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STUDENT EDITION

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RSMeans

RSMeans Cost Data, Student Edition

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Table of Contents

Introduction

The purpose of this book is to provide students with reliable information to assist in determining quantities of materials, as well as labor required for construction projects. Construction estimating can be separated into two basic components: how many units are required and reasonable costs for those units. The determination of quantities is commonly called the quantity takeoff. It is, simply, the tabulation of the physical units of materials needed for the construction of the project. While this may sound like a straightforward task, any estimator knows that the process can be quite involved. For example, when estimating a concrete footing (excavation and backfill not included), the items necessary include formwork (forms, ties or spreaders, keyway, inserts, form oil, delivery, erecting, stripping, and cleaning); reinforcing (delivery, cutting, bending, ties, splices, chairs, and other accessories); and the concrete itself (placing, consolidating, finishing, curing, protecting, and patching). A working knowledge of construction materials and methods is a must for a successful estimator. This knowledge helps to ensure that all items are accounted for and tabulated correctly—a sound basis for a good estimate.

The determination of "reasonable" costs for tabulated quantities is one of the main reasons why estimates vary. What may be reasonable for one job may be unrealistic for another. Labor rates (and productivity) will vary from region to region. Costs for the same materials also vary—from city to city and even from supplier to supplier within the same town. The experienced estimator evaluates each project individually, investigates fluctuations in costs, and uses that knowledge as an advantage.

Estimating for building construction is certainly not as simple a task as many people believe. Before one can obtain a quantity and apply a cost per unit to that quantity, many hours, days, or even weeks of hard work may be put into a detailed project before arriving at that one "magic number."

Electronic access to Means CostWorks can be found at **https://rsmeansonline.com/academic**. There you will find the drawings referred to in the chapter exercises as well as the electronic version of the database. Estimating requires practice, consistency, and attention to detail. By challenging yourself with the exercises at the end of each chapter, you'll be well on your way to developing sound estimating skills.

*Note: The cost data included in this book has been abbreviated. Access to the complete data set can be obtained at **https://rsmeansonline.com/academic**

Overview

Types of Estimates

Several different levels of estimates are used to project construction costs. Each has a different purpose. The various types may be referred to by different names, some of which may not be recognized by all as necessary or definitive. Most estimators will agree to several basic levels, each of which has its place in the construction estimating process.

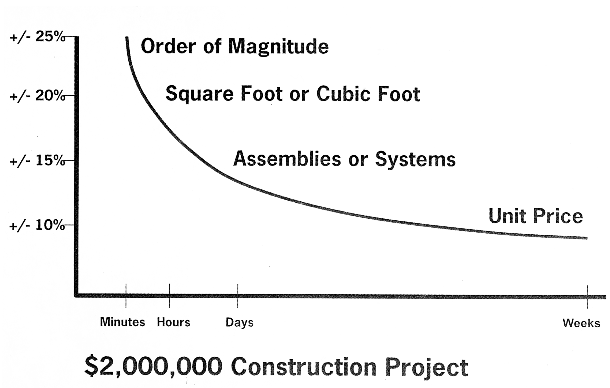
RSMeans, through its publications and seminars, has traditionally presented the following four levels of estimates:

> **Order of Magnitude Estimates:** The order of magnitude estimate could be loosely described as an educated guess. It can be completed in a matter of minutes. Accuracy is –30% to +50%.
>
> **Square Foot and Cubic Foot Estimates:** This type of estimate is most often used when only the proposed size and use of a planned building are known. Accuracy is –20% to +30%.
>
> **Assemblies (Systems) Estimate:** An assemblies estimate is best used as a budgetary tool in the planning stages of a project. Accuracy is expected at –10% to +20%.
>
> **Unit Price Estimate:** Working plans and full specifications are required to complete a unit price estimate. It is the most accurate of the four types, but is also the most time-consuming. Used primarily for bidding purposes, accuracy is –5% to +10%.

Order of Magnitude Estimates:

The order of magnitude estimate can be completed when only minimal information is available. The use and size of the proposed structure should be known. The "units" can be general. For example: "A small office building for a service company in a suburban industrial park will cost about $1,000,000." This type of statement (or estimate) can be made after a few minutes of thought, drawing on experience, and by making comparisons to similar projects. End product units estimating methods may also be used. Instead of expressing costs in dollars per square

Figure 0.1 *Estimating Time vs. Accuracy Curve*



foot or dollars per cubic foot, costs are expressed in units related to the particular type of project, such as dollars per bed for hospitals, per student for schools, or per car for parking garages. While this rough figure might be appropriate for a project in one region of the country, an adjustment may be required for a change of location and for cost changes over time (price changes, inflation, etc.).

Square Foot and Cubic Foot Estimates: The use of these types of estimates is most appropriate prior to the preparation of plans or preliminary drawings, when budgetary parameters are being analyzed and established. Costs may be broken down into different components or elements, and then according to the relationship of each component to the project as a whole, in terms of costs per square foot. This breakdown enables the designer, planner, or estimator to adjust certain components according to the unique requirements of the proposed project.

Historical data for square foot costs of new construction are plentiful. However, the best source of square foot costs is the estimator's own cost records for similar projects, adjusted to the parameters of the current project. While helpful for preparing preliminary budgets, square foot and cubic foot estimates can also be useful as checks against other, more detailed estimates. While slightly more time is required than with order of magnitude estimates, a greater accuracy is achieved due to more specific definition of the project.

Assemblies (or Systems) Estimates: Ever-increasing design and construction costs make budgeting and cost efficiency increasingly important in the early stages of designing building projects. Unit price estimating, because of the time and detailed information required, is not suited as a budgetary or planning tool. A faster and more cost-effective method for the planning phase of a building project is the "assemblies," or "systems" estimate. The assemblies method is a logical, sequential approach that reflects how a building is constructed. Seven "UNIFORMAT II" elements organize building construction into major components that can be used in assemblies estimates. These UNIFORMAT II elements are listed below.

A — Substructure
B — Shell
C — Interiors
D — Services
E — Equipment & Furnishings
F — Special Construction
G — Building Site Work

Each element is further broken down into individual assemblies. Each individual assembly incorporates several different items into a system that is commonly used in building construction.

In the assemblies format, a construction material may appear within more than one element. For example, concrete is found in Substructure, as well as in Shell and Equipment. Conversely, each element may incorporate many different areas of construction and the labor of different trades.

A great advantage of the assemblies estimate is that the estimator/designer is able to substitute one system for another during design development and can quickly determine the cost differential. The owner can then anticipate accurate budgetary requirements before final details and dimensions are established.

Unlike unit price estimates, the assemblies method does not require final design details, but the estimators who use it must have solid background knowledge of construction materials and methods, code requirements, design options, and budgetary restrictions.

The assemblies estimate should not be used as a substitute for the unit price estimate. While the assemblies approach can be an invaluable tool in the planning stages of a project, it should be supported by unit price estimating when greater accuracy is required.

Unit Price Estimates: The unit price estimate is the most accurate and detailed of the four estimate types, and therefore takes the most time to complete. Detailed plans and specifications must be available to the unit price estimator to determine the quantities of materials, equipment, and labor. Current and accurate costs for these items (unit prices) are also necessary. All decisions regarding the building's materials and methods must have been made before this type of estimate can be completed. There are fewer variables, and the estimate can, therefore, be more accurate.

Because of the detail involved and the need for accuracy, unit price estimates require a great deal of time and effort to complete properly. For this reason, unit price estimating is often used for construction bidding. It can also be effective for determining certain detailed costs in conceptual budgets or during design development.

Most construction specification manuals and cost reference books, such as *RSMeans Building Construction Cost Data*, divide all unit price estimating information into the 50 CSI MasterFormat divisions.

Before Starting the Estimate

In recent years, plans and specifications have become massive volumes containing a wealth of information. It is of utmost importance that the estimator read all contract documents thoroughly. These documents exist to protect all parties involved in the construction process. The contract documents are prepared so that the estimators will be bidding equally and competitively, ensuring that all items in a project are included. The contract documents protect the designer (the architect or engineer) by ensuring that all work is supplied and installed as specified. The owner also benefits from thorough and complete construction documents, being guaranteed a measure of quality control and a complete job. Finally, the contractor benefits because the scope of work is well defined, eliminating the gray areas of what is implied, but not stated. "Extras" are more readily avoided. Change orders, if required, are accepted with less argument if the original contract documents are complete, well stated, and most important, read by all concerned parties.

During the first review of the specifications, all items to be estimated should be identified and noted. The General Conditions, Supplemental Conditions, and Special Conditions sections of the specifications should be examined carefully. These sections describe the items that have a direct bearing on the proposed project, but may not be part of the actual, physical construction. An office trailer, temporary utilities, and material testing are examples.

