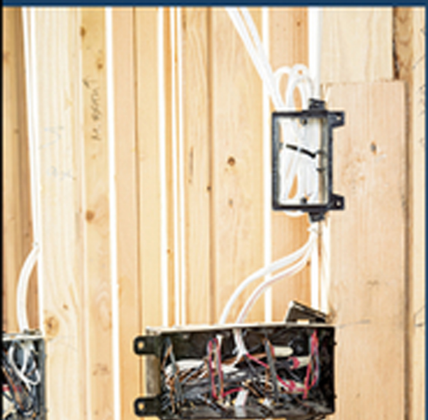
RSMeans
FROM THE GORDIAN GROUP

ELECTRICAL ESTIMATING METHODS

FOURTH EDITION




Wayne J. Del Pico

WILEY

Electrical Estimating Methods

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Fourth Edition

WAYNE J. DEL PICO, CPE

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Dedicated to the memory of

Sid Numerof

1929–2013

Good friend, valued coworker, and dedicated family man

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About the Author

Wayne J. Del Pico is president of W. J. Del Pico, Inc., where he provides construction management and litigation support services for construction related matters. He has more than 35 years of experience in construction project management and estimating and has been involved in projects throughout most of the United States. His professional experience includes private commercial construction, public construction, retail construction, and residential land development and construction.

Mr. Del Pico holds a degree in civil engineering from Northeastern University in Boston, where he taught construction-related curriculum in Cost Estimating, Project Management, and Project Scheduling from 1992 until 2006. He is also a member of the adjunct faculty at Wentworth Institute of Technology in Boston, where he presently teaches programs in Construction Cost Analysis, Estimating, Project Control, and Construction Scheduling.

Mr. Del Pico is a seminar presenter for the RSMeans Company, where he provides instruction on topics from estimating to scheduling. He is the author of *Plan Reading and Material Takeoff* (1994), *Estimating Building Costs (2004)* and its second edition in 2012, and is a co-author of *The Practice of Cost Segregation Analysis (2005)*. His most recent book, *Project Control: Integrating Cost and Schedule in Construction,* was published by Wiley in September 2013.

His construction experience and knowledge of the industry has qualified him to be the past president of the Builders Association of Greater Boston (2010). He is also a practicing Neutral for the American Arbitration Association, where he hears construction-related arbitration cases.

To learn more about the author, visit www.wjdelpico.com.

1 THE ESTIMATING PROCESS

1 Components of an Estimate

One of the most difficult tasks in estimating any project is to capture all of the costs involved in the project. Construction has many variables, and it is these variables that can have an impact of the way the estimator "sees" the work and ultimately its costs. The means and methods selected, or the plan to execute the work, will impact price significantly. Another important variable is the bid documents; comprehensive, fully developed designs offer a better chance for the estimator to reach an accurate price. It is the goal of the estimator to arrive at the most accurate price for the cost of the work under a specific set of circumstances and conditions.

While different estimators may see a project differently and thereby arrive at a different price for the work, all estimates share some basic components. Every cost estimate requires three basic components. The first is the establishment of standard *units of measure.* The second component of an estimate is the determination of the *quantity* of units for each component, which is an actual measurement process: how many linear feet of wire, how many device boxes, and so on. The third component, and perhaps the most difficult to obtain, is the determination of a reasonable *cost* for each unit.

The first element, the designation of measurement units, is the step that determines and defines the level of detail, and thus the degree of accuracy, of a cost estimate. In electrical construction, such units could be as all-encompassing as the number of watts per square foot of floor area or as detailed as a linear foot of wire. Depending on the estimator's intended use, the designation of the unit of measure may describe a complete system, or it may be a single task within the entire scope of the project. The selection of the unit of measure also determines the time required to do the estimate.

