Materials Estimation

Unit: Core Applied Skills

Problem Area: Visualization Techniques

Lesson: Materials Estimation

Student Learning Objectives.

Instruction in this lesson should result in students achieving the following objectives:

1. **Describe building material estimation.**
2. **Create a cost estimate.**

Resources.

The following resources may be useful in teaching this lesson:

E-unit(s) corresponding to this lesson plan. CAERT, Inc. http://www.mycaert.com.

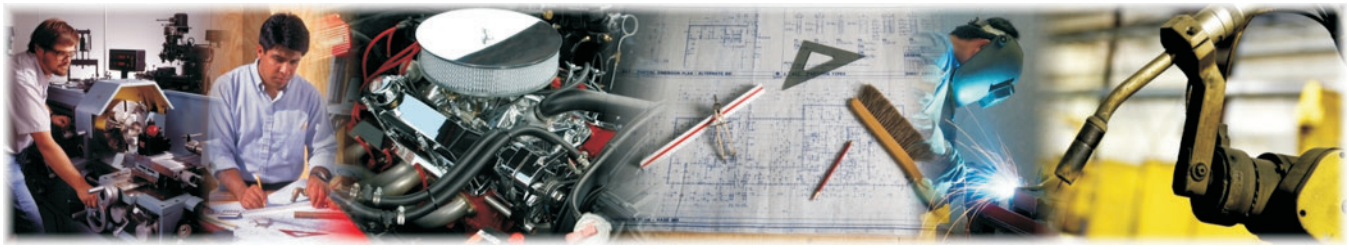
"Estimate with Accuracy," *RSMeansOnline*. Accessed Oct. 30, 2013. http://rsmeansonline.com/.

Froeschle, Lynn M. "Environmental Assessment and Specification of Green Building Materials," *The Construction Specifier*. Accessed Oct. 30, 2013. http://www.calrecycle.ca.gov/greenbuilding/materials/CSIArticle.pdf.

RSMeans Engineering Department. *RSMeans Residential Cost Data 2013*. RSMeans, 2012.

RSMeans Engineering Department, and Barbara Balaboni. *RSMeans Square Foot Costs 2013*. RSMeans, 2012.

RSMeans Engineering Department, and Bob Mewis. *RsMeans Contractor's Pricing Guide: Residential Repair & Remodeling 2011*. RSMeans, 2011.



"Sweets™," *McGraw Hill Construction*. Accessed Oct. 30, 2013. http://products.construction.com.

U.S. Building Green Council. Accessed Oct. 30, 2013. http://www.usgbc.org/articles/grid.

Equipment, Tools, Supplies, and Facilities

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials

Key Terms.

The following terms are presented in this lesson (shown in bold italics):

- carpenter
- cost estimate
- estimation
- excavator
- mason
- materials estimate
- material specifications
- quantity surveyor

Interest Approach.

Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

> *Explain that cost estimates for building materials are required in every construction and engineering project. They are a vital design tool that allows contractors and designers to receive the most for their money. More experience with cost estimation makes for more efficient use of time and provides cost savings.*

> *Ask students to relate cost estimation of materials to a planned remodel or rebuild of their classroom. Estimate the cost of wall, floor, and window coverings and the cost of replacing doors, desks, computers, windows, chairs, communication systems, and lighting. Record the student cost estimates for materials, and compare this to actual costs to remodel or rebuild the classroom.*

CONTENT SUMMARY AND TEACHING STRATEGIES

Objective 1: Describe building material estimation.

Anticipated Problem: How are cost estimates for building materials calculated?

I. Materials estimation

A. ***Estimation*** is a rough appraisal or judgment of the amount, size, or extent of something: a close guess. A ***materials estimate*** is a professional approximation and calculation of the cost of materials to complete a program, project, or operation. A materials estimate is also called a ***cost estimate***. A building cost estimate includes all the materials and processes needed to complete the building, while a basic materials estimate may include just the amount and cost of materials. Installation costs are included in most building and materials estimates. Installation costs often exceed the materials cost.

