Cost Estimating Simplified

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1. COST ESTIMATING

Cost estimating is a well-formulated prediction of the probable construction cost of a specific building project. A cost estimate can be an important management tool to library planners during the design phases of a project providing information about the facility and the project budget.

All projects begin with an idea and end by filling a need. Most projects at conceptual design require changes to present an acceptable workable solution. The conceptual cost estimate is becoming more important to owners, architects, and builders. It is a tool for determining required funding and to gauge the needs of a project. This tool continues to be refined during the design stages of the project.

The cost estimate accounts for all items that will generally be included in the general contractor's bid. The cost estimate is prepared by breaking down the items of work using a standard format and determining the cost of each item from experience and a database of current construction cost information.

A cost estimate should not be confused with a project budget. A project budget will include the total of the cost estimate, and will also include what are known as "soft costs". These soft costs will specifically be excluded from the cost estimate and will typically include land acquisition, architectural and design fees, movable furniture and equipment, building permits and fees, fire and all risk insurance. The project budget will also include non-construction related costs such as fundraising and moving costs.

1.1 The Professionals

Licensed professionals known as cost estimators prepare cost estimates. An estimator cannot be trained entirely in a classroom. The theory and science of estimating is important, but it takes experience with construction, as well as experience actually quantifying and costing work, to complete the training of an estimator. A person possessing the "art of estimating" has a good feel for the effort required to produce work, good construction experience, and knowledge of the theory and science of estimating. The less information available about a project, the more experience is required to do a cost estimate.

An estimator would typically have an engineering or architectural background and be qualified by experience. A knowledge of building technology is essential to be able to break down a building into components in a structured way and then price the different components with applicable unit rates to derive the total cost.

For state or public funded projects (e.g., public libraries) there will most likely be owner-mandated limits placed on the A/E firm to design within a set budget. A professional construction cost planning and management firm will generally contract to perform a cost estimating function as a consultant throughout the various pre-design and design phases of the project. Frequently, larger architectural and engineering firms will have in-house cost estimating departments. Large construction firms may also have in-house cost estimators. Many planners chose to have two cost estimates as a check against each other, but if a single cost estimate is to be utilized, then the use of an independent cost estimator is highly recommended.

1.2 Types of Cost Estimate

Cost estimates fall into two groups: conceptual estimates and detailed estimates. Each can be broadly defined as follows:

1.2.1 Conceptual Estimate

Conceptual estimating or parametric estimating is the process of establishing a project's cost, often before any graphical representation of a facility has been developed.

1.2.2 Detailed Estimate

The detailed construction estimate is the product of a process whereby the cost of a proposed construction project is predicted. The estimate is prepared by breaking down the items of work in an orderly and logical basis, determining the cost of each item from experience, and summarizing the total.

1.3 Number and Timing

The number of cost estimates required will be project/owner specific, and will generally be linked to the various design phases of the project. A cost estimating approach to a typical project, which dictates the number and timing of cost estimates, can be summarized as follows:

1.3.1 Pre-Design Phase

Prior to the commencement of programming and/or design, the cost estimator prepares a cost model and budget cost plan for the project. The cost model establishes a construction budget and defines how the project budget is to be allocated among various building systems. The cost model also confirms the project scope and identifies any costs or work to be funded separately.

1.3.2 Schematic/Design Development Phase

The cost estimator works as an integral member of the design team to evaluate design decisions made throughout the design phases against the pre-established cost model. This approach allows the cost management team to provide an integrated value engineering process throughout the design phase.

At the end of the schematic design and design development stages, the cost estimator produces a comprehensive cost estimate. The estimate is compared against the cost model developed during the pre-design phase of the project.

1.3.3 Contract Document Phase

Further cost estimates are prepared upon completion of the 50% and 100% construction document stages.