The second component of every estimate, the determination of quantity, is more than simply counting units. In construction, this process is called the *quantity takeoff* or *quantity survey.* It is an integral part of the estimating process that requires an intimate understanding of the work being estimated and a commitment to accuracy. To perform this function successfully, the estimator should have a working knowledge of the materials, methods, and codes used in electrical construction. An understanding of the technical specifications that were the basis of the design is also particularly important. This knowledge helps to ensure that each quantity is correctly tabulated and that essential items are not forgotten or omitted. The estimator with a thorough knowledge of construction is also more likely to account for all requirements in the estimate.

A clear understanding of the *scope*, or limits of the work, what is included and what is not, is also critical for a defining the estimate.

Not all of the tasks in an estimate involve materials; some are labor-only tasks. Testing is an example of a labor-only item. Some can be just material items, for example, a work box and conduit that is set in a masonry wall by the bricklayer. Experience is, therefore, invaluable to ensure a complete estimate.

The third component is the determination of a reasonable cost for each unit referred to as *pricing.* This aspect of the estimate is significantly responsible for variations in estimating. Rarely do two estimators arrive at exactly the same material cost for a project. Even if material costs for an installation are the same for competing contractors, the labor costs for installing that material can vary considerably, as a result of varying productivity and pay scales in different areas. The use of specialized equipment can decrease installation time and, therefore, cost. Finally, material prices fluctuate within the market. These cost differences occur from city to city and even from supplier to supplier in the same town. It is the experienced and well-prepared estimator who can keep track of these variations and fluctuations and use them to his or her best advantage when preparing accurate estimates.

This third phase of estimating, the determination of costs, can be defined in three different ways by the estimator. With one approach, the estimator uses a unit cost that includes all the elements (i.e., material, installation, overhead, and profit) in one number expressed in dollars per unit of work. A variation of this approach is to use a unit cost that includes total material and installation as a single amount, adding a percent markup for overhead and profit in the estimate summary.

A second method is to use individual unit costs for material and for installation. Costs are calculated separately for each category without markups. These are called *bare costs*. Different profit and overhead markups are applied to each item before the material and installation prices are totaled. The result is called the *billing* rate or price.

A third method of pricing uses unit costs for materials, with labor-hours as the measure of labor. Again, these figures are totaled separately; one represents the value of materials expressed in dollars, and the other shows the total labor-hours for installation. The average cost per hour of trade labor is determined by allowing for the expected ratios of foremen, journeymen, and apprentices. This is sometimes called a *composite labor rate.* This rate is multiplied by the total labor-hours to get the total bare cost of installation. Different overhead and profit markups can then be applied to each, material and labor, and the results added to get the total billing rate.

Whichever methodology is selected, it is important to remember that it should remain consistent through the entire estimate to avoid errors, omissions, or duplications. The estimator must, therefore, exercise care to utilize these methods correctly and consistently for the format of each particular estimate.

As a point of clarification, the word *unit* is used in many ways, as can be seen in the preceding definitions. Keeping the concepts of units clearly defined is vital to achieving an accurate, professional estimate. For the purposes of this book, the following references to different types of units are used:

- **Unit of measure.** The standard by which the quantities are counted, such as *linear feet* of conduit, or *number* of boxes. There are industry-accepted standards of units for almost all work.
- **Cost units.** The total dollar price per each installed unit of measure, including the costs of material and installation. This figure may be a bare cost or may include overhead and profit.
- **Material unit cost.** The cost to purchase each unit of measure. This cost represents material dollars only—with no overhead and profit.
- **Installation unit cost.** The cost for installing each unit of measure. This cost includes labor dollars only—with no overhead and profit.
- **Labor unit.** The labor-hours required to install a unit of measure. (*Note:* Labor units multiplied by the labor rate per hour equals the installation unit cost in dollars.)

A final thought on cost: It is important to note that the word *cost* is defined by its frame of reference. For the general contractor; the electrical contractor's entire price is a cost. When the work is complete, the general contractor will pay the entire contract amount to the electrical contractor and record it as a cost to the project. For the electrical contractor, cost is defined as all amounts in the estimate, with the *exception* of the profit. The electrical contractor will records costs as material, labor, and equipment paid to others, while the profit made is the only item not classified as a cost.