1. A set of project drawings and/or material specifications is required to create a materials estimate. ***Material specifications*** are technical data about the materials to be used in a project. They may specify a proprietary name brand or provide prescriptive information about a material's performance.
2. Material specifications may list or describe any standards met by the product and/or any tests to which the material was subjected. Standards and tests have a direct bearing on the eventual material cost—describing high-quality (typically higher cost) and low-quality (typically lower cost) materials.

B. Construction project estimation factors

1. The amount of each material needed is calculated from the building or project plans. The plans list or provide instruction about how the material is to be detailed. More complex details cost more money.
2. The structural and enclosure system has a direct effect on the project cost. Structural systems are wood, steel, or stone. Meanwhile, enclosure systems are brick or windows. Each system has a different cost.
3. Materials for walls, floors, ceilings, and doors are included in an estimate.
4. Some projects require additional fees for building permits, design, insurance, legal, and financing. These fees may have significant effects on the project cost, depending on scale and location.
5. A building contractor's costs are considered in a cost estimate. Contractors have different fees and rates depending on skills and quality of work. They use different specialty or subcontractors (trade specialists) to supply and install various materials (e.g., tile, HVAC, or solar panels). The standard way to organize trade specialists involved in the building process is by the materials they

use or their specific work on the construction project. A trade specialist may be one of the following:

a. An ***excavator*** is a contractor who systematically removes soil from a building site. For example, an excavator digs foundations, trenches, and holes.
b. A ***mason*** is a craftsperson who lays bricks, stones, cinder blocks, tiles, or other forms of masonry with mortar or cement to construct walls, fireplaces, patios, and more.
c. A ***carpenter*** is a skilled craftsperson who builds or repairs structures primarily with timber and wood. He or she constructs, makes installations, and maintains buildings.
d. Roofer
e. Siding contractor
f. Plumber
g. Electrician
h. Heating, Ventilation, and Air Conditioning (HVAC) Contractor
i. Insulator
j. Drywall installer
k. Painter

C. Creating materials estimates

1. Material estimates are usually produced at the beginning of a project and are used to monitor the cost changes/variations throughout the design and construction phase of the project. Contractors, designers, architects, engineers, and/or project managers prepare estimates.
2. Methods to create cost estimates vary. The method selected is usually determined by the type of project, the project history, and the amount of information available for the cost estimate.
   a. Area method is an estimation method based on the square footage or floor area of the project (e.g., price per square foot). This method is commonly used in the early stages of programming. A unit cost per square foot of material is used to calculate overall material costs.
   b. Accommodation unit method is an estimation method used in large-scale projects in which a small set of materials is used repeatedly in the same way. For instance, a cost is calculated for one unit in an apartment, condominium, or dormitory project. Then an estimate for the total project is determined by multiplying the total units by the single unit cost.
   c. Elemental (assemblies and subsystem) method is an estimation method that includes material costs, labor costs, subcontractor costs, overhead costs, and profit. The elemental method is typically used on projects that require different assemblies of materials and parts for a multistory building. Material cost projections involve breaking down the project and estimating each component of each assembly or subsystem. It requires designs and layouts of the project.

d. Quantity survey method is an estimation method that requires a detailed schedule of all components necessary for the completed project, including all building materials, methods, and time for installation. Usually a professional quantity surveyor is hired for the task. A ***quantity surveyor*** is an estimation professional in the construction industry whose primary concern is building cost. He or she specializes in measurement and calculation and includes all aspects of procurement, contractual, and project cost management.

Teaching Strategy: *Many techniques can be used to help students master this objective. Use VM–A. Demonstrate how to create a basic material cost estimate or have a local contractor or professional lecture on a unique method used in the local area. You may wish to have students locate local bid and spec documents in preparation for LS–A.*

Objective 2: Create a cost estimate.

Anticipated Problem: How is a cost estimate created?