While analyzing the plans and specifications, the estimator should evaluate the different portions of the project to determine which areas warrant the most attention. For example, if a building is to have a steel framework with a glass and aluminum frame skin, then more time should be spent estimating Division 05, Metals; and Division 08, Openings; than Division 06, Wood, Plastics & Composites.

The estimator should always visit the project site to ascertain the overall scope and to address specific conditions that may not be apparent from review of the plans. Items to look for include site access, proximity to resources, including utilities, and adequacy of space for storage and equipment.

Figures 0.2 and 0.3 are charts showing the relative percentage of different construction components by MasterFormat Division and Assemblies (UNIFORMAT II) Element, respectively. These charts have been developed to represent the average percentages for new construction as a whole. All commonly used building types are included. The estimator should determine, for a given project, the relative proportions of each component, and estimating time should be allocated accordingly. More time and care should be given to estimating those areas that contribute more to the cost of the project.

The Quantity Takeoff

The quantity takeoff can be thought of as two processes: quantifying and tabulating. In the quantifying process, materials and work items are scaled, counted, and calculated. In the tabulating process, the resultant quantities are tabulated in a way that costs can be assigned to them.

Quantifying can be performed manually, electronically assisted, or digitally. The manual method is done with pencil and paper, architect's scales, and calculators. The electronically assisted method typically employs the use of a device called a "digitizer." The digitizer allows the quantity surveyor to save time because the scaling operation is much more efficient. Using a pointing device, the quantity surveyor simply points to the beginning and end points of a line on a plan, and it is automatically scaled. Similarly, square footages of areas can be determined, and items counted. The digital method is used with CAD (computer assisted design) plans or BIM (building information modeling) based projects. No paper is required since CAD plans are viewed on a computer monitor, and dimensions can be determined by highlighting items or through an electronically generated report. With the necessary programming, not only quantities, but descriptions, labor-hours, and raw costs, can be linked to items on the plan. This information can be used to start a quantity takeoff and estimate within the software, or exported into a separate estimating software package. The estimating information must be modified utilizing the estimator's knowledge and experience.

For the tabulation process, the resultant calculations from any of the quantification methods are transferred, tabulated, and stored—either manually on paper (columnar sheets or preprinted forms) or electronically (using a spreadsheet or database program). An advantage of spreadsheet and database programs is that quantification and tabulation are performed concurrently. In addition, multiple codes can be assigned to each takeoff item so that they can be easily sorted or filtered by project phase, location, expected order of work, or any user-defined criteria.

When working with the plans during the quantity takeoff, consistency is the most important consideration. If each job is approached in the same manner, a pattern will develop, such as moving from the lower floors to the top, clockwise, or counterclockwise. Consistency is more important than the method used and helps to avoid duplications, omissions, and errors. Preprinted forms and spreadsheet templates create documents that provide an excellent means for developing consistent patterns.

Figure 3.1 is an example of a pre-printed form. Preprinted forms can also be used as guides for creating customized spreadsheet templates.

Templates are created ahead of time by the user and include all key labels, formulas, and formatting. Only the variables need to be input when estimates are produced.

Costing the Estimate

When the quantities have been determined, then prices, or unit costs, must be applied to determine total costs. No matter which source of cost information is used, the system and sequence of pricing should be the same as those used for the quantity takeoff. This consistent approach should continue through both accounting and cost control during construction of the project. Refer to Figure 5.1 for a sample Cost Analysis form.

Unit price estimates for building construction are typically organized according to the 50 divisions of the CSI MasterFormat. However, other organizational structures can be used. Within each division, the components or individual construction items are identified, listed, and assigned costs. This kind of definition and detail is necessary to complete an accurate estimate. In addition, each "item" can

Figure 0.2 *Cost Distribution by MasterFormat Division*

NO.	DIVISION	%	NO.	DIVISION	%	NO.	DIVISION	%
015433	CONTRACTOR EQUIPMENT*	6.6%	0510	Structural Metal Framing	3.9%	0920	Plaster & Gypsum Board	1.9%
3120,3130	Earth Moving & Earthwork	4.1	0520, 0530	Metal Joists & Decking	9.2	0930, 0966	Tile & Terrazzo	2.3
3160,3170	LB Elements & Tunneling	0.1	0550	Metal Fabrications	1.0	0950, 0980	Ceilings & Acoustical Treatment	2.9
3210	Bases, Ballasts & Paving	0.3	**05**	**METALS**	**14.1**	0960	Flooring	1.9
3310,3330,3340,3350	Utility Services & Drainage	0.2	0610	Rough Carpentry	0.7	0970, 0990	Wall Finishes & Painting/Coating	0.9
3230	Site Improvements	0.1	0620	Finish Carpentry	0.3	**09**	**FINISHES**	**9.9**
3290	Planting	0.6	**06**	**WOOD & PLASTICS & Composites**	**1.0**	**Covers**	**Divs 10-14, 25,28,41,43,44**	**6.0**
0241,31-34	**SITE & INFRASTRUCTURE, DEMO**	**5.4**	0710	Dampproofing & Waterproofing	0.1	2210, 2230, 2240, 2320	Piping, Pumps, Plumbing Equipment	13.4
0310	Conc. Forming & Accessories	2.8	0720, 0780	Thermal, Fire & Smoke	1.4	2113	Fire Suppression Sprinkler Systems	3.0
0320	Concrete Reinforcing	2.3		Protection		2350	Central Heating Equipment	2.6
0330	Cast-in-Place Concrete	5.2	0740, 0750	Roofing & Siding	1.2	2330, 2340 ,2360 ,2370, 2380	Air Conditioning & Ventilation	3.1
0340	Precast Concrete	2.1	0760	Flashing & Sheet Metal	0.3	**21, 22, 23**	**FIRE SUPPRESS., PLUMB. & HVAC**	**22.1**
			07	**THERMAL & MOISTURE PROT.**	**3.0**	**26, 27, 3370**	**ELECTRICAL, COMMUN. & UTIL.**	**12.0**
03	**CONCRETE**	**12.4**	0810, 0830	Doors & Frames	6.1		**TOTAL (Div. 1-16)**	**100.0%**
0405	Basic Masonry Mat. & Methods	0.6						
0420	Unit Masonry	6.0	0840, 0880	Glazing & Curtain Walls	1.0			
0440	Stone Assemblies	0.4	**08**	**Openings**	**7.1**			
04	**MASONRY**	**7.0**						

* Percentage for contractor equipment is spread among divisions and included above for information only

Figure 0.3 *Cost Distribution by UNIFORMAT II Elements (Assemblies)*

Division No.	Building System	Percentage	Division No.	Building System	Percentage
A	Substructure	6.3%	D10	Services: Conveying	3.9%
B10	Shell: Superstructure	19.8	D20-40	Mechanical	22.1
B20	Exterior Closure	11.5	D50	Electrical	12.0
B30	Roofing	2.9	E10	Equipment & Furnishings	2.1
C	Interior Construction	15.5	G	Site Work	3.9
				Total (Div. A-G)	100.0%

be broken down further into material, labor, and equipment components.

Types of Costs: All costs included in a unit price estimate can be divided into two types: direct and indirect. Direct costs are those directly linked to the physical construction of a project, those costs without which the project could not be completed. The material, labor, and equipment costs mentioned above, as well as subcontract costs, are all direct costs. These may also be referred to as "bare," or "unburdened" costs.

Indirect, or overhead, costs are those costs which are incurred in achieving project completion, but not applicable to any specific task. They may include items such as supervision, temporary facilities, insurance, professional services, and contingencies. Indirect costs are separated into two groups: job site overhead, and main office overhead. Job site overhead costs are those indirect costs associated with a job site. They can be estimated in detail, but are also calculated as a percentage of direct costs and included in CSI MasterFormat Division 1 of the estimate. Main office overhead costs are costs associated with the operation of the contractor's home (or main) office. Overhead costs are typically calculated as a percentage of the total project cost and added at the end of the estimate. Some costs, such as professional services, may be either project overhead or main office overhead cost, depending on how the resource is used.

Compiling the Data: At the costing stage of the estimate, there is typically a large amount of data that must be assembled, analyzed, and organized. Generally, the information contained in these documents falls into the following major categories, and can exist in paper or digital form.

- Quantity takeoffs for all general contractor items
- Material supplier written quotations and published prices
- Material supplier telephone quotations
- Subcontractor quotations
- Equipment supplier quotations and published prices
- Cost analysis
- Historic cost data from previous projects
- Costs and historic data from independent sources

A system is needed to efficiently handle this mass of data and to ensure that everything will get transferred (and only once) from the quantity takeoff to the cost estimate. Some general rules for this procedure are:

- Code each document with a division number in a consistent place.
- Use telephone quotation forms and templates for uniformity when recording telephone quotes.
- Document the source of every quantity and price.
- Use a logical, consistent directory filing system and file naming convention.
- Back up all important data.