2 Types of Estimates

Estimators use four basic types of estimates. These types may be referred to by different names and may not be recognized by all as definitive. Most estimators, however, will agree that each type has its place in the construction estimating process. The four types of estimates are as follows:

- **Order of magnitude estimate.** The order of magnitude estimate could be loosely described as an educated guess. It can be completed quickly. Accuracy will vary between 20% and 25%.
- **Square foot estimate.** This type is most often useful when only the proposed size and use of a planned building is known. This method can be completed within an hour or two. Accuracy can be plus or minus 15%.
- **Assemblies estimate.** A systems estimate is best used as a budgetary tool in the planning stages of a project when some parameters have been decided. This type of estimate could require as much as one day to complete. Accuracy is expected to be plus or minus 10%.
- **Unit price estimate.** Working drawings 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, the accuracy of a unit price estimate can be plus or minus 5%.

As an estimator *and* his or her company gain repetitive experience on similar or identical projects, the accuracy of all four types of estimates will improve dramatically. In fact, given enough experience and the historical data backup, *square foot* estimates can be extremely accurate for certain types of work. However, most prudent contractors would never sign a contract based on a square foot price for the electrical scope of the work without some wiggle room. Unit price estimates are still the method of choice for competitive bidding leading to contract.

ORDER OF MAGNITUDE ESTIMATES

The order of magnitude estimate, also called a *rough order of magnitude (ROM) estimate,* can be completed with a minimum amount of information and a small expenditure of time. The units of measure, described in Chapter 1, "Components of an Estimate," can be very general for this type of estimate and require little definition. The units of measure are frequently units not typical to the construction industry and are used for cost-benefit analysis and very early decision making. For example, the cost of electrical work for a residential apartment building can be provided in a cost per apartment.

This type of ROM estimate can be made after a few minutes of analysis, drawing on experience and historical data from similar past projects. While this ROM might be appropriate for initial decision making, it does not take into account the uniqueness of individual projects. Experienced electrical contractors with historical data from similar projects can distill the total project cost into units of measure that are at their most basic. For example, the total electrical cost for an apartment complex could be provided in terms of the number of apartments in the complex. For parties with no historical cost data from which to draw, there are sources of published cost data that can provide data that can be the basis of a ROM estimate.

Table 2.1 and 2.2, from *Means Electrical Cost Data*, is a source of data that can be used in generating early ROM estimates. As previously stated, this cost data is in a unit of measure that is representative of the type and use of the project. As an

Table 2.1 Order of Magnitude Data (Lines 9000 and 9500)

50 17 | Square Foot Costs

	50 17 00 | SF Costs		UNIT	UNIT COSTS 1/4	UNIT COSTS MEDIAN	UNIT COSTS 3/4	% OF TOTAL 1/4	% OF TOTAL MEDIAN	% OF TOTAL 3/4	
01	0010	**APARTMENTS Low-Rise (1 to 3 story)**	SF	73	92.50	123				01
	0020	Total project cost	CF	6.55	8.70	10.75				
	0100	Site work	SF	5.35	8.55	15	6.05%	10.55%	13.95%	
	0500	Masonry		1.44	3.55	5.80	1.54%	3.92%	6.50%	
	1500	Finishes		7.75	10.65	13.15	9.05%	10.75%	12.85%	
	1800	Equipment		2.40	3.63	5.40	2.71%	3.99%	5.95%	
	2720	Plumbing		5.70	7.30	9.30	6.65%	8.95%	10.05%	
	2770	Heating, ventilating, air conditioning		3.63	4.47	6.55	4.20%	5.60%	7.60%	
	2900	Electrical		4.25	5.65	7.65	5.20%	6.65%	8.35%	
	3100	Total: Mechanical & Electrical		15.10	19.60	24	16.05%	18.20%	23%	
	9000	Per apartment unit, total cost	Apt.	68,000	104,000	153,500				
	9500	Total: Mechanical & Electrical	"	12,900	20,300	26,500				

Source: Reprinted with permission from Reed Construction Data from *RSMeans Electrical Cost Data 2014.*

example, refer to the bottom of the category titled *APARTMENTS Low-Rise (1 to 3 Story)*. The proposed use and magnitude of the planned structure—such as the desired number of apartments in an apartment complex—may be the only parameters known at the time the ROM Estimate is done. The data given in Table 2.2 does not require that details of the proposed project be known to determine rough costs; the only required information is the intended use and capacity of the building. The lack of accuracy can be subsidized with the addition of a contingency of 20% to 25%.