II. Creating a cost estimate

A. The following building material categories and elements are considered when developing an estimate. They may not all be required for each project. If one or several elements are not applicable, they are removed. The total square footage of material for the project is multiplied by the material cost for each category or element. In the case of equipment, appliances, doors, windows, and furnishings, the cost for one each is multiplied by the total required for the entire project.

1. General site conditions
   a. General site structures
   b. Required temporary materials (barricades, etc.)
   c. Permits
   d. Fencing
2. Site work
   a. Existing conditions
   b. Excavation (including removal of soil and landscaping)
3. Concrete
   a. Foundation
   b. Floors
   c. Walls
   d. Other
4. Masonry (including mortar or cement)
   a. Brickwork
   b. Stonework

c. Cinder block
d. Tile

5. Metals (broken into structural and non-structural)
   a. Structural steel beams
   b. Non-structural metal stairs and railing
6. Woods and plastics (structural wood—truss materials and stair materials are noted separately from finish wood or non-structural woods or plastics)
7. Thermal and moisture protection (includes maintenance)
   a. Insulation
   b. Fillers
   c. Sealers
   d. Flashing
   e. Sheathing and siding materials
   f. Roofing materials
   g. Other
8. Doors and windows
   a. Interior and exterior windows
   b. Interior and exterior doors
   c. Closet assemblies
9. Finish materials (e.g., flooring and walls)
   a. Gypsum board
   b. Tile
   c. Carpet
   d. Bamboo manufactured flooring
   e. Countertops
   f. Wallpaper
   g. Other
10. Specialties
    a. Appliances
    b. Shower doors
    c. Alarm systems
    d. Other
11. Equipment
    a. Projection systems
    b. Screens
    c. Other
12. Furnishings
    a. Chairs and sofas
    b. Tables
    c. Desks
    d. Other

13. Special construction (specialty items)
14. Mechanical and plumbing
    a. Furnace
    b. Air conditioner
    c. Hot water heater
    d. Piping
    e. Duct work
    f. Sump pump
    g. Other
15. Electrical
    a. Wiring (length and gauge)
    b. Electrical panel
    c. Outlets and switches
    d. Lighting fixtures
    e. Other

B. Material cost estimate spreadsheet schedules (See VMs.)
    1. General conditions, site work
    2. Concrete, masonry, metals, wood & plastics, thermal & moisture protection
    3. Doors & windows; finishes
    4. Specialties, mechanical-plumbing, or electrical

Teaching Strategy: *Many techniques can be used to help students master this objective. Use VM–B through VM–E. If possible, teams should set up a spreadsheet to construct a cost estimate with a minimum of "Sum Formula" use in LS–A. Assign LS–A.*

Review/Summary.

Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the ends of chapters in the textbook may be used in the Review/Summary.

Application.

Use the included visual master(s) and lab sheet(s) to apply the information presented in the lesson.

Evaluation.

Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided.

Answers to Sample Test:

Part One: Matching

1. d

2. c
3. a
4. e
5. f
6. b
7. g

Part Two: True/False

1. T
2. F
3. T
4. T
5. F
6. T

Part Three: Short Answer

1. Answers will vary but should include eight of the following:
   a. General site conditions
   b. Site work
   c. Concrete
   d. Masonry
   e. Metals
   f. Woods and plastics
   g. Thermal and moisture protection
   h. Doors and windows
   i. Finishes (materials)
   j. Specialties (e.g., appliances, shower doors, and alarm systems)
   k. Equipment
   l. Furnishings
   m. Special construction
   n. Mechanical equipment and plumbing
   o. Electrical
2. Estimation is a rough appraisal or judgment of the amount, size, or extent of something: a close guess. A materials estimate (cost estimate) is a professional approximation and calculation of the cost of materials to complete a program, project, or operation.