All subcontract costs should be properly noted and listed separately. These costs contain the subcontractors' markups, and will be treated differently from other direct costs when the estimator calculates the project overhead, profit, and contingency allowance.

Additional Tips: When estimating manually, follow these guidelines:

- Write on only one side of a page if possible.
- Keep each type of document in its pile (quantities, material, subcontractors, equipment) filed in order by division number.
- Keep the entire estimate file in one or more compartmented folders.

When using electronic spreadsheets:

- Save commonly used templates in a separate folder.
- Spot-check important formula results with manual calculations to verify results.
- Frequently save spreadsheets to avoid losing work.
- Combine related spreadsheets into workbooks.
- Use a naming convention that indicates whether a spreadsheet is in progress or complete.
- When entering quantities into a spreadsheet cell, include useful numerical information. For example, *if 10% is added to a quantity of 300, instead of simply entering 330, enter =300*1.1*

Since over 50% of the work on a typical building project is performed by subcontractors, two aspects of bid preparation deserve special attention. The first is the subcontractor's scope of work, a clear

Figure 0.4 *Sample Estimate*

How RSMeans Data Works

Sample Estimate

This sample demonstrates the elements of an estimate, including a tally of the RSMeans data lines, and a summary of the markups on a contractor's work to arrive at a total cost to the owner. The RSMeans Location Factor is added at the bottom of the estimate to adjust the cost of the work to a specific location.

Work Performed: The body of the estimate shows the RSMeans data selected, including line number, a brief description of each item, its take-off unit and quantity, and the bare costs of materials, labor, and equipment. This estimate also includes a column titled "SubContract." This data is taken from the RSMeans column "Total Incl O&P," and represents the total that a subcontractor would charge a general contractor for the work, including the sub's markup for overhead and profit.

General Requirements: This item covers project-wide needs provided by the general contractor. These items vary by project, but may include temporary facilities and utilities, security, testing, project cleanup, etc. For small projects a percentage can be used, typically between 5% and 15% of project cost. For large projects the costs may be itemized and priced individually.

Bonds: Bond costs should be added to the estimate. The figures here represent a typical performance bond, ensuring the owner that if the general contractor does not complete the obligations in the construction contract the bonding company will pay the cost for completion of the work.

Location Adjustment: RSMeans published data is based on national average costs. If necessary, adjust the total cost of the project using a location factor from the "Location Factor" table or the "City Cost Index" table. Use location factors if the work is general, covering multiple trades. If the work is by a single trade (e.g., masonry) use the more specific data found in the "City Cost Indexes."

Project Name: Pre-Engineered Steel Building **Architect:** As Shown
Location: Anywhere, USA

Line Number	Description	Qty	Unit	Material
03 30 53.40 3950	Strip footing, 12" x 36"	33.33	C.Y.	$4,232.91
03 30 53.40 3940	Strip footing, 12" x24"	14.8	C.Y.	$1,953.60
03 31 05.35 0300	Concrete ready mix, 4000 psi, for slab	185.2	C.Y.	$19,075.60
03 31 05.70 4300	Placing concrete, slab on grade	185.2	C.Y.	$0.00
03 11 13.65 3000	Concrete forms	500	L.F.	$135.00
03 22 05.50 0200	WWF	150	C.S.F.	$3,225.00
03 39 23.13 0300	Curing	150	C.S.F.	$840.00
03 35 29.30 0250	Concrete finishing	15000	S.F.	$0.00
03 35 29.35 0160	Control joints	650	L.F.	$65.00
Division 03	**Subtotal**			**$29,527.11**
08 33 23.10 0100	10' x 10' OH Door	8	Ea.	$14,200.00
08 33 23.10 3300	Add for enamel finish	800	S.F.	$1,320.00
Division 8	**Subtotal**			**$15,520.00**
13 34 19.50 1000	Pre-Engineered Steel Building	15,000	SF Flr.	
13 34 19.50 6050	Framing for doors, 3' x 7'	4	Opng.	$0.00
13 34 19.50 6100	Framing for doors, 10' x 10'	8	Opng.	$0.00
13 34 19.50 6200	Framing for windows, 3' x 4'	6	Opng.	$0.00
13 34 19.50 5750	PESB doors	4	Opng.	$2,240.00
13 34 19.50 7750	PESB windows	6	Opng.	$2,130.00
13 34 19.50 6550	Gutters	380	L.F.	$2,128.00
13 34 19.50 8650	Roof vent	15	Ea.	$360.00
13 34 19.50 6900	Insulation	25,000	S.F.	$10,500.00
Division 13	**Subtotal**			**$17,358.00**
Estimate Subtotal				**$62,405.11**

Gen. Requirements	**4,368.36**
Sales Tax	**3,120.26**
Subtotal	**69,893.72**
GC O & P	**6,989.37**
Subtotal	**76,883.10**
Contingency	**@5%**
Subtotal	
Bond	**$12/1000 +10% O&P**
Subtotal	
Location Adjustment	**Factor**
Grand Total	

Figure 0.4 *Sample Estimate (continued)*

This example shows the cost to construct a pre-engineered steel building. The foundation, doors, windows, and insulation will be installed by the general contractor. A subcontractor will install the structural steel, roofing, and siding.

01/01/12				
Labor	**Equipment**	**SubContract**	**EstimateTotal**	
$1,983.14	$13.00	$0.00		
$1,102.60	$7.25	$0.00		
$0.00	$0.00	$0.00		
$2,240.92	$77.78	$0.00		
$795.00	$0.00	$0.00		
$3,000.00				
$667.50	$0.00	$0.00		
$6,300.00	$300.00	$0.00		
$208.00	$52.00	$0.00		
$16,297.16	**$450.03**	**$0.00**	**$46,274.30**	
$3,320.00	$0.00	$0.00		
$0.00	$0.00	$0.00		
$3,320.00	**$0.00**	**$0.00**	**$18,840.00**	
		$279,010.00		
$0.00	$0.00	$1,799.82		
$0.00	$0.00	$7,519.60		
$0.00	$0.00	$2,669.86		
$464.00	$0.00	$0.00		
$270.00	$50.40	$0.00		
$691.60	$0.00	$0.00		
$2,190.00	$0.00	$0.00		
$5,750.00	$0.00	$0.00		
$9,365.60	**$50.40**	**$290,999.93**	**$317,773.93**	
$28,982.76	**$500.43**	**$290,999.93**	**$382,888.23**	
2,028.79	**35.03**	**20,370.00**		**Gen. Requirements**
	25.02	**7,275.00**		**Sales Tax**
31,011.55	**560.48**	**318,644.92**		**Sub Total**
20,901.79	**56.05**	**31,864.49**		**GC O & P**
51,913.34	**616.53**	**350,509.42**	**$479,922.38**	**Subtotal**
			23,996.12	**Contingency**
			$503,918.50	**Subtotal**
			6,651.72	**Bond**
			$510,570.22	**Subtotal**
102.30			**11,743.12**	**Location Adjustment**
			$522,313.34	**Grand Total**

Sales Tax: If the work is subject to state or local sales taxes, the amount must be added to the estimate. Sales tax may be added to material costs, equipment costs, and subcontracted work. In this case, sales tax was added in all three categories. It was assumed that approximately half the subcontracted work would be material cost, so the tax was applied to 50% of the subcontract total.

GC O&P: This entry represents the general contractor's markup on material, labor, equipment, and subcontractor costs. RSMeans' standard markup on materials, equipment, and subcontracted work is 10%. In this estimate, the markup on the labor performed by the GC's workers uses "Skilled Workers Average" shown in Column F on the table "Installing Contractor's Overhead & Profit," which can be found on the inside-back cover of the book.

Contingency: A factor for contingency may be added to any estimate to represent the cost of unknowns that may occur between the time that the estimate is performed and the time the project is constructed. The amount of the allowance will depend on the stage of design at which the estimate is done, and the contractor's assessment of the risk involved. Refer to section 01 21 16.50 for contigency allowances.

understanding of which is essential, not only to compare the bids of competing subs, but to ensure that the estimator has included all the items that the subcontractors may have excluded (such as cutting and patching, temporary protection, scaffolding, hoisting, etc.). The second is that subcontractor prices typically do not arrive until bid day, which leaves little time to analyze competing bids, and makes last-minute gaps in coverage difficult to address if the estimator has not done the necessary coordination with these subs beforehand.