SQUARE FOOT ESTIMATES

Another type of estimate requires more definition to the project. In addition to the building's use or type, the definition is provided in the form of its size in gross square area of the building. This type of estimate is called the *square foot estimate.* The use of square foot estimates is most appropriate after the conceptual design has been started and maybe only a floor plan and elevation exist, although these types of estimates can be applied in the absence of any plans. This allows early cost estimates to be generated and budgetary parameters to be set.

For the electrical contractor with the historical data and experience, he or she can translate total project costs into dollars per gross square foot of building. The best source of square foot costs is the estimator's own cost records for similar projects, adjusted to the parameters of the project at hand. Once again, this is a preliminary estimate and not meant to be the cost basis of a contract.

Table 2.2 Square Foot Cost Data

50 17 | Square Foot Costs

				UNIT COSTS			% OF TOTAL			
	50 17 00 | SF Costs		**UNIT**	**1/4**	**MEDIAN**	**3/4**	**1/4**	**MEDIAN**	**3/4**	
01	0010	**APARTMENTS Low-Rise (1 to 3 story)**	SF	73	92.50	123				01
	0020	Total project cost	CF	6.55	8.70	10.75				
	0100	Site work	SF	5.35	8.55	15	6.05%	10.55%	13.95%	
	0500	Masonry		1.44	3.55	5.80	1.54%	3.92%	6.50%	
	1500	Finishes		7.75	10.65	13.15	9.05%	10.75%	12.85%	
	1800	Equipment		2.40	3.63	5.40	2.71%	3.99%	5.95%	
	2720	Plumbing		5.70	7.30	9.30	6.65%	8.95%	10.05%	
	2770	Heating, ventilating, air conditioning		3.63	4.47	6.55	4.20%	5.60%	7.60%	
	2900	Electrical		4.25	5.65	7.65	5.20%	6.65%	8.35%	
	3100	Total: Mechanical & Electrical	↓	15.10	19.60	24	16.05%	18.20%	23%	
	9000	Per apartment unit, total cost	Apt.	68,000	104,000	153,500				
	9500	Total: Mechanical & Electrical	"	12,900	20,300	26,500				

Source: Reprinted with permission from Reed Construction Data from *RSMeans Electrical Cost Data 2014*.

For parties with no historical cost data of their own, published cost data can serve as the basis of the estimate. Referencing the *APARTMENT Low-Rise (1 to 3 Story)* category in Table 2.2, one will note that costs are presented first as *total project costs* by square foot. These costs are broken down into major categories of work in terms of costs per square foot, and then into the relationship of each category to the project as a whole, in percentages. This breakdown enables the estimator to adjust certain categories of work according to the unique requirements of the proposed project. The costs on this and other pages of *Means Electrical Cost Data* are representative of actual project costs contained within the RSMeans database. These costs include the contractor's overhead and profit but do not include architectural fees, carrying costs, or other soft costs. The 1/4 column shows the value at which 25% of the projects had lower costs and 75% had higher. The 3/4 column value denotes that 75% of the projects had lower costs and 25% had higher. The median column value shows that 50% of the projects had lower costs and 50% had higher.

While helpful for preparing preliminary budgets, square foot estimates can also be useful as checks against other, more detailed estimates—a "big-picture" check and balance. While more time is required than with ROM estimates, a greater accuracy is achieved because of a more specific definition of the project.

