

国外大学优秀教材——建设管理系列（影印版）

建筑工程估价

（第5版）

Estimating in Building
Construction
(Fifth Edition)

Frank R. Dagostino

Leslie Feigenbaum



清华大学出版社

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国外大学优秀教材——建设管理系列（影印版）

序 言

建设管理原是我国土木工程专业中重要的方向，许多土木类院系设有该专业，近年不少综合性大学也设置了该专业。随着我国加入 WTO、中国企业角逐国际工程、国外建筑企业挤入中国市场，使得建设管理专业教育必须提供从内容到语言上能够与国际建筑业接轨的课程。

鉴于这种趋势，清华大学出版社秉承在引进国外原版教材方面的领先地位，与全球高等教育出版巨擘——美国培生教育出版集团——合作，经过清华大学建设管理系专家评审，精选出这套“国外大学优秀教材——建设管理系列（影印版）”教材。

“国外大学优秀教材——建设管理系列（影印版）”适合作为建设管理专业、相关经济类专业和土木工程专业的原版教材，以及具有较好英文基础和专业背景、渴望了解国外相关领域知识的企业界人士学习使用。

“国外大学优秀教材——建设管理系列（影印版）”包括：《房屋设计与施工案例分析》（Case Studies in Building Design and Construction, 1e）、《建筑工程合同》（Construction Contracts, 3e）、《建筑工程估价》（Estimating in Building Construction, 5e）、《建筑工程项目管理（专业版）》（Construction Project Management-Professional Edition, 1e）和《建筑施工计划与进度》（Construction Planning and Scheduling, 1e）。另外，在我社的“清华经济学系列英文版教材”中包括《工程经济学》（Engineering Economy, 12e）、《环境与自然资源经济学》（Environmental and Natural Resource Economics, 6e），在“清华管理学系列英文版教材”和“工商管理优秀教材译丛·管理学系列”中包括《面向商务和技术的项目管理》（Project Management for Business and Technology, 2e）等教材可配套选用。对清华大学出版社相关教材最新资讯感兴趣的读者，可查询清华大学出版社网站 www.tup.com.cn。

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preface

The fifth edition continues to build on the strong foundation of the previous four editions. Computerized estimating software has become commonplace in most construction organizations. However, it is critical for all estimators to know and understand the math theory behind quantification. Without this knowledge, the estimator cannot utilize or fully understand computerized estimating or its output. This belief, coupled with the author's experience as a constructor and educator, has been the guiding premise in this book. This has been operationalized by presenting examples from a sample project, and then including a completed workup sheet.

In this edition, as in the last, there is estimating software designed by Timberline Software Corporation. This CD contains Timberline's Basic Edition Trial software. There are problems at the end of most chapters that allow users to familiarize themselves with the estimating software. In addition, a number of blank spreadsheets that can be used with Excel 97 are included on the CD. These are included to give users a feel for how estimating can be performed using a spreadsheet program. Developing the formulas for these spreadsheets is helpful in reinforcing the math theory behind quantification.

Estimating in Building Construction, Fifth Edition, has a number of large commercial and residential drawings inserted as foldouts at the back of the book. These drawings are included to give the user the feel for what it is like to have to "dig" for the desired information. In addition, these drawings are the basis for all of the examples that are included in this book.

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chapter

1

Introduction to Estimating

1-1 GENERAL INTRODUCTION

Building construction estimating is the determination of probable construction costs of any given project. Many items influence and contribute to the cost of a project; each item must be compiled, analyzed, quantified, and priced. Because the estimate is prepared before the actual construction of the project, much study and thought must be put into the construction documents. The estimator who can visualize the project and accurately determine its cost will become one of the most important persons within any construction company.

In most instances, it is necessary to submit a cost estimate for the project, often in competition against other firms. The competition in construction bidding is intense, sometimes with ten or more firms bidding on a single project. To stay in business, a contractor must be the lowest qualified bidder on a certain number of projects, yet the prices of the projects must include an acceptable profit margin. This profit margin must provide the general contractor an acceptable rate of return and compensate for the risk associated with the project. Because the estimate is prepared from the working drawings and specifications of a building, the ability of the estimator to visualize all the different phases of the construction project becomes a prime ingredient in successful bidding.