The Estimate Summary

When the pricing of all direct costs is complete, the estimator can transfer the total costs for each subdivision to the Estimate Summary sheet and apply all indirect overhead costs to this document. This step should be double-checked, since an error of transposition may easily occur. Refer to Figure 0.4 for a sample and Figure 5.2 for a blank summary sheet. As items are listed in the proper columns, each category is added, and appropriate markups applied to the total dollar values. Generally, the percentages for each of the following categories of indirect costs are added to the sum of each column at the end of the estimate:

- General Requirements
- Sales Tax
- General Contractor Overhead & Profit
- Contingency
- Bonds

Chapter 1 The Contract Documents

Estimating projects requires fluency in the language and symbols used in construction drawings and a familiarity with the various components included in the project manual. This chapter provides an overview of the contract documents: the working drawings and project manual which includes the technical specifications and construction contract. It does not offer detailed instruction in plan reading, but will review the organization of the drawings and specifications and highlight the various parts of the project manual—essential information for estimating a construction project.

The working drawings are the graphic representation or illustration of the project, and comprise the lines, symbols, and abbreviations printed on paper that represents the owner's wishes, as interpreted by the architect. They convey quantitative information such as how many doors and where they are located. The technical specifications however, convey information that is more qualitative in nature such as specifying the quality of the materials and workmanship.

Together, the drawings and specifications make up the contract documents and form the basis of the contract for construction

Working Drawings

Most drawings develop over several generations of review and modification as a result of owner input, coordination with other design disciplines, building code compliance, and general fine-tuning. This process is referred to as design development and occurs before the release of the final version of drawings, called the working drawings. Working drawings are the completed design—a code-compliant representation of the project, ready for bidding and, ultimately, construction. They will be the focus of this section and are the prerequisite for preparing a detailed unit price estimate. (Note: "Preliminary" drawings created early in the design process may be used as a basis for budget estimates. Budget estimating, though, requires specific skills that are covered in chapters 7, 8 and 9.)

The completed drawings become a "set," which incorporates all adjustments, changes, and refinements made by the architect or engineer as the final step in design development. Working drawings should comply with all applicable building codes, including any local ordinances having jurisdiction. Drawings should include all the information needed to prepare a detailed estimate and eventually build the project. The set of working drawings consists of various disciplines, including architectural, showing the layout of the building and its use of space; structural engineering, design of the structure to ensure that it will support the imposed loads; and mechanical and electrical design, to make the space habitable.

Other drawings in the set include designs that are less concerned with the structure itself than with support services, such as utilities that will be provided to the structure. These *civil* or *site drawings* include grading and drainage plans, which indicate how surface water will be channeled away from the structure; landscaping and irrigation design, paving, and curbing layout. Fire protection, equipment plans, and furniture plans are examples of other drawing types that may also be included in a working drawing set.

Organization of Working Drawings

There is a distinct organizational structure to the working drawings, which is almost universally accepted, and is as follows:

The Cover Sheet

The cover sheet, although very basic in nature, is one of the most important pages in a set of drawings. It lists information such as the name of the project, the location, and the names of the architects, engineers, owners, and other consultants involved in the design. The cover sheet also lists the drawings that comprise the set in the order they will appear. The drawing list is organized by the number of each drawing and the title of the page on which it appears. The cover sheet may also list information specifically required by the building code, including the total square foot area of the building, the use group, and the type of construction.

Another important element on the cover sheet is a list of abbreviations or graphic symbols used in the drawing set. There is often a section that contains "general notes," such as "All dimensions shall be verified in the field," or "All dimensions are to face of masonry." These notes help set the standards for background information that you will encounter throughout the drawings. In the absence of a separate set of bound specifications (most common in the residential market, where separate specs are not often written), the cover sheet may list the general technical specifications that will govern the quality of materials used in the work. Optional information, such as a locus plan locating the project with respect to local landmarks or roadways or an architectural rendering of the building may be included in the cover sheet.

Title Block

The title block is typically located in the lower right-hand corner of each sheet in the drawing set and should include the following information:

- The prefixed letter and number of the sheet (the letter designates the discipline of the drawing followed by the sheet number)
- The name of the drawing (e.g., "First Floor Plan")
- The date of the drawing
- The initials of the draftsperson
- Any revisions to the final set of drawings

The date and scope of the revisions should be noted within the title block. If there is not enough space available, the revisions should be noted close to it. The title block should specify whether the entire drawing is one scale, or whether the scale varies per detail, as in the case of a sheet of details. Sets of drawings for commercial projects require a stamp (and usually a signature) of the architect or engineer responsible for the design.

Revisions

Often, after the set of working drawings has been completed, recommendations are made for correction or clarification of a particular detail, plan, or elevation. While major changes may require redrafting an entire sheet, smaller changes are shown as a revision of the original. All changes must be clearly recognizable. They are indicated with a revision marker, which encloses the revised detail within a scalloped line that resembles a cloud. Tied to the revision marker is a triangle that encloses the number of the revision. Revisions are noted in the title block, or close to it, by date and number. This procedure provides a mechanism for identifying the latest version of drawings.

Drawings, Major Disciplines

Site Plan (SI)

The main purpose of the site plan is to locate the structure within the confines of the building lot. Even the most basic site plans clearly establish the building's dimensions, usually by the foundation's size and the distance to property lines. The latter, called the *setback* dimensions, are shown in feet and hundredths of a foot, versus feet and inches on architectural drawings. For example, the architectural dimension of 22′-6″ would be 22.50′ on a site plan. This decimal system is used because it is the basis of measurement for the land surveyor, the predominant engineer responsible for laying out the site. Site drawings are prefixed with the letters "SI" and numbered sequentially.

Civil Drawings (C)

The grouping of different types of site drawings, such as utility and drainage, grading, site improvement, and landscaping plans, is known under the general classification of *civil drawings.* Civil drawings encompass all the work that serves the building and is outside the structure itself. The most obvious difference between civil drawings and architectural drawings is the scale of the drawing and use of the engineer's scale.

Architetural drawings (A)

Architectural drawings are considered core drawings, since all the other drawings in the set support them. They show the layout of the building and its use of space. Architectural drawings convey the aesthetics of the building, denote the construction type, and indicate the dimensions and placement of all key features. The first architectural drawings in a set generally show large areas in less detail. As one progresses through the set, the level of detail increases. These drawings are prefixed by the letter "A" and sequentially numbered.

Structural drawings (S)

Structural drawings illustrate how the various load-carrying systems transmit both the live and dead loads of the structure to the earth below. Structural design is based on the architectural features, and is designed around the core drawings. (For example, columns and beams are designed to avoid interrupting a space.) Structural drawings are prefixed by the letter "S" and are sequentially numbered.

Mechanical drawings (M, P, FP)

Mechanical drawings illustrate the environmental systems of a building, such as plumbing, fire suppression/protection, and HVAC (heating, ventilating, and air conditioning) systems. These drawings may be prefixed by the letter "M" for mechanical, "P" for plumbing, or "FP" for fire protection. Building services drawings, as they are often named, are shown mainly in plan view and are sequentially numbered.

Electrical drawings (E)

Electrical drawings illustrate the electrical requirements of the project, including power distribution, lighting, and low-voltage specialty wiring, such as for fire alarms, telephone/data, and technology wiring. They often show the provision for power wiring of equipment illustrated on other types of drawings. They are prefixed by the letter "E" and are sequentially numbered.

Specialty drawings

Specialty drawings illustrate the unique requirements of various spaces' special uses (such as kitchens, libraries, retail, and home theater spaces). They define the coordination among other building systems, most commonly the mechanical and electrical systems. The drawings are sequentially numbered, and named according to the type of drawings. For example, "K" might be used for kitchen drawings, "F" for fixture drawings, and so forth.

Graphic Formats Used in Working Drawings

There are accepted standards or methods that architects and engineers use to present graphic information. Different views ensure that all required information is visible on the drawings. There are six main graphic formats:

- Plan views
- Elevations
- Sections
- Details
- Schedules
- Diagrams

Plans, elevations, and sections belong to a family of drawings called orthographic projections. Each represents a specific view or aspect of a building. Each drawing describes a limited part of the building, but when seen together, accurately describes the entire building. These types of drawings are commonly used for working drawings because they are true to size and shape. In other words, they are quantifiable.

Plan Views

The most common graphic view, the plan view, is presented as if looking down on the space. It is the view seen as if an imaginary horizontal cut is made several feet above the floor plane. In this sense, it is actually a section view looking down. Plan views form the basis of the project, and often provide the most complete view. The most common plan view is the *architectural floor plan*, which shows the shape of the building or building footprint, doors, windows, walls, and partitions. Other types of plan views include *reflected ceiling plans* and *partial plan views*, which illustrate a particular area and enlarge it for clarity. Partial views are most often used in areas of high congestion or detail. *Demolition plans* show proposed changes to the existing floor plan. *Roof plans* show the roof layout as would be seen from overhead. Plan views provide dimensions, which are needed to calculate areas. Dimensions should be accurate, clear, and complete, showing both exterior and interior measurements of the space. Plan views are also a starting point from which the architect directs the reader to other drawings for more information. They are also used extensively in other disciplines throughout the drawing set including *structural*, *fire suppression*, *plumbing*, *HVAC*, and *electrical plans*. Each shows the work of the respective trades in plan view as they fit into the architectural floor plan.