Sample Test

Name _____

Materials Estimation

Part One: Matching

Instructions: **Match the term with the correct definition.**

a. mason
b. material specifications
c. excavator
d. quantity surveyor
e. materials estimate
f. carpenter
g. estimation

_____1. An estimation professional in the construction industry whose primary concern is building cost

_____2. A contractor who systematically removes soil from a building site

_____3. A craftsperson who lays bricks, stones, cinder blocks, tiles, etc.

_____4. A professional approximation and calculation of the cost of materials to complete a program, project, or operation

_____5. A skilled craftsperson who builds or repairs structures primarily with timber and wood

_____6. Technical data about the materials to be used in a project

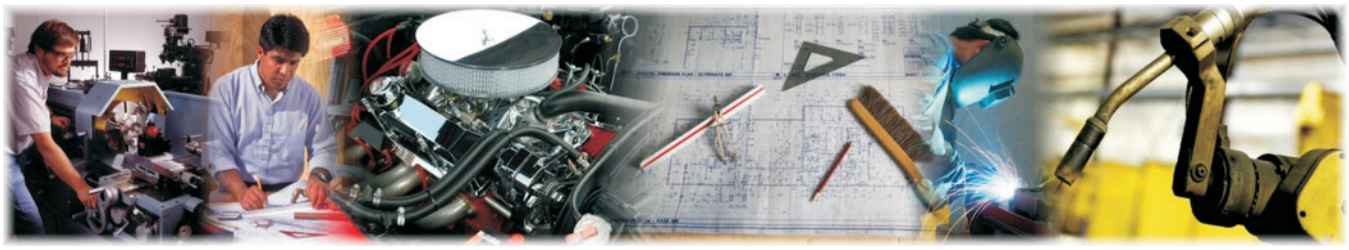
_____7. A rough appraisal or judgment of the amount, size, or extent of something: a close guess

Part Two: True/False

Instructions: **Write *T* for true or *F* for false.**

_____1. The accommodation unit method is used when large-scale projects use a small set of materials repeatedly in the same way.

_____2. Material estimates are usually produced at the end of a project to determine final cost.



_____3. The area method is based on the per square foot floor area of the project.

_____4. The amount of material required is calculated from building or project plans.

_____5. Interior materials for walls, floors, ceilings, and doors are not included in an initial cost estimate.

_____6. A set of construction drawings and material specifications are required to create a cost estimate.

Part Three: Short Answer

Instructions: **Answer the following.**

1. List eight elements of a construction project cost estimate.

2. Describe the following two terms: estimation and materials estimate.

VM–A

MATERIAL SPECIFICATION DATA SHEET: MASONRY

SECTION 04200
MASONRY

Scope:

Provide reinforced concrete block masonry where shown (and as specified or as needed) for a complete and proper installation.