1.4 Accuracy

The cost estimate is based on the measurement and pricing of quantities wherever information is provided and/or reasonable assumptions for other work not specifically covered in the drawings or specifications. Unit rates are based on historical data and discussions with contractors and sub-contractors. The unit rates reflect current bid costs in the area. All unit rates relevant to subcontractor work include the subcontractors' overhead and profit unless otherwise stated. The

mark-ups cover the costs of field overhead, home office overhead, and profit and range from 15% to 25% of the cost for a particular item of work.

Pricing reflects probable construction costs obtainable in the project locality on the date of cost estimate of probable costs. This estimate is a determination of fair market value for the construction of the project. It is not a prediction of low bid. Pricing assumes competitive bidding for every portion of the construction work for all subcontractors and general contractors, with a minimum of four bids for all items of subcontracted work and six to seven general contractor bids. Experience indicates that a fewer number of bidders may result in higher bids, conversely an increased number of bidders may result in more competitive bids.

Since the cost estimator has no control over the cost of labor, material, equipment, the contractor's method of determining prices, or the competitive bidding or market conditions at the time of bid, the cost estimate of probable construction cost is based on industry practice and the estimator's professional experience in the construction industry, and represents the professional cost estimator's best judgment. The accuracy clearly is dependent on various external factors, but it is typically expected to be within 5% of the average bid.

2. COST ESTIMATE DETAILS

2.1 Inclusions and Exclusions

A cost estimate includes all items that will typically be in the general contractor's bid. A list of exclusions might include:

- Professional design, testing, inspection and management fees
- Assessments, taxes, finance, legal or development fees
- Building permits and fees
- Fire and all risk insurance
- Scope changes and post contract contingencies for change orders and/or claims
- Land and easement acquisition
- Owner supplied and installed furniture, fixtures and equipment
- Movable furniture and equipment

Since the exclusions to a cost estimate are project specific, it is very important that all parties involved make a point of studying the list of exclusions to ensure that they have a clear understanding of the scope of work accounted for in the cost estimate.

2.2 Units of Measurement for Pricing

The unit of measurement is dictated by the specific item and also by the level of estimating detail. For example: a reinforced suspended concrete slab can be priced per square foot with a composite rate for all the components that makes up the slab. Alternatively each item that makes up the slab can be quantified separately in the unit of measurement that is applicable. A reinforced suspended concrete slab can typically also be priced in the following level of detail:

- Concrete — Cubic Yard
- Reinforcing steel — Pounds
- Formwork to soffit of slab — Square Foot
- Curing top of concrete — Square Foot

The key factor dictating the unit of an item is that it can be quantified and priced in that specific unit. Pricing units include Linear Feet (LF), Each (EA), Square Feet (SF), Cubic Yard (CY), and Allowance or Lot (LS).

- Display case, wall mounted EA
- Book return chute and cart, interior EA
- Wood or metal shelving LF
- Bench at reading area LF
- Base cabinet and countertop LF
- Projection screen EA
- Lockers EA
- Wall safe EA
- Book detection system at main entry EA
- Clocks EA
- Signage LS

2.3 Components

Cost estimates are broken down into different sections, which can be referred to as components, elements or divisions. Cost estimators will generally use a component format for their cost estimates. Components are basic parts of construction or groups of building systems performing a specific function or functions. Construction costs are segregated by component for comparison and analysis. Following is a brief description of each component in a typical component format estimate that represents a good checklist to ensure that all relevant items have been included in the cost estimate.

(1) Foundations

- Basement excavation, from general site subgrade to subgrade for lowest floor, and disposal of excavated material or backfill.
- All necessary means of temporarily supporting sides of excavation and removal of ground water including permanent drain fields.
- All supporting members driven into or resting on ground including any necessary excavation, backfill, removal of surplus, temporary supports and reinforcing.
- Pile caps and tie beams, which are not part of a floor system.

(2) Vertical Structure

- All columns, pilasters or hangers with the roughest finish acceptable as structurally sound.
- All load bearing retaining shear walls or bracing, rough structural finish only.
- Necessary fireproofing.