Elevations

Elevations provide a pictorial view of the walls of the building, similar to a photograph. They are used to depict both exterior and interior wall surfaces. Building surfaces that are perpendicular to the viewer's line of sight (principal wall surface in an elevation) are true to size and shape and are therefore quantifiable. Angled surfaces or those that are not perpendicular to the line of sight are distorted and cannot be measured.

Exterior elevations may be titled based on their location with respect to the headings of a compass (north, south, east, or west elevation), or their physical location (front, rear, right side, or left side elevation). The scale of the elevation should be noted either in the title block or under the title of the elevation. Interior elevations provide views of the walls on the inside of a building. They illustrate architectural features, such as casework, standing and running trims, fixtures, doors, and windows. Exterior elevations provide a clear depiction of the exterior shape of the building, the doors, windows and exterior features. Doors and windows are often tagged with numbers or letters in circles to show types that correspond to information provided in door and window schedules. In addition, elevations show the surface materials of walls, and any changes within the plane of the elevation or facade. While the floor plan shows measurements in two dimensions along a horizontal plane, elevations provide two dimensional measurements in a vertical plane. These dimensions provide the vertical measure of floor-to-floor heights, windowsill or head heights, floor-to-plate heights, roof heights, ceiling heights, or a variety of dimensions from a fixed horizontal surface. Since elevations are true to size and shape, these measurements can be used to calculate quantities of materials needed.

Building Sections

The building section, is a "vertical slice" or cut-through of a particular part of the building. It offers a view through a part of the structure not found on other drawings. Several different sections may be incorporated into the drawings. Sections taken from a plan view are called *building-sections*; and can be both longitudinal, cut through the building lengthwise, or transverse. Sections taken from an elevation are commonly referred to as *wall sections.* Wall sections provide an exposed view of the materials and construction of the wall and their connection to other horizontal components of the building such as floor plates and roofs. By referring to sections in conjunction with floor plans and elevations, a complete understanding of the size, shape, and construction of a building is possible.

Details

For greater clarification and understanding, certain areas of a floor plan, elevation, section, or other part of the drawing may need to be enlarged. This enlargement provides information that is critical to a part of the building item that may otherwise not be available in another view. Enlargements are drawn to a larger scale and are referred to as *details*. Details can be found either on the sheet where they are first referenced, or grouped together on a separate detail sheet included in the various disciplines they reference. The detail is shown in larger scale to provide additional information and space for dimensions and notes. Details are not limited to architectural drawings, but can be used in structural and site plans and, to a lesser extent, in mechanical or electrical plans.

Schedules

In an effort to keep drawings from becoming cluttered with too much printed information or too many details, architects have devised a system to organize all types of repetitive information in an easy-to-read table, known as a *schedule*. Schedules list information pertaining to a similar group of items, such as doors, windows, room finishes, columns, trusses, and electrical or plumbing fixtures. The most common schedules are door, window, and room finish schedules. However, information of a repetitive nature of any item type can be assembled into a matrix and incorporated in a set of drawings. Schedules are not limited to architectural drawings, but can be found in any discipline included within the set. A typical door schedule lists each door by number, or *mark*, and provides information on size and type, thickness, frame material, composition, and hardware. In addition, the door schedule will provide specific instructions or requirements for an individual door, such as fire ratings, undercutting, or weather-stripping. Door schedules are accompanied by door elevations which indicate panel configurations or size and number of vision panels. In the "remarks" portion of the schedule, the architect lists any non-standard requirements or special notes to the installer.

Diagrams

Some of the information presented in the set of drawings is more diagrammatic than pictorial. A *diagram* illustrates how the various components of a system are configured, and is often provided for purposes of coordination. Diagrams are commonly used for mechanical and electrical drawings, because of the complex nature of the work. Common examples include diagrams for fire alarm risers, waste and vent piping risers, and fire protection.

Drawing Conventions

Certain conventions have been adopted to provide a standard for drawings—from one design firm to another. The most common graphic features are lines, in-fill techniques, and shading, which can often contain subtle, but very important information relative to the detail shown. While most of these conventions are widely accepted and practiced, there are always minor deviations based on local practices. This is most apparent in the use of abbreviations and symbols. In many cases, unfamiliar symbols and abbreviations usually become clear after studying the drawings.

Line Types

Drawings must convey a great deal of information in a relatively small space, where there is no room for a lot of text. Consequently, different types of lines are used to communicate information. The most common ones are discussed below.

Main object line: A thick, heavy, unbroken line that defines the outline of the structure or object. Used for the main outlines of walls, floors, elevations, details, or sections.

Dimension line: A light, fine line with arrowheads or "tic" marks at each end, used to show the measurements of the building or main objects. The arrowheads fall between extension lines that extend from the main object to show the limits of the item drawn. The number that appears within the break or above the dimension line is the required measurement between extension lines.

Extension line: A light line that extends from the edge or end of the main object line, touching the arrowheads. Used together with dimension lines to help determine the limits of a particular feature.

Hidden or invisible line: A light dashed line of equal segments that indicates the outlines of an object hidden from view, under or behind some other part of the structure, such as a foundation shown in elevation that is below grade.

Center line: A light line of alternating long and short segments that indicates the center of a particular object. Frequently labeled with the letter "C" superimposed over the letter "L."

Material Indication Symbols and Shading

In-filling techniques are used on drawings to help convey their content or composition. They indicate the type of material used and are named *material indication symbols*. Because of the various views of drawings, different materials must be recognizable in each view, from plan to section to elevation. As with abbreviations, material indication symbols are subject to change based on specific materials used in various parts of the country.

Shading

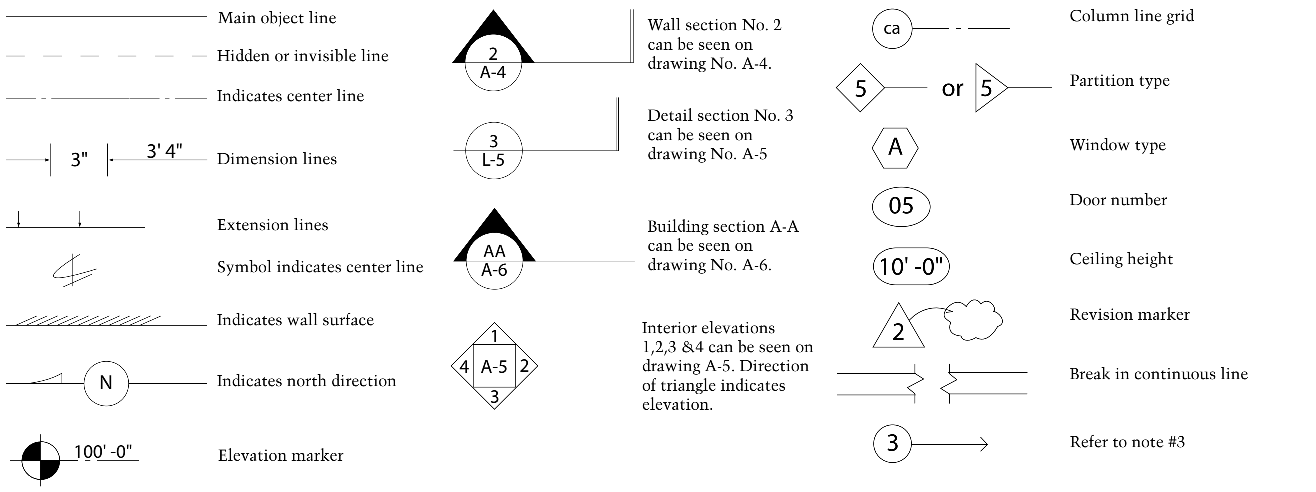
Architects and engineers convey information in a subtler manner by changing the intensity of a particular feature. This effect, called *shading*, increases or decreases the focus on the item, merely by its intensity. Items in the foreground or focus are often drawn darker or thicker. Objects in the background are lighter, and drawn less sharply. Shading is often used to differentiate between proposed and existing work on renovation projects. Using grayed-out architectural base drawings is a technique that is often used by various disciplines such as mechanical or electrical to distinguish their specific work while showing it relative to the architectural plans.