The working drawings usually contain information relative to design, location, dimensions, and construction of the project, while the specifications are a written supplement to

the drawings and include information pertaining to materials and workmanship. The working drawings and specifications constitute the majority of the contract documents and *must* be considered together when preparing an estimate. The two complement each other and they often overlap in the information they convey. The bid submitted must be based on the drawings and specifications provided by the owner or architect. The estimator is responsible for including everything contained in the drawings and specifications in the submitted bid. Due to the complexity of the drawings and specifications, coupled with the potential cost of an error, the estimator must read everything thoroughly and recheck all items. Initially the plans and specifications must be checked to ensure that they are complete. Then the estimator can begin the process of quantifying all the materials presented. Every item included in the estimate must contain as much information as possible. The quantities determined for the estimate will ultimately be used to order and purchase the needed materials.

Estimating the ultimate cost of a project requires the integration of many variables. These variables fall into either direct field costs or indirect field costs. The direct field costs are the material, labor, equipment, and subcontracted items that are permanently and physically integrated into the building. For example, the labor and materials for the foundation of the building would be a direct field cost. Indirect field costs are the costs for the items that are required to support the field construction efforts. For example, the project site office would be an indirect field cost. In addition, factors such as weather, transportation, soil conditions, labor strikes, material availability, and subcontractor availability need to be integrated into the estimate. Regardless of the variables involved, the estimator must strive to prepare as accurate an estimate as possible. Carefully organized work, based on the estimator's best judgment and records of completed projects, will result in accurate estimates.

The increased use of computers and their integration into the construction process have provided the experienced estimator an opportunity to have the most accurate information possible. This in turn allows the estimator to compare past costs with projected costs; to estimate quantities of materials; and to manage the entire construction process, from selecting material suppliers and subcontractors to ordering materials and scheduling the construction of each phase of the project.

1-2 TYPES OF ESTIMATES

The required level of accuracy coupled with the amount of information about the project that is available will dictate the type of estimate that can be prepared.

Detailed Estimate

The detailed estimate includes determination of the quantities and costs of everything required to complete the project. This includes the materials, labor, equipment, insurance, bonds, and overhead, as well as an estimate of profit. To perform this type of estimate the contractor must have a complete set of contract documents. Each item of the project should be broken down into its parts and estimated. Each piece of work has a distinct labor requirement that should be estimated.

The detailed estimate must establish the estimated quantities and costs of material, the time required for and costs of labor, the equipment required and its cost, the items required for overhead and the cost of each item, and the percent of profit desired considering the investment, the time to complete, and the complexity of the project.

Preliminary Estimates (Volume and Area)

The *volume method* involves computing the number of cubic feet contained in the building and multiplying that volume by an assumed cost per cubic foot. Using the *area*

method, compute the square footage of the building and multiply that area by an assumed cost per square foot. Both methods require skill and experience in adjusting the unit cost to the varying conditions of each project. The amount of information required to produce these types of estimates is much less than with the detailed estimate. For example, a preliminary set of design drawings would have the dimensions for determining the area or volume. These types of estimates are helpful to check whether the project as designed is within the owner's budget; however, they lack accuracy. If the unit price comes from previously completed projects, it is assumed that this project is identical to the completed project. That assumption is clearly not valid in the construction of buildings. Weather conditions as well as design and construction team members change from project to project, all adding to the uniqueness of every project. Companies such as R. S. Means publish annual guides that contain a range of unit costs for a wide variety of building types. These guides, in order to enhance accuracy, provide a number of adjustments to compensate for varying building component systems.

Conceptual Estimates

When performing a conceptual estimate, typically, there are no drawings available. What exists is a vague verbal or written description of the project scope. When preparing this type of estimate the contractor makes assumptions about virtually every aspect of the project. These types of estimates are usually priced using some unit of measurement that has little to do with actual construction materials or measurements. A typical unit of measurement would be cost per apartment dwelling unit or cost per parking space.

This type of estimate is used early in the design process to check the reality of the owner's wants with their budget. In addition, these estimates are often used as a starting point to begin contract negotiations.