(3) Floor & Roof Structure

- Floor slabs on grade including supporting rock base, sand cushion and vapor barriers, but not waterproof membranes.
- All beams, girders, trusses, catenary supports, etc. supported by vertical structure.

- Structural framing joists, rafters, ledgers, blocking, etc., sheathing and decking of all supported floors and roofs, rough structural finish only.
- Necessary fireproofing.

The total cost of the complete structure, including all unfinished floor or roof decks, all necessary structural sheathing and all necessary fireproofing of structural members, is included in components 1, 2 and 3.

(4) Exterior Cladding

- Any non-structural skin, finish color or curtain wall added to the structure to enclose or finish the sides or soffits of the building.
- Any supported framing or connections required to reinforce or secure the cladding materials to the structure.
- Any insulation of the enclosing walls or soffits.
- Waterproofing or damp-proofing membrane or coating added to above grade enclosing walls or soffits.
- Any furring, finish surface and minimum decoration (paint) to interior face of enclosing structural walls.
- Non-structural balcony or parapet walls and railings including all finishes on both sides.
- Fascias, copings, bands, cornices, friezes, trim and exterior decoration of all sorts.
- Windows, doors and louvers in exterior walls including all glazing, screens, frames, hardware and finishes.
- Screens, shades or trellises applied to the exterior face of the building.

(5) Roofing & Waterproofing

- Waterproof membranes on floors or walls and skylighting, below grade or concrete admixtures and joint waterstops including sun slabs and protective coverings.
- Exterior or interior roofing insulation.
- Exterior applied membranes and surfacing on structural decks or roofs including paving.
- All flashings and exterior rainwater gutters and downspouts.
- Skylights and roof glazing.
- Roof hatches, scuttles and vents.
- All caulking and sealants.

The total cost of the completely weatherproofed, and externally decorated enclosed building shell, including minimum finish (paint) to the inside face of enclosing walls, is included in Components 1 through 5.

(6) Interior Partitions, Doors & Glazing

- Non load-bearing partitions including framing and minimum finish (paint) to both sides.
- Surface treatment including furring and minimum finish to both sides of interior structural walls.
- Sound insulation in partitions.
- Balustrades, rails, screens, etc. used to divide spaces, including all finishes; except prefabricated toilet or shower compartments.
- All interior doors and windows including frames, hardware and finish.

(7) Floor, Wall & Ceiling Finishes

- Floor covering of all types over structural decks including any necessary supports, underlayments or membranes.
- Bases or skirtings including finish.
- All special finishes, extra over the cost of paint, on walls and partitions, including rails and trim.
- Furring and finish to all structural columns.
- Finish to interior soffits of structure including suspension for ceilings and sound insulation above ceilings.
- Ceiling trim or decoration of any kind.
- Expansion joint covers.

(8) Function Equipment & Specialties

- Any built-in fixed shelving, cabinetry, appliances, accessories or equipment.
- Protective guards, barriers, bumpers, etc.
- Prefabricated compartments and accessories.
- Operable, sliding or folding room dividers or partitions.
- Shelving and casework.
- Cabinets and counter tops.
- Chalkboards, insignia and graphics.
- Light control.
- Horizontal conveying and powered mechanical equipment.
- Special use equipment of all types.
- Broadly anything not included in components 1 through 7 and 9 through 18.

(9) Stairs & Vertical Transportation

- Staircases and ramps complete including landings, finishes, balustrades and wall rails–enclosing walls are part of components 2, 4 or 6.
- Elevators and moving staircases or ramps.
- Dumbwaiters, book lifts and hoists rising from floor to floor.
- Trash and mail chutes.

The total building cost except for mechanical and electrical services is included in Components 1 through 9.

(10) Plumbing Systems

- All sanitary, service, laboratory and special institutional fixtures.
- Wastes, soil pipes and vents to connections immediately (within 5 feet) outside the building.
- Hot and cold water, gas, vacuum, special gases and fuel piping systems within the building.
- Water treatment, storage and circulation, including hot water generation, within the building.
- Roof and floor drains and piping.
- Subsurface drainage below the building and pumps for water or sewage ejection.
- Wet and dry fire stand pipes.