Graphic Symbols

Graphic symbols are another means of providing a standardized way to recognize information and depict repetitive information on drawings. *Section markers* indicate where a section is cut through an object, and can be directional or non-directional. *Elevation symbols* on a floor plan direct the reader to the sheet that contains the noted elevation. Another type of elevation symbol indicates differences in vertical height, such as the distance between floors, and provides a reference point used to calculate the height of components in walls or partitions.

Frequently, the design professional draws a feature, and, to save drawing space on the page, uses a *break line*. This symbol conveys that the feature is not

Figure 1.1 *Graphic Symbols*



drawn in its entirety. Geometric shapes with letters, numbers, or dimensions within them define certain features or main objects. This graphic symbol is frequently used to name windows, doors, rooms, partition types, and ceiling heights. The important information is within the shape, not the shape itself. Different shapes are often used to differentiate the types of items named.

Trade-Specific Symbols

Like graphic symbols, trade-specific symbols depict items that are common to the various trades. Because of the highly diagrammatic nature of mechanical and electrical drawings, there is an abundance of unique, trade-specific symbols used on these drawings. Engineers typically provide legends that define the symbols used. Some, such as for a water closet or toilet, are highly recognizable because they mirror the feature in real life.

Abbreviations

Abbreviations are used to save design professionals time, as well as space, on drawings. There is a wide and varied selection of abbreviations used in daily practice. It is not necessary to memorize each abbreviation. Standard practice is to list the abbreviations on the cover sheet of the set of drawings. This compilation of abbreviations saves time by locating the meaning of each abbreviation in a central location

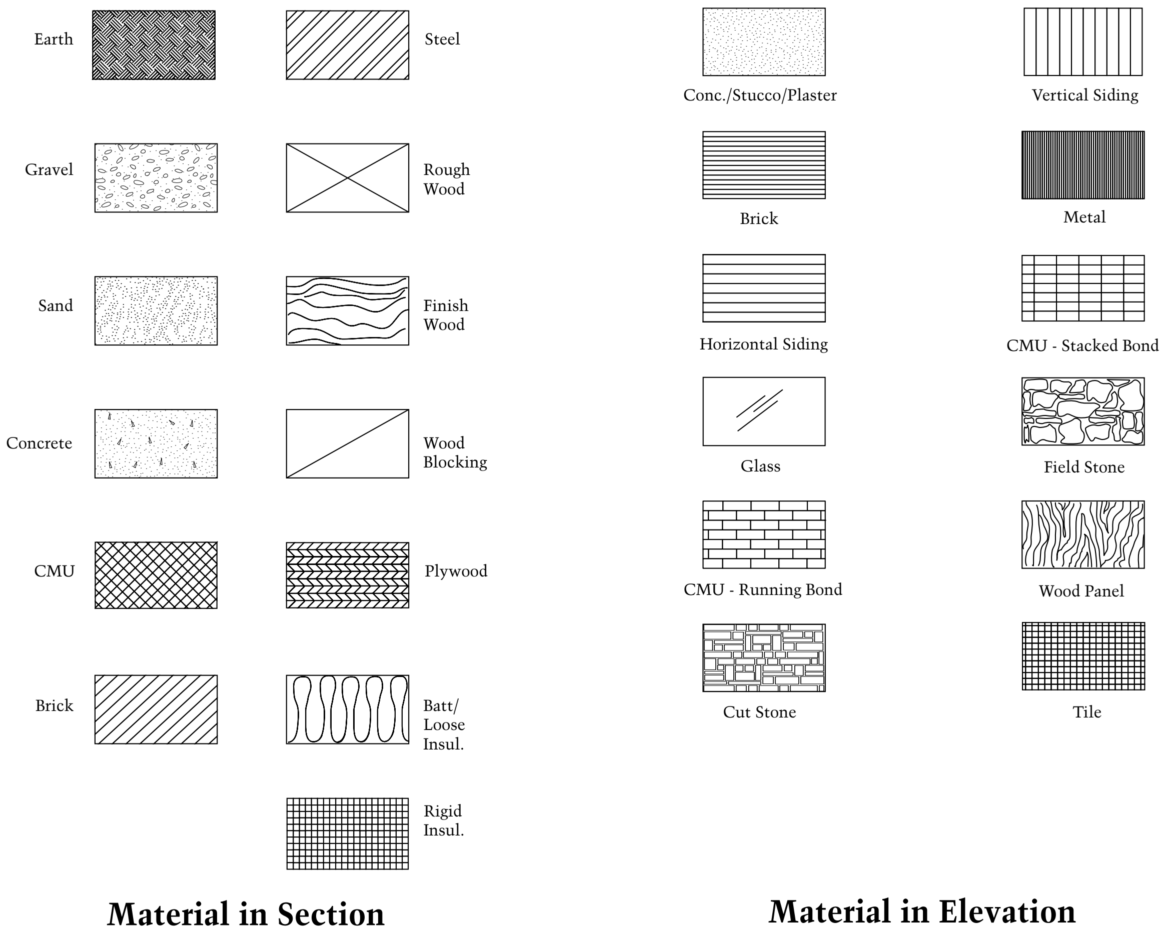
Scale

Since there are obvious physical limitations to drawing a building's actual size on a piece of paper, drawings retain their relationship to the actual size of the building using a ratio, or scale, between full size and what is seen on the drawings. There are two major types of scales: the *architect's scale* and the *engineer's scale*. Occasionally, architects and engineers include a detail strictly for visual clarification. These details are labeled "NTS," meaning "Not to Scale." This lets the reader know that the details are not for determining quantities and measurements, but for illustrating a feature that would otherwise be unclear. Diagrams are also typically not drawn to scale.

Architect's Scale

The architect's scale is used for the architectural drawings and the engineering drawings as well. The actual architect's scale may be flat, like a ruler, or three-sided. The three-sided architect's scale has ten separate scales: 1/8″ and 1/4″, 1″ and 1/2″, 3/4″ and 3/8″, 3/16″ and 3/32″, and 1-1/12″ and 3″. The one remaining side is in inches, similar to a ruler. Each noted scale is equal to one foot. For example, when used on a floor plan that is drawn at 1/4″ scale, each 1/4″ increment represents one foot. The same rule applies for 1/8″ scale; each 1/8″ segment on the drawing represents 1′-0″ of actual size. The first foot on each scale is further divided into inches. There is no strict convention that states which scale should be used on which drawings, although generally, floor

Figure 1.2 *Material Indication Symbols*



plans are drawn at 1/4″ or 1/8″ scale. Details are better illustrated in 1/2″ or 3/4″ scale for clarity.

Engineer's Scale

The engineer's scale is similar to the architect's scale and is typically (though not exclusively) used to prepare civil drawings. The difference is the size of the increments on the sides of the scale. The engineer's scale has six scales: 10, 20, 30, 40, 50, and 60. For example, the 10 scale refers to 10 feet per inch; the 20 scale is 20 feet per inch, and so on. The engineer's scale is further divided into hundredths of a foot. Other specialty scales are divided into even smaller increments, such as 100. The engineer's scale is used to measure distance on site plans, when it is greater than would be encountered in the plans of the building

Working Drawing Review

At this point we have reviewed the different types of plans and drawing elements that together comprise a full set of working drawings. It is essential to become familiar with the drawings prior to the site inspection and quantity takeoff. A thorough review of the drawings may reveal discrepancies or omissions and will help formulate questions posed to the architect before starting the quantity takeoff. It should also be noted that the various views should be used together. Information located on one drawing can often be corroborated on another. This checks and balances process is fundamental in estimating.

The Project Manual

Successful communication of the architect's/engineer's design intent to the contractor depends heavily on how well the project manual is written and organized. The *project manual* is the bound document that contains the technical specifications and the upfront documents including the contract for construction. Information in the manual must be written clearly and presented logically. It should be easy to follow and comprehensive in order to prevent delays as a result of constant clarification. Over time, the term "specifications" has come to be synonymous with the project manual. In actuality, the specifications refer to the technical specifications, whereas the project manual is the entire bound document that includes:

- Bidding Requirements
- Contract Forms
- General Conditions
- Technical Specifications

Preparation of the project manual is a substantial task, primarily the responsibility of the architect. Individual disciplines, such as mechanical, electrical, and structural engineers, review, edit, and contribute to their individual sections of the technical specifications. Problems tend to occur when the various disciplines fail to coordinate their part of the work with each other and with the core language of the General and Supplemental Conditions, as well as with the drawings. The technical writer must create a complete document using very specific language that will guide the contractor in the bidding and building processes, and will also serve as a powerful tool to enforce the contract. It takes a skillful use of language, a high level of proficiency in understanding and coordinating technical information, and the ability to process that data into usable information. Over the next several pages, we will review the structure of the project manual and its four main components.