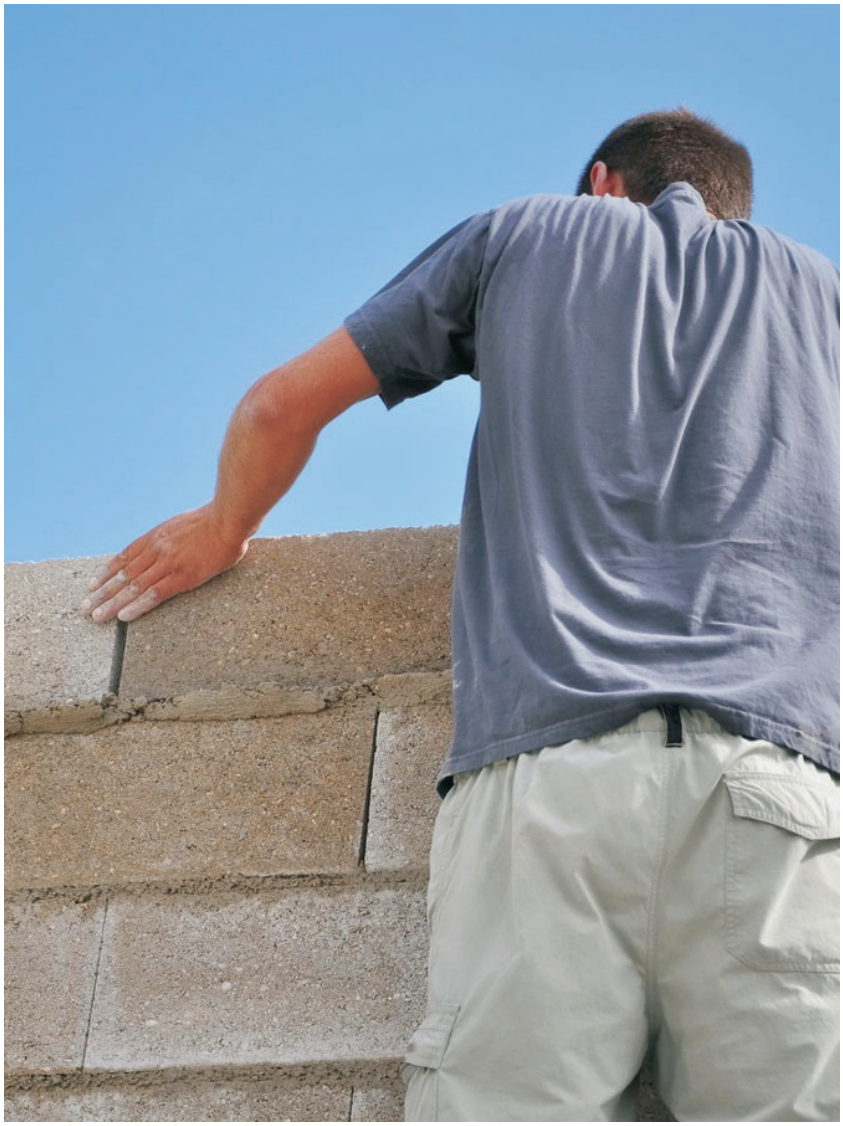
Material Specifications:

♦ Concrete block masonry	ASTM C 90, Grade N-1 medium-weight
♦ Mortar	Type S 1,800 psi at 28 days
♦ Grout	Minimum compressive strength = 2,000 psi at 28 days

- Construct masonry in accordance with Code and Concrete Masonry Association for reinforced masonry.
- Continuous inspection by deputy inspector will be required.
- Testing laboratory will test mortar and grout.

Where indicated on the drawings as “Alt No. 2,” use the following:

- Concrete block masonry: Acme block normal weight and normal stress
- Finish: Burnished
- Color: Sandstone, with sealer on all exposed surfaces



VM–B

MATERIAL ESTIMATE SPREADSHEET: GENERAL CONDITIONS AND SITE WORK

COST ESTIMATE					
Discipline	**Unit Cost**	**Quantity**	**Contract/ Vendor**	**Contingency**	**Subtotal**
01 Structures—General Conditions					$49,000.00
Temporary barricades, etc.	$150.00 per month	0	$0.00		
Misc. provisions					
Permits/expediting	$2,500.00	1	$2,500.00		
Temporary power/connections & use	$1,500.00	1	$1,500.00		
Clean up	$150.00 each	10	$1,500.00		
Portables	$100.00 each	25	$2,500.00		
Waste/recycling	$500.00 each	10	$5,000.00		
Surveying allowance			$500.00		
Technical information			$500.00		
Construction Services					
Insurance/accounting/office			$35,000.00		
02 Site Work					$13,467.20
Site testing	$0.00				
Excavation & fill			$7,800.00		
Permeable pavers materials	$0.00 sf	426	$0.00		
Permeable pavers installation	$7.20 sf	426	$3,067.20		
Lighting	$50.00	6	$300.00		
Landscaping			$2,100.00		
Rain barrels each	$0.00	2	$0.00		
Other	$100.00 each	2	$200.00		
Fencing	$17.00 lf	0	$0.00		