(11) Heating, Ventilation & Air Conditioning

- Heating, cooling and air cleaning equipment and controls located within the building.
- Thermal storage and circulation pumps.

- All piping and ductwork to distribute and retrieve steam, hot and cold water, condensation and treated air.
- Grills, louvers, dampers, supply and exhaust fans, etc.
- Unit heater, gas or electric, and ventilators.
- Surface heating systems.

(12) Electric Lighting, Power & Communication

- Main service from main disconnect breaker or switch, and all switchgear, panels and transformers within the building.
- All lighting fixtures, conduit wiring and power circuits.
- Sound, communication and signal systems.
- Emergency power generation and uninterrupted power systems.
- Building and energy management control systems.

(13) Fire Protection Systems

- Automatic fire protection sprinkler or halon® systems.

The total cost of a complete building excluding its connection to site utilities is included in components 1 through 13.

(14) Site Preparation & Demolition

- Demolition, shoring of existing structures and site clearing.
- Grading to ground level floor subgrade including any necessary fill to construct a building pad.
- General site grading to required subgrades.
- Removal or relocation of existing utilities or drains.
- Retaining walls necessary to protect adjoining property or to maintain existing grades.

(15) Site Paving, Structures & Landscaping

- Retaining walls to support site terraces or landscaping.
- Paving and curbs.
- Landscaping and irrigation.
- Site furniture, pools, sculpture, equipment, etc.
- Covered walks, trellises, pergolas and small ancillary structures.
- Fencing and rails.
- Drainage (not main storm sewers).
- Lighting.

(16) Utilities on Site

- Connection of mains in the immediate vicinity of the property line to all service lines in the building or on site.
- Sanitary and storm sewers.
- Domestic and fire water mains and hydrants.
- Gas, electric and fuel oil services.
- Telephone or communications systems conduit and pull boxes.
- Heating and cooling lines and enclosing structures.
- On site septic tanks and leaching fields, wells, fuel oil storage, electric substations, etc.

(17) Off Site Development

- All improvements to the site outside the designated project property line.

(18) Off Site Utilities

- Any required extension of services from existing distribution points to immediate vicinity of designated project property line.

The cost and unit cost of building components 1 through 13 and site components 14 through 18 may be expressed net (direct cost) or each including a proportion of the following additional costs.

(19) General Conditions

- All costs of administering and performing a construction job which cannot be assigned to any component: Site establishment and storage facilities, supervision, temporary service, security, insurance, weather problems, general equipment, permits and bond, etc.

(20) Contractor's Overhead & Profit or Fee

- General management and overhead, return on fee or contractor's capital investment and profit.

2.3.1 Contingency and Escalation

The above components will include the total project cost at the time of the cost estimate. To arrive at the total recommended budget, additional line items will be included in the component summary for:

- Contingency for design development.
- Allowance for rising costs to the mid-point of construction.

The contingency for design development is determined by consultation with the owner and typically can range from 5% up to 15% of the total construction cost. Frequently, the contingency is decreased during the design process as the likelihood of changes to the plans decreases.

Allowance for rising costs, or escalation, is determined by national or regional conditions. A predetermined monthly percentage is used to increase the construction cost from the date of the cost estimate by the number of months to start plus one-half of the number of months of construction. For example, if it is June 2002 and construction is anticipated to begin in December 2002 and last for a period of 12 months, the construction cost will be increased or escalated by the percentage utilized times 6 (June 2002 to December 2002) plus 6 (January 2003 to June 2003), or times 12. At an annual inflation rate of 3%, or a monthly rate of .25%, the escalation would be .25% x 12 months, or a total of 3% of the total construction cost.