Bidding Requirements

The Bidding Requirements are composed of the following items:

- Bid Solicitation
- Instructions to Bidders
- Information Available to Bidders
- Bid Forms and Supplements

Bid Solicitation

The bidding requirements begin with a solicitation for bids or proposals. This solicitation can be in the form of an *Invitation for Bid, Request for Proposals (RFP)*, or, in the case of public work, an *Advertisement for Bid*. In the private sector, bid solicitations can also be offered as an Invitation to Bid to selected firms only. All are similar in that they request bids from contractors. The RFP invites qualified general contractors and subcontractors to submit proposals for a particular project. It identifies the name and location of the project, along with a brief summary of the work involved. It clearly defines the date, time, and location for bids to be submitted. The RFP should name the owner or authority responsible for the bid award, whether the bids will be publicly or privately opened, and even (in some cases) the lender responsible for the funding. In the case of taxpayer-funded projects, the bids are usually opened publicly and made available for the inspection of the general public. The RFP typically identifies the architect and key engineering firms contributing to the design. For publicly funded projects, the statute governing such considerations as bidding and payments is also identified, along with any established budget for the work.

Instructions to Bidders

The Instructions to Bidders contain any required pre-qualification or eligibility criteria to eliminate bidders who could later be considered unacceptable. In the case of private bidding, the Invitation to Bid may be all that is required. In some states, publicly bid projects require formal qualification forms and a summary of the contractor's performance record. If a pre-bid conference or site inspection is scheduled, the date, time, and location are also stated. Additionally, the Instructions to Bidders defines the various forms and amount of bid security or bid bond that will be required. It states any liquidated damages that may be part of the contract, times for the commencement and completion of the work, and addenda or rules governing interpretation of the documents.

The Instructions to Bidders portion of the Bidding Requirements indicate the date, time, and location for procuring a set of contract documents and the cost, if any, to bidders. Other pertinent information, such as the time frame for award or rejection, special wage rates, tax-exempt status, or legal rights of the awarding authority to accept or reject proposals, is also provided.

Information Available to Bidders

The Information Available to Bidders provides locations where bidders can obtain copies of additional documents helpful in the bidding process. These documents could include geotechnical reports or subsurface investigation, property surveys and record drawings, conservation commission reports or directives, and hazardous materials management reports.

Bid Forms and Supplements

This section contains the forms developed by the architect for use by the contractors submitting bids, as well as bid security forms. Bid forms are used to keep proposals uniform in appearance and content. They provide the owner and architect with a mechanism for comparing "apples to apples." Bid forms provide the language of the proposal with blanks for the contractor to fill in. Space is provided to acknowledge addenda; add or deduct alternates; enter unit prices; record the name, address, and signatory party of the bidding contractor; and write the dollar amount. "Non-responsive" is the term applied to a bidder who has incorrectly filled out or inadvertently left out information on the bid form, thereby rendering that bidder ineligible for award.

Contract Forms

The most important contract form is the agreement between the owner and contractor, more commonly referred to as the *Contract for Construction*. This is a legal instrument supported by all of the contract documents. The Contract for Construction must contain the following basic items in order for it to be considered a functional document:

- Clear identification of the parties to the agreement
- Clear identification of the project
- Rights and responsibilities of each party
- Basis and terms of compensation

This agreement is incorporated within the project manual so that prospective bidders can carefully review the contract that will be executed when the project is awarded.

Performance and Payment Bonds

Other contract forms include performance and payment bond forms. A *performance and payment* bond is a type of contractual guarantee offered by a contractor to the owner of a property for a specific project that the contractor is willing to do. The bond ensures that the contractor will complete the project as specified, or face serious default penalties. Many organizations, including the government, require performance bonds when they choose a contractor to work on projects.

Certificates

The last section in the contract forms section of the specifications contains forms for insurance required for the project. This document defines the dollar limits for the various policies required.

General Conditions of the Contract

Although the Contract for Construction is the primary legal instrument in the project manual, it is insufficient on its own. Because of its complexity, a separate set of guidelines is necessary, called the *General Conditions of the Contract for Construction*. The General Conditions are meant to complement the Contract for Construction, defining the complex relationships between the owner, architect, and contractor and the mutual responsibilities and rights of the signatory parties. The General Conditions include the definitions of key terms and provide procedures and mechanisms for resolving disputes or clarifying information provided on the drawings or specifications.

Supplements to the General Conditions of the Contract

As noted previously, the General Conditions of the Contract address specific issues (in a general format) that could be considered applicable to the industry as a whole. Often projects have specific needs or unique conditions that require an amendment to the General Conditions. Because the General Conditions document is intended to interface with a whole series of other legal documents, any modifications can have serious legal ramifications. For this reason, a separate document is added, called the *Supplemental Conditions of the Contract*, or the *Supplementary General Conditions*. This custom-tailored document allows the author of the project manual great flexibility in meeting the specific needs of the individual client or project without risking the loss of continuity that the General Conditions provide. They are often presented in a way that a dollar value can be established against their impact. A classic example is insurance requirements. While the General Conditions describe the type and extent of insurance coverage, the Supplementary Conditions establish its limits. Using this information, you can establish the increased insurance policy dollars and thereby include the difference in the appropriate category of the estimate.

Technical Specifications

The last of the four categories is called the *Technical Specifications*, which define the scope, products, and execution of the work. This is the "meat and potatoes" section, providing the estimator with the necessary information (in a highly organized and industry-accepted format) to accurately price and build the structure. The technical sections provide the following information for each activity:

- Administrative (submittal) requirements
- Quality or governing industry standards
- Products and accessories
- Installation or application procedures
- Workmanship requirements

The specifications, or specs, as they are commonly referred to, are part of the contract documents, along with the working drawings. They are written documents included in the project manual that define in detail the processes and materials of the project. While the drawings define "how much and how many," the technical specs define the quality of materials and workmanship. For most light commercial and many upscale residential projects, working drawings are issued with a separate set of specifications. Even the simplest projects have some specifications, whether incorporated on the drawings or issued as a separate document to guide the contractor and subcontractors.

As owners become more informed and technically savvy, they are no longer satisfied by the term, "industry standard" when defining the quality of materials or workmanship to be included in a project. As a result, many contractors, especially in the high-end residential market, use technical specifications to establish the quality level for owners and as a guideline for subcontractors. Over the last decade, in fact, specifications have become increasingly popular as *the* standard of measurement for quality.

The specs perform a variety of functions, including:

- Defining the quality or grade of materials to be used in the project
- Defining the acceptable workmanship or providing standards to judge workmanship
- Providing a basis for accurately estimating cost
- Complementing the graphic portion of the project, the drawings

The plans and specifications are of equal importance to the contract documents, each documenting different aspects of the project. The specs are intended to be used in conjunction with the drawings. If the drawings are the *quantitative* representation of the project shown in a graphic format, then the specs are the *qualitative* requirements of the project described in a written document. Technologies, processes, and products are continually evolving in the construction industry, and architects and engineers incorporate these advancements more frequently into their designs. As a result, highly specific information is needed in the specifications. The materials and processes are described in such detail that the intent of the designer, as well as the product or system, can be upheld in case of a dispute or if products are installed incorrectly.

The specifications serve as a basis for bidding and performing the work. The person preparing the specifications, sometimes called a *specification or technical writer*, makes every effort to cover all of the items or segments of work shown on the working drawings. In the past, if there was a discrepancy between the specifications and the drawings, the specifications generally took precedence. This is no longer always the case. Many specifications now state that when there is a discrepancy between the plans and specifications, whichever results in the greater quantity, is more expensive, or is of greater benefit to the project will supersede.

Organization of Specifications

CSI MasterFormat is the most widely accepted system for arranging construction specifications and estimates. Developed by the Construction Specifications Institute, the MasterFormat system is also used for classifying data and organizing manufacturers' literature for construction products and services.