MATERIAL ESTIMATE SPREADSHEET: CONCRETE, MASONRY, METALS, WOOD & PLASTICS, AND THERMAL & MOISTURE PROTECTION

COST ESTIMATE					
Discipline	**Unit Cost**	**Quantity**	**Contract/ Vendor**	**Contingency**	**Subtotal**
03 Concrete					$21,000.00
Concrete material	$0.00	0	$4,500.00		
Concrete labor	$0.00	0	$16,500.00		
04 Masonry					0
	0	0	0		
05 Metals					0
Exterior metal stairs	0	0	0		
06 Wood & Plastics					$13,146.00
14" open web truss material	$5.20 sf	0	$0.00		
14" open web truss labor	$3.40 sf	1,241	$4,219.40		
2 × 4, 16" OC partition frame material	$0.60 sf	0	$0.00		
2 × 4, 16" OC partition frame labor	$1.10 sf	1,206	$1,326.60		
Molding materials	$0.70 lf	800	$560.00		
Molding labor	$1.80	800	$1,440.00		
Interior stairway, pine 14 risers—material	$950.00	0 total	$0.00		
Interior stairway, pine 14 risers—labor	$450.00	0 total	$0.00		

COST ESTIMATE					
Discipline	**Unit Cost**	**Quantity**	**Contract/ Vendor**	**Contingency**	**Subtotal**
Kitchen cabinets			$5,000.00		
Misc. cabinets & hardware			$600.00		
07 Thermal & Moisture Protection					$26,886.00
SIPS, roof & wall—material	$0.00	1870	$0.00		
SIPS, roof & wall—labor	$5.30	1870	$9,911.00		
Truck lift rental—SIPS installation	$1,500.00 week	2	$3,000.00		
Fire insulation & fire caulking			$300.00		
Gutters and downspouts	$10.00 lf	0	$0.00		
Single ply roof	$0.00 sf	1035	$0.00		
Green roof 3"			$5,000.00		
Roof hatch			$500.00		
Ships latter—roof access			$500.00		
6" fiber cement siding—material	$0.00 sf	1870	$0.00		
6" fiber cement siding—labor	$2.50 sf	1870	$4,675.00		
Misc. tools			$1,000.00		
Exterior caulking mat. & lab.			$2,000.00		

MATERIAL ESTIMATE SPREADSHEET: DOORS & WINDOWS AND FINISHES

COST ESTIMATE					
Discipline	**Unit Cost**	**Quantity**	**Contract/ Vendor**	**Contingency**	**Subtotal**
08 Doors & Windows					$27,980.00
Front and rear entrance door	0 each	2	$0.00		
Solar chimney double window assembly	30 sf	576	$17,280.00		
Windows—labor	400 each	16	$6,400.00		
Windows—cost	0 each	16	$0.00		
Interior doors—materials	0 each	6	$0.00		
Interior doors—labor	250 each	6	$1,500.00		
Closet door assemblies—materials	150 each	8	$1,200.00		
Closet door assemblies—labor	200 each	8	$1,600.00		
09 Finishes					$8,150.00
Gypsum board	$13.00 sheet	0	$0.00		
Gypsum labor	$12.00 sheet	150	$1,800.00		
Flooring					
Porcelain tile	$0.00 sf	260	$0.00		
Carpet	$0.00 sy	292	$0.00		
Bamboo/cork	$0.00 sf	254	$0.00		
Vinyl tile	$0.00 sf	27	$0.00		
Linoleum	$0.00 sf	135	$0.00		
Painting—material	$0.45 sf	4800	$2,160.00		
Painting—labor	$0.30 sf	4800	$1,440.00		
Countertops	$55.00 sf	50	$2,750.00		