2.4 Summary Page

The summary page provides a one-page overview of the total cost summary with a single line item and cost per square foot for each building component. Table 1 below illustrates the Components Summary for an 87,500 square foot facility with a cost estimate of $18,909,000.

Table 1: Budget Component Summary

Budget Cost Plan
COMPONENT SUMMARY

		Area: 87,500 SF	
		$/SF	**$ x 1000**
1. Basement Excavation and Foundations		7.69	673
2. Vertical Structure		10.95	958
3. Floor and Roof Structures		18.89	1,653
4. Exterior Cladding		26.30	2,301
5. Roofing and Waterproofing		12.00	452
Shell (1 - 5)		68.99	6,037
6. Interior Partitions		7.30	639
7. Interior Finishes: Floors, Walls, Ceilings		11.46	1,003
Interiors (6 - 7)		18.77	1,642
8. Function Equipment and Specialties		6.93	606
9. Vertical Transportation		5.28	462
Equipment and Vertical Transportation (8 - 9)		12.21	1,068
10. Plumbing		4.53	396
11. Heating, Ventilation and Air Conditioning		26.75	2,341
12. Electrical and Communications		26.50	2,105
13. Fire Protection		2.80	245
Mechanical and Electrical (10 - 13)		58.14	5,087
Total Building Construction (1 - 13)		**158.10**	**13,834**
14. Site Preparation and Demolition		1.11	97
15. Site Development		7.81	683
16. Site Utilities		2.75	241
Total Site Construction (14 - 16)		11.67	1,021
TOTAL BUILDING AND SITE (1 - 16)		**169.77**	**14,855**
General Conditions	7.0%	11.88	1,040
Overhead and Profit	5.0%	9.08	795
PLANNED CONSTRUCTION COST		**190.74**	**16,690**
Design Contingency	10.0%	19.07	1,669
Allowance for Rising Costs	3.0%	6.29	551
BUDGET FOR CONSTRUCTION		**216.11**	**18,909**

2.5 Component Detail

The component detail sheets provide a more detailed overview of the contents of each line item. In the illustration below for the component, Function Equipment & Specialties, library shelving is included in the cost estimate with the specific quantities and cost per unit shown. End panels are included as an additional cost. The reference desk is estimated at $500 per linear foot (LF) for a total cost of $12,500.

The general contract supplied marker boards are estimated at $15 per square foot (SF). Audiovisual equipment for the bibliographic instruction classroom is included as an allowance (LS) at $50,000. Signage is included as an allowance (LS) at $35,000. Window shades are calculated by the square foot (SF) at $15.00 per square foot for electronically operated window shades. The total of the component detail for these items appears on line 8 of the Component Summary (See above.)

Table 2: Component Budget (Component 8:Function & Equipment Specialties)

COMPONENT BUDGET

Function & Eqpt. Specialties	*Quantity*	*Unit*	*Rate*	*Total*
Shelving and millwork				
Library book stacks, 3' wide	425	EA	325.00	138,125
Wood end panels	120	EA	125.00	15,000
Shelf in B.I. Support room	5	LF	20.00	100
Cabinets and countertops				
Vanity countertops	68	LF	150.00	10,200
Knee space and countertop, plastic laminate finish	70	LF	125.00	8,750
Index counter with countertop	58	LF	350.00	20,300
Base cabinet and countertop	25	LF	300.00	7,500
Upper cabinets				
4-tier, open	22	LF	125.00	2,750
With door	20	LF	175.00	3,500
High cabinets				
6-tier, open	20	LF	300.00	6,000
With door	8	LF	375.00	3,000
Information Desk	20	LF	500.00	10,000
Circulation Desk	48	LF	500.00	24,000
Reference desk	25	LF	500.00	12,500