ASSEMBLIES ESTIMATES

The next level on the evolutionary scale of estimating is the *assemblies estimate.* This method categorizes the estimate into major systems of the structure. The assemblies estimate provides the distinct advantage of enabling alternate construction techniques to be readily compared for budgetary purposes. Rapidly changing construction costs in recent years have made budgeting and cost-effectiveness studies increasingly important in the early stages of building projects. Unit price estimates, because of the time and detailed information required, are not well suited as budgetary or planning tools. A faster and more cost-effective method with the needed flexibility was created for the planning phase of a building project. It is the assemblies estimate.

The assemblies method is a logical, sequential approach that reflects how a building is constructed. The estimate is organized into seven groups based on the major components that can be found in a project. This organizational structure is called *UNIFORMAT II* and is outlined as follows:

Assemblies Major Groups

A—Substructure

B—Shell

C—Interiors

D—Services

E—Equipment & Furnishings

F—Special Construction

G—Building Sitework

Each major group is further broken down into systems. *Division D, Services*, which covers electrical construction, is composed of the following groups of systems:

D5010—Electrical Service & Distribution

D5020—Lighting & Branch Wiring

D5030—Communications & Security

D5090—Other Electrical System

Each system incorporates several different components into an assembly that is commonly used in construction.

A great advantage of the assemblies estimate is that the estimator is able to substitute one system or assembly for another during design development and can quickly determine the relative cost differential. This allows the decision makers for the project to determine the benefit of one system over another. The owner can use the assemblies estimate as guidance in keeping the project on a budgetary tract.

The assemblies method does not require the degree of final design details needed for a unit price estimate, but estimators who use this approach must have a solid background knowledge of construction materials and methods, code requirements, design options, and budget considerations.

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 whenever greater accuracy is required.

UNIT PRICE ESTIMATES

At the top of the evolutionary scale of estimating is the *unit price estimate*. This method is the most accurate and detailed of the four estimate types and therefore takes the most time to complete. It is a decomposition of the design into incremental units called *tasks* or *activities*. It requires detailed working drawings and specifications as a basis of the estimate. All decisions regarding the project's materials and systems must have been made to complete this type of estimate. The lack of variables provides the basis for a more accurate estimate than with any of the previous methods.

Working drawings and specifications are used to determine the quantities of materials, equipment, and labor. Current and accurate unit costs for these items are also necessary. The most accurate cost basis is always historical data collected and analyzed from previous projects of a similar type. Wherever possible, estimators should use prices based on experience or developed from actual, similar projects.

In the absence of a historical basis, costs can come from published data, such as *Means Electrical Cost Data*.

Because of the detail involved and the need for accuracy, completion of a unit price estimate entails a great deal of time and expense. For this reason, unit price estimating is best suited for construction bidding. It can also be an effective method for determining certain detailed costs in a conceptual budget or during design development.

The organization of the unit price estimate follows an industry recognized format called *CSI MASTERFORMAT 2010*™. CSI MASTERFORMAT 2010 was developed by *Construction Specifications Institute, Inc*. or *CSI* and is an expansion of the original CSI MASTERFORMAT that has been used and accepted for years. CSI grouped similar types of work into *divisions*. In an effort to accommodate the changes in technology, the original version has been expanded to 50 divisions. The outline of CSI MASTERFORMAT 2010 is as follows:

MasterFormat Divisions

Division 00—Procurement and Contracting Requirements

Division 1—General Requirements

Division 2—Existing Conditions

Division 3—Concrete

Division 4—Masonry

Division 5—Metals

Division 6—Wood & Plastics

Division 7—Thermal & Moisture Protection

Division 8—Openings

Division 9—Finishes

Division 10—Specialties

Division 11—Equipment

Division 12—Furnishings

Division 13—Special Construction

Division 14—Conveying Systems

Divisions 15–20—*Reserve divisions for future expansions*

Division 21—Fire Suppression

Division 22—Plumbing

Division 23—HVAC

Division 24—*Reserve division for future expansion*

Division 25—Integrated Automation

Division 26—Electrical

Division 27—Communications

Division 28—Electronic Safety and Security

Divisions 29 and 30—*Reserve divisions for future expansions*

Division 31—Earthwork

Division 32—Exterior Improvements

Division 33—Utilities

Division 34—Transportation

Division 35—Waterway and Marine Construction

Divisions 36–39—*Reserve divisions for future expansions*

Division 40—Process Integration

Division 41—Material Process and Handling Equipment

Division 42—Process Heating, Cooling & Drying Equipment

Division 43—Process Gas & Liquid Handling, Purification and Storage Equipment

Division 44—Pollution Control Equipment

Division 45—Industry-Specific Manufacturing Equipment

Division 46—Water and Wastewater Equipment

Division 47—*Reserve division for future expansion*

Division 48—Electrical Power Generation

Division 49—*Reserve division for future expansion*

CSI MASTERFORMAT 2010™ is categorized into five subgroups:

General Requirements Subgroup—Division 1

Facilities Construction Subgroup—Divisions 2–19

Facilities Services Subgroup—Divisions 20–29

Site and Infrastructure Subgroup—Divisions 30–39

Process Equipment Subgroup—Divisions 40–49

Each of the divisions is further divided into subsections, as a way of refining the categorization of work. For example, consider *Division 26—Electrical:*

26 01—Operation and Maintenance of Electrical Systems

26 05—Common Work Results for Electrical

26 06—Schedules for Electrical

26 08—Commissioning of Electrical Systems

26 09—Instrumentation and Controls for Electrical Systems.

26 10—Medium-Voltage Electrical Distribution

26 20—Low-Voltage Electrical Transmission

26 30—Facility Electrical Power Generating and Storing Equipment

26 40—Electrical and Cathodic Protection

26 50—Lighting

The CSI method of organizing the various components provides a standard of uniformity that is widely used by construction industry professionals: contractors, material suppliers, engineers, and architects.

A sample unit price page from *Means Electrical Cost Data* is shown in Table 2.3. This page lists various types of interior light fixtures each with a unit price for each type of fixture. In the absence of historical data, publish cost data can provide a database of information useful in developing a Unit Price Estimate. The type of work to be performed is described in detail: typical crew make-ups, unit labor-hours, units of measure, and separate costs for material and installation. Total costs are extended to include the installing contractor's overhead and profit.

As a subset to the unit price estimate, another type of estimate warrants an introduction. The *scheduling estimate* involves the application of labor allocations. A complete unit price estimate is a prerequisite for the preparation of a scheduling estimate. While the discussion of scheduling estimates goes beyond the scope of this book, an introduction to the practice will be addressed in Chapter 9, "Prebid Scheduling."

Table 2.3 Unit Price Costs Data

26 51 Interior Lighting

26 51 13 - Interior Lighting Fixtures, Lamps, and Ballasts

26 51 13.50 Interior Lighting Fixtures		Crew	Daily Output	Labor-Hours	Unit	2014 Bare Costs				Total Incl O&P
						Material	Labor	Equipment	Total	
5500	12", four 60 watt lamps	1 Elec	6.70	1.194	EA	69.50	63.50		133	172
5510	Pendant, round, 100 watt		8	1		111	53.50		164.50	202
5520	150 watt		8	1		121	53.50		174.50	213
5530	300 watt		6.70	1.194		169	63.50		232.50	282
5540	500 watt		5.50	1.455		320	77.50		397.50	465
5550	Square, 100 watt		6.70	1.194		149	63.50		212.50	260
5560	150 watt		6.70	1.194		156	63.50		219.50	267
5570	300 watt		5.70	1.404		227	75		302	360
5580	500 watt		5	1.600		310	85.50		395.50	470
5600	Wall, round, 100 watt		8	1		64.50	53.50		118	151
5620	300 watt		8	1		113	53.50		166.50	204
5630	500 watt		6.70	1.194		375	63.50		438.50	505
5640	Square, 100 watt		8	1		102	53.50		155.50	192
5650	150 watt		8	1		104	53.50		157.50	194
5660	300 watt		7	1.143		164	61		225	272
5670	500 watt		6	1.333		288	71		359	420

Source: Reprinted with permission from Reed Construction Data from *RSMeans Electrical Cost Data 2014.*