MATERIAL ESTIMATE: SPECIALTIES, MECHANICAL—PLUMBING, AND ELECTRICAL

COST ESTIMATE					
Discipline	**Unit Cost**	**Quantity**	**Contract/ Vendor**	**Contingency**	**Subtotal**
Ten Specialties					$3,490.00
Wire closet shelves	$80.00 each	5	$400.00		
Residential appliances	$2,500.00 total	1	$2,500.00		
Shower doors	$350.00 each	1	$350.00		
Mailbox	$40.00 each	1	$40.00		
Security alarm system	$200.00 each	1	$200.00		
15 Mechanical—Plumbing					$25,870.00
Plumbing			$15,000.00		
Underground rough plumbing			$4,000.00		
Above-ground rough plumbing			$2,600.00		
Plumbing fixtures	0.00 avg	0	$0.00		
Sump pump	10.00	106			
4" drain tile & bedding					
HVAC					
Three-ton compressor, 94 mbh furnace	840.00 tons	3	$2,520.00		
Contractor oversight & materials, labor			$1,750.00		
16 Electrical					$7,862.50
Electrical					
Exterior primary drop panel	$1,800.00	1	$1,800.00		
Light fixtures	$0.00 avg	25	$0.00		
Electrical rough-in, conduit and wiring	$1.25 lf	4850	$6,062.50		
Electric panel	$1,500.00 each	1	$1,500.00		
Subtotals					$196,851.70
General contracting fee @ 10%					$19,685.17
Total project cost					$216,536.87

LS–A

Name _____

Materials Cost Estimation

Purpose

The purpose of this activity is to produce a materials cost estimate sheet.

Objectives

1. Take room measurements.
2. Create a data sheet (or spreadsheet, optional).
3. Calculate an estimate for each category and product.
4. Research the per-unit cost of each product.
5. Calculate the total cost of the materials estimate.

Materials

- computer with spreadsheet software (optional)
- writing utensil
- paper
- VM–B through VM–E (copies for each person or pair)
- local and/or state material specifications data sheets for appropriate materials (optional)
- class notes

Procedure

1. Work independently or in pairs to produce a material cost estimate to rebuild your classroom. Use the materials currently in place for your estimate. For example, if the floor has a concrete base and a terrazzo surface, assume you will replace that floor system in the rebuild. You should estimate the costs for the concrete, terrazzo, and installation (including any adhesives). Use your class notes about the elements of the materials cost estimation. Use any material specifications data sheets available to enhance the accuracy of your cost estimates.
2. To create your cost estimation, you have two choices:
   a. Set up a spreadsheet with the cost estimation categories.
   b. Use your lab sheet and a separate piece of paper for the calculations.
3. Which estimation method would be the most appropriate for this project: area, accommodation unit, or elemental? _____

4. Take measurements of your classroom, including the windows, doors, heating elements, storage areas, etc. Place those measurements in Column 2.
5. Create a spreadsheet similar to the table shown below. (Optional)
6. Then calculate an estimated amount of material or the total square footage for each product/material listed on the cost estimate form below (or spreadsheet). Record the amount required in Column 2. Write in "NA" (not applicable) when a category does not apply or a material is not used in your classroom. Make notes in Column 1 to indicate the materials you are estimating.
7. Next, find the per-unit cost of each product in each category. Record this in Column 3. Use the Internet and a search engine to find the per-unit cost by typing in the name of the product plus the word "cost" for items such as windows and doors. For materials, type in the name of the material and the phrase "cost per square foot." You should be able to find estimates for all the materials and products used in your classroom.
8. Finally, multiply each per-unit cost by the total amount required (or square feet), and record those amounts in Column 4. Tally the Total Cost Estimate column, and record it in the last line of the estimate.
9. Participate in a discussion of material cost estimation.
10. Turn in your completed lab sheet to your instructor.

Category	Amount Required [Record Measurements Here]	Per Unit Cost	Total Cost Estimate
General site conditions			
Site work			
Concrete			
Masonry			
Metals			
Woods & plastics			
Thermal & moisture protection			
Doors & windows			
Finish materials			
Specialties			
Equipment			
Furnishings			
Special construction			
Mechanical-plumbing			
Electrical			
TOTALS			