the cost associated with sustainable initiatives, examine the benefits and seek to justify the expenditure.

In this scenario, Mr. Smith, the owner of a small retail store, has approached you to design a new location for his growing enterprise. The client does not have a large budget, and doubling his inventory and sales space to two locations is a risky venture for his small business. Your firm has a reputation in the local community for sustainable design. This client is not familiar with the LEED rating system but is receptive to improving sustainability and heard about your work when you won an AIA green design award last year. You believe that seeking a LEED rating for the project is a good idea and will benefit the owner. Achieving this rating may increase the cost of the project by approximately 3-5 percent.

## Activity - Elective

Consider how to justify this additional expenditure to your client:

- Outline four sustainability changes to include in the project that would have modest cost but significant impact.
- Estimate the initial cost premiums associated the changes.
- Use life-cycle costing and value analysis to determine whether the higher LEED rating is actually cost-effective in the long run.
- Estimate the benefits of the sustainability changes to the design in both economic and non-economic terms.

With the data you find, write a brief memo to the client justifying this additional expenditure.

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

## Initial Budget Overrun

***Supplemental Experience for eight (8) Elective IDP Hours***

In this scenario, your practice is invited in January to submit to a commercial client an expression of interest to build a 275,000 GSF distribution facility. The owner has stated that the approximate budget for construction is $10M. You respond and are short-listed. You are invited to an interview at which you submit a fee proposal based on a general description of the facility and its scope provided by the owner.

To prepare your submittal and calculate your fees, you estimate that the construction and site work will cost approximately $9.7 million, which correlates well to the owner's budget. A week after the interviews, you receive the good news that you have been selected to design the project (see Exhibit 1C-1).

You complete an intensive two-week evaluation of the client's program and requirements, as requested by the client, and submit a pre-contract evaluation report. Working closely with a professional cost consultant, you conclude that the scope, performance, and quality requirements reflected in the program you developed will require a budget of $13.5 million. This includes the fact that your analysis indicates the facility will exceed 300,000 GSF. You are scheduled to meet with the client to discuss and defend your report and recommend actions.

# Activity - Elective

Prepare an outline agenda for the meeting. Consider the following questions:

- The client said a budget of $10 million was based on a previous project constructed about five years ago that the owner claims was similar to the current project.
- How will you defend projection of scope, quality and resulting estimate, while convincing the client your work is accurate?
- How do you explain it may not be affordable?
- The owner has expressed concern over the schedule. If the design phase takes longer than the client expected, how will you respond?
- What are the next steps you will recommend to the client?

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

1C

## Office Building Costs

***Supplemental Experience for eight (8) Elective IDP Hours***

In this scenario, your architectural practice has been retained to prepare the design for a headquarters building of a small regional textile company, which has outgrown its administrative space that is currently attached to one of the company's plants. The gross floor area is 50,000 SF, on a single floor.

No budget has been set for the project. You proceed to develop a two-story conceptual design and prepare a cost estimate that predicts a construction cost of $8,000,000.

You meet with the company president and the reaction to your cost estimate is immediate and it is clear their company expected to spend less. The president focuses on the cost per square foot ($160.00). A board member contends that their company has just built an office building and it only cost $120.00 per square foot.

The president knows very little about design and construction. Decide how to explain why office buildings can vary a great deal in cost.

# Activity - Elective

Talk with colleagues experienced in office building design. Develop an outline presentation to the owner including:

- What are the major variables that affect the cost of office buildings?
- What are the assumptions on design approach, quality and other features that would be consistent with a $160/SF office facility? With a $120/SF office facility?
- Compare and contrast the above cost per square foot.
- How would you convince the owner to spend more money?
- If the owner remained fixed on $120/SF for the building, how would you proceed?

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

## Exhibit 1C-1



ACME MANUFACTURING COMPANY

21 January 2008

Jones & Jones Architects
1021 Z Street
Washington, DC 20020

East Coast Distribution Facility, Baltimore, MD

Dear Sirs:

I am pleased to inform you that our Evaluation Committee has selected your firm as architect/engineers for this facility.

Prior to us entering into a contract for complete design and supervision, you are authorized to proceed with a pre-contract evaluation report of our proposed building program and user requirements, with particular concentration on cost and schedule. You should note that the company has established a budget for construction of $10.0million (hard and soft costs) and wishes to put the facility into complete operation before the end of 2009.

My staff is available to assist you in providing any information required, and we will be pleased to receive your report on or before February 14, 2008.

You are authorized to proceed on a time and material basis not to exceed $20,000.00.

We look forward to a long and rewarding association with your company on this project.

Yours sincerely,

Ralph Smith
Director of Facilities

Back to "Initial Budget Overrun"

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