Function & Eqpt. Specialties	*Quantity*	*Unit*	*Rate*	*Total*
Chalkboards, insignia and graphics				
Marker board	400	SF	15.00	6,000
Sliding marker board	85	SF	20.00	1,700
Light and vision control				
Vertical louver blinds	225	SF	10.00	2,250
Electronically operated shades, 30% filter fabric at curtain wall	6,475	SF	15.00	97,125
Black out shades	275	SF	10.00	2,750
Amenities and convenience items				
Signage	1	LS	35,000.00	35,000
Fire extinguisher - allowance	10	EA	250.00	2,500
Special use equipment of all types				
Bibliographic instruction room audiovisual system	1	LS	50,000.00	50,000
Heavy duty concrete filled access flooring including diffusers	11,150	SF	12.00	133,800
Cable floor to B.I. Classroom	1,625	SF	8.00	13,000
				$605,850

3. MANAGING THE BUDGET

3.1 Dealing with Bad News

If a cost estimate is too high based on the available project budget, the actions to be taken depend on the magnitude of the cost overrun. If the overrun is no more than 5%, meetings can be conducted for each building system or site element to determine the cost of any variances and to brainstorm opportunities for budget adherence and/or further economies. Normally minor changes in specifications could resolve the problem.

If the magnitude of the problem is substantial, however, a formal *value engineering workshop* may be required to address the problem. The cost estimator will take the lead by involving all parties associated with the project to look at more economical alternatives to the design. The result is an expedited project schedule, less redesign and budget savings.

3.1.1 Alternates

In many cases when the cost estimate indicates that the project costs will exceed the available funds, the owner and architect will identify a list of alternates which are items that are to be either added back into the project if the bids are lower than anticipated, or deducts which are then deleted from the project if the bids run too high. Alternates which are identified for deletion are items which usually do not affect the functionality or the basic program for the facility, but require qualitative changes to the materials or design.

Alternates might involve, for example, a change in the type of roofing material, elimination of a skylight, use of less expensive carpet or wall treatment, a different ceiling system, upgraded or downgraded lighting fixtures. In extreme cases, functional issues may be impacted such as the elimination of a second elevator or reduction in the power or data distribution. The librarian must be invited to participate in these meetings.

In the cost estimate represented by the component detail in Section 2.5 above, the owner might remove the end panels from the general contract and substitute metal end panels for the solid core wood panels included. The marker boards may be excluded and added by the owner later, or included as an alternate item. The access flooring might be eliminated and a concrete floor with conduit substituted. By reviewing each line item with the assistance of the cost estimator, the architect and library planner can effectively make decisions to correct a cost overrun.

3.1.2 Similar Projects

It can be extremely useful to the library planner to review copies of cost estimates for recent projects of similar size and construction type to help identify possible causes for cost overruns. By reviewing the per square foot costs by component category, it is possible to identify areas where the budget is being impacted by the building design. For example, review the cost for individual doors, toilet stalls, lighting fixtures, commodes, and drinking fountains. Are any of these excessively high compared to other projects? Review the costs for component 5, Roofing & Waterproofing. Are there too many skylights? Review the costs for component 8, Function Equipment & Specialties. What is the cost per linear foot for casework? Are the circulation and reference desks too expensive? An experienced cost estimator can be extremely helpful in identifying possible causes for cost overruns during this stage of the process.

3.2 Discrepancy

As noted above in Section 1.1, the owner will frequently request a cost estimate from two different sources. Differences in the cost estimates are addressed through a structured approach of reconciliation with the contractor, the project manager, and/or the cost estimator.

If the cost estimates vary widely, then a meeting should be scheduled to identify where errors or omissions might have occurred. In some cases, one of the estimators may have misunderstood a building detail. In other cases, items may have been included in one estimate and not the other. In all cases, a comparison of the two estimates will result in a single, more accurate cost estimate for the project.

The Author

Nick Butcher is a Principal with Davis Langdon Adamson, a construction cost and project management firm. The firm provides a comprehensive cost planning and management service to library projects throughout the United States, focused on controlling cost, limiting risk and adding value throughout the course of a projects' development. With more than 2000 staff members in 25 countries around the globe, the firm is one of the largest international construction cost management firms.