1-3 ESTIMATING OPPORTUNITIES

For anyone who is not aware of the many opportunities in the estimating field, this section will review some of the areas in which knowledge of estimating is necessary. Generally, knowledge of the procedures for estimating is required by almost everyone involved in or associated with the field of construction. From the estimator, who may be involved solely with the estimating of quantities of materials and pricing of the project to the carpenter, who must order the material required to build the framing for a home, this knowledge is needed to do the best job possible at the most competitive cost. Others involved include the project designer, drafters, engineers, contractors, subcontractors, material suppliers, and material representatives. In the following sections a few of the estimating opportunities are described.

Architectural Offices. The architectural office will require estimates at three design stages; preliminary (rough square foot or cubic foot costs), cost evaluation during drawing preparation (usually more accurate square foot or cubic foot costs), and a final estimate (usually based on material and installation costs, to be as accurate as possible).

In large offices the estimating may be done by an estimator hired primarily to do all required estimating. In many offices the estimating may be done by the chief drafter, head or lead architect, or perhaps someone else in the office who has developed the required estimating skills. There are also estimating services or consultants who perform estimates on a for-fee basis.

Engineering Offices. The engineering offices involved in the design of building construction projects include civil, structural, mechanical (plumbing, heating, air conditioning), electrical, and soil analysis. All of these engineering design phases require

preliminary estimates, estimates while the drawings are being prepared, and final estimates as the drawings are completed.

General Contractors. Typically, the general contractor makes *detailed* estimates that are used to determine what the company will charge to do the work required. The estimator will have to take off the quantities (amounts) of each material, determine the cost to furnish (buy and get to the site) and install each material in the project, assemble the bids (prices) of subcontractors, as well as determine the costs of insurance, permits, office staff, and the like. In smaller companies one person may do all the estimating, whereas in larger companies several people may work to negotiate a final price with an owner or to provide a competitive bid. Many times, the contractor's business involves providing assistance to the owners, beginning with the planning stage and continuing through the actual construction of the project (commonly called *design-build* contractors). In this type of business the estimators will also provide preliminary estimates and then update them periodically until a final price is set.

Estimating with Quantities Provided. Estimating for projects with quantity surveys involves reviewing the specifications for the contract and material requirements, reviewing the drawings for the type of construction used, and assembling the materials used. The estimator will spend part of the time getting prices from subcontractors and material suppliers and the rest of the time deciding on how the work may be most economically accomplished.

Subcontractors. Subcontractors may be individuals, companies, or corporations hired by the general contractor to do a particular portion of the work on the project. Subcontractors are available for all the different types of work required to build any project and include excavation, concrete, masonry (block, brick, stone), interior partitions, dry-wall, acoustical ceilings, painting, steel and precast concrete, erection, windows and metal and glass curtain walls, roofing, flooring (resilient, ceramic and quarry tile, carpeting, wood, terrazzo), and interior wall finishes such as wallpaper, wood paneling, and sprayed-on finishes. The list continues to include all materials, equipment, and finishes required.

The use of subcontractors to perform all the work on the project is becoming an acceptable model in building construction. The advantage of this model is that the general contractor can distribute the risk associated with the project to a number of different entities. In addition, the subcontractors' craft personnel perform the same type of work on a repetitive basis and are therefore quasi experts in their niche. However, the general contractor relinquishes a substantial amount of control over the project when this method is employed.

The subcontractor carefully checks the drawings and specifications and submits a price to the construction companies who will be bidding on the project. The price given may be a unit or lump-sum price. If a subcontractor's bid is presented as what he or she would charge per unit, then it is a *unit price* (such as per square foot, per block, per thousand brick, per cubic yard of concrete) bid. For example, the bid might be \$5.25 per linear foot (L.F.) of concrete curbing. Even subcontractors who bid on a unit basis will do at least a rough quantity takeoff so that they can have an idea of what is involved in the project, at what stages they will be needed, how long it will take to complete their work, and how many workers and how much equipment will be required. If the subcontractor submits a lump-sum bid, then he or she is proposing to install, or furnish and install, a portion of work. For example, the bid might state "agrees to furnish and install all Type I concrete curbing for a sum of \$12,785.00."

Each subcontractor will need someone (or several people) to check specifications, review the drawings, determine the quantities required, and put the proposal together. It may be a full-time estimating position or part of the duties assumed, perhaps in addition to purchasing materials, helping to schedule projects, working on required shop drawings, or marketing.