Division 01 — General Requirements
Division 02 — Existing Conditions
Division 03 — Concrete
Division 04 — Masonry
Division 05 — Metals
Division 06 — Wood, Plastics, and Composites
Division 07 — Thermal and Moisture Protection
Division 08 — Openings

Division 09 — Finishes
Division 10 — Specialties
Division 11 — Equipment
Division 12 — Furnishings
Division 13 — Special Construction
Division 14 — Conveying Equipment
Division 21 — Fire Suppression
Division 22 — Plumbing
Division 23 — Heating Ventilation and Air Conditioning
Division 25 — Integrated Automation
Division 26 — Electrical
Division 27 — Communications
Division 28 — Electronic Safety and Security
Division 31 — Earthwork
Division 32 — Exterior Improvements
Division 33 — Utilities
Division 34 — Transportation
Division 35 — Waterway and Marine
Division 40 — Process Integration
Division 41 — Material Processing and Handling Equipment
Division 42 — Process Heating, Cooling, and Drying Equipment
Division 43 — Process Gas and Liquid Handling, Purification and Storage Equipment
Division 44 — Pollution and Waste Control Equipment
Division 45 — Industry-Specific Manufacturing Equipment
Division 46 — Water and Wastewater Equipment
Division 48 — Electrical Power Generation

Format of Individual Specification Sections

In addition to the overall organization of the specifications, each spec section follows a specific format. The three-part format of each technical section provides a consistent organizational system for locating pertinent information quickly and efficiently:

Part 1 — General
Part 2 — Products
Part 3 — Execution

Part 1, General

Part 1, the general section of the specifications, provides a summary of the work included within that particular section. It ties the technical section to the General Conditions and Supplementary General Conditions of the Contract, an essential feature in maintaining continuity between the general contractor and subcontractors. Part 1 identifies the applicable agencies or organizations by which quality assurance will be measured. It defines the scope of work that will be governed by this technical section including, but not limited to, items to be furnished by this section only, or furnished by others and installed under this section. It also identifies other technical sections that have potential coordination requirements with this section, and defines the required submittals or shop drawings for the scope of work described in this section. Part 1 also establishes critical procedures for the care, handling, and protection of work within this section, including such ambient conditions as temperature and humidity. If applicable, it addresses inspection or testing services required for this scope of work.

Part 2, Products

Part 2 deals exclusively with the products and materials to be incorporated within this technical section of the work. For products that are directly purchased by the contractor from a manufacturer or supplier, the items can be identified using one of three methods:

- Proprietary Specification
- Performance Specification
- Descriptive Specification

Proprietary Specifications: These specifications spell out a product by name and model number. Proprietary specifications have the unique advantage of allowing the architect or owner to select a product they desire or have used successfully on prior projects. The advantage of requiring specific products is the level of reliability they provide. The disadvantage is that they eliminate open competition.

Performance Specifications: An alternate method of specifying products and materials is based less on makes and models and more on the ability to satisfy a design requirement or perform a specific function. This type of specifying is called a *performance specification*. In lieu of specifying a particular product by name, the architect opens competition to all products or materials that can perform the specific functions required to complete the design. This approach allows healthy competition among various manufacturers that have a similar line of products. It ensures competitive pricing and more aggressive delivery schedules. Performance specs can identify products by characteristics, such as size, shape, color, durability, longevity, resistivity, and an entire host of other requirements. For a specification section that involves custom-fabricated work, the language might be a mixture of proprietary and performance specifications.

Descriptive Specifications: The last method of specifying a product or process is by using *descriptive specifications*, which are written instructions or details for assembling various components to comprise a system or assembly. Most often, descriptive specifying is used for generic products such as mortar or concrete. Frequently, no manufacturers' or proprietary names are mentioned or needed.

Part 3, Execution
Part 3, called the *execution*, deals exclusively with the method, techniques, and quality of the workmanship. This section makes clear the allowable tolerances of the workmanship. The term "tolerances" refers to plumb, straight, level, or true. The Execution section should also describe any required preparation to the existing surfaces in order to accommodate the new work, as well as a particular technique or method for executing the work. This method or technique should be considered when developing an estimate since various work tasks require more or less labor and will ultimately affect the cost of the project. Part 3 also addresses issues such as fine-tuning or adjustments to the work after initial installation, general cleanup of the debris generated, final cleaning, and protection of the work once it is in place. Some sections of Part 3 may identify any ancillary equipment or special tools required to perform the work, such as staging or scaffolding.

Modifications to the Contract Documents

Addenda

The bidding process often produces questions that require clarification from the architect or engineer. Any changes to the contract documents made during the bidding period (the time period beginning on the date the drawings are issued and ending on bid day) in the form of modifications, clarifications, or revisions, are called *addenda*. Addenda, or an addendum (singular), can be issued only by the architect. Addenda must be issued in writing and will automatically become part of the contract documents, complete with all of the benefits of the Contract for Construction and the General Conditions of the Contract. Addenda should, at a minimum, contain the following information:

- Number of the addendum and date of issue
- Name and address of the architect and/or engineer
- Project name and location
- Bidders' names to whom the addendum is addressed
- Contract documents that are to be modified
- Explanation of the addendum's purpose

Bid forms often include an area for bidders to acknowledge addenda. Failure to do so could render the bid non-responsive. Since each addendum affects the bid price, each one should be carefully evaluated. Since addenda can affect the bids of all parties involved, subcontractors and materials suppliers should be made aware of any addenda, so they can adjust their bids accordingly.

Alternates

Often, owners want to see how a change in materials, method of construction, or addition or subtraction of work will affect the project's price. This information is presented in the form of additions or deletions to the base price, called *alternates*. Typically, the alternate is listed at the end of the specification section that is affected by it, and also in Division 1 under the section, "Alternates." Any increase or decrease in the cost for the work, including all taxes, labor burden, and overhead—both direct and indirect costs and profit should be included.

> For example, the total consequence of an alternate might look like: *Alternate 1: Delete door frame and hardware for Door #3 in its entirety. DELETE $500.*

In this example, you would not only delete the cost of the door, frame, and hardware, but must also include the additional wall materials, wood, gypsum board, paint, etc., to fill in the area Door #3 originally occupied in the base bid. The actual price of the alternate is the difference between the two. In some cases, the addition or deletion of large scopes of work by alternates can have a tremendous effect on the project's duration, thereby increasing or decreasing overhead and other time-sensitive costs of the project. Projects with limited budgets often include a series of alternates as a way of choosing how to most effectively use the budget.

Allowances

Occasionally, as the contract documents are ready to be issued, certain items have yet to be finalized and are not ready for inclusion in the bid set. Rather than leaving the item out altogether, the designer includes a cash allowance. The allowance is a fixed lump sum, such as "$10,000 for the purchase and delivery of sod and plantings." The allowance can also be in the form of a unit price, such as, "an allowance of $450 per M (thousand) for brick, including delivery to the job site." Typically, it is clearly stated what the allowance is for: materials, furnished and delivered only; materials and labor; or the entire scope of work. If there is any doubt, request clarification. At the completion of the project, the actual cost is computed for items included as allowances, savings are returned to the owner, and overages are added to the contract price. Typically, allowances are listed in Division 1 under the section, "Allowances."

Unit Prices

In the course of design for some projects, architects or engineers are sometimes unable to provide sufficient detail to the drawings so that the estimator can determine an exact quantity of a certain task or activity. An example of this is excavation of rock or unsuitable fill materials. The architect or engineer may be aware of what needs to be done and the techniques or quality required, but is unable to determine the exact amount of rock or materials to be removed. In an effort to at least establish the cost of this work for post-bid purposes, unit prices are requested and submitted as part of the bid form or proposal. Unit prices are included on the bid for each item by a unit of measure, such as excavation of unsuitable materials at $45 per CY. The unit price should always include markups for taxes, insurance, overhead, and profit.

Frequently, the unit price may be tiered-based on stipulated quantities since unit prices tend to decrease as the quantity increases. For example:

Excavation of unsuitable materials $75 per CY for 1 to 50 CY quantities

Excavation of unsuitable materials $65 per CY for 51 to 200 CY quantities

Excavation of unsuitable materials $45 per CY for 201 CY and over quantities

Conclusion

As you can see, all aspects of the contract documents affect the cost of a building project. Once the plans, specifications, and addenda have been documented and, if appropriate, a site visit has been conducted, then the quantity survey or takeoff can begin. (This process will be discussed in chapter 3.) Prior to beginning the takeoff, it may be helpful to review basic area and volume calculations, covered in chapter 2 since performing an accurate quantity takeoff requires careful area calculations and consistent use of units.

Chapter 1 Exercises

1. Why is it important to study the contract documents prior to preparing a bid?
2. Why are scales used in drawings, and what two types are commonly used in working drawing sets?
3. An abbreviation commonly found in working drawings is NTS. What does it mean and where do you find definitions for abbreviations used in the working drawing set?
4. On which drawing type would you typically find floor to floor heights?
5. What is a schedule? What type of information is commonly depicted in one?
6. Which scale is commonly used on a site plan? Why?
7. What is a performance and payment bond? Why is it important information for an estimator to know while preparing a bid?
8. What are the technical specifications?
9. Addenda are often part of a bid package. What are they and why should an estimator familiarize him/herself with them before preparing a bid?

10. How are the technical specifications organized?
11. Define the term, unit price. Where are unit prices typically found in a construction document set?
12. Graphic conventions are used in drawings to convey specific information about a building. What does a hidden line represent?
13. What is an allowance? How is it used in a construction document set?
14. What is an alternate? Provide an example of how it is used in a construction document set.
15. What is the graphic convention used to indicate a revision to a drawing? Why is this important for an estimator to know?