ARE 431 BUILDING ECONOMY-I

ARE 431Building Economy
Building Estimating part

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Pre-Construction Estimates

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Introduction to Pre-Construction Estimates. 1/3

Pre-construction estimates are prepared during the pre-construction stage of a project.

These estimates would be prepared by the owner, designer, and/or construction manager depending on the delivery method that has been chosen.

In the previous chapter, an overview of the estimates was presented, in this subject it will show the steps involved in the preparation of each of them.

There are several factors to consider when preparing an estimate:

- the size of the project,
- the quality of materials and methods used,
- the project location,
- the time of the year, and
- the market conditions.

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Introduction to Pre-Construction Estimates. 2/3

As the project proceeds, more information becomes available about all these factors.

As a consequence, the time required to prepare the estimate increases, but the accuracy of the estimate also increases.

All pre-construction estimates start with a database of past projects.

Companies that are large or have been in existence for several years normally develop a history of project costs, which is used for the estimate of future projects.

Companies that are new, too small, or looking to enter a new market may have to purchase this data from companies that specialize in the research and sale of project costs.

Introduction to Pre-Construction Estimates. 3/3

In working with historical data, it is important to understand what costs are included and not included in each item.

- **Are costs separated by project type?**
- **Is overhead and profit included or broken out?**
- **What type of foundations were used?**
- **What was the quality level of the project?**
- **Where was its location?**

All of these questions and more must be considered as the estimate is prepared.

Types of Pre Construction Estimates

There are three types of pre-construction estimates:

- **Conceptual estimate.**
- **Square foot estimate.**
- **Assemblies estimate.**

In each method, an explanation of

- **Approach**
- **Data**
- **Adjustments**
- **presentation**

Will be done.

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Conceptual Estimate – Approach 1/2

Conceptual estimate, also called rough order of magnitude (ROM) estimates, are typically developed by establishing a cost per usable unit from past projects and multiplying this cost times the number of units being proposed.

Example of these costs might be:

- Cost per bed for a hospital.
- Cost per apartment.
- Cost per student for a school.
- Cost per mile for a highway.

If the costs are developed on a national average basis, they must be adjusted using the appropriate cost index.

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Conceptual Estimate – Approach 2/2

Cost taken from past projects must also be adjusted to current future dollars.

If the proposed project will be smaller or larger than normal, the cost can also be adjusted for size.

An appropriate contingency should be applied to allow for scope adjustments as well as economic or market conditions.

Conceptual estimates can be done quickly, in 10-15 minutes, and provide an accuracy in the plus or minus 20% range.

Conceptual Estimate – Data 1/3

The accuracy of a conceptual estimate is dependent on the quality of the data that the estimator has available.

The best scenario would be to look into the company data and find the exact project size, quality, and location, then adjust for inflation and market conditions, and the estimate is done.

Unfortunately, most projects vary enough that it is difficult to compare one with another.

Companies that specialize in certain areas of work often do have reasonably good data on that type of project, but companies that do a lot of different kinds of work must rely on published data.

Example: figure 5-1.

Conceptual Estimate – Data 2/3

These data are based on an average of over 11, 500 projects as reported to Means from contractors, designers, and owners.

These costs are all adjusted to the current year and averaged.

To adjust for quality, the unit costs are divided into three columns, ¼, median, and ¾. This allows the estimator to adjust for quality quickly.

The median cost value represents the cost of average quality projects.

The ¾ cost value represents the cost of higher quality projects.

The ¼ cost value represent the cost of lower quality projects.

Conceptual Estimate – Data 3/3

After selecting the appropriate project type and quality value, the next step is to multiply the cost times the appropriate number of units.

Let us take the example of a 50-unit motel; assume a high quality (3/4) price, 1995 data:

Total cost = Number of units x unit cost
Total cost = 50 units x 40,700 per unit
Total cost = $2,035,000

This total cost reflects the cost of building a typical, high quality motel in a national average location.

It includes contractor's overhead and profit and, assuming this project is of normal size, should represent the average of the bids received in that year under normal market conditions.

Conceptual Estimate – Adjustments 1/10

There are a number of adjustments that may have to be made. These include adjusting for:

<u>1-Size</u>

As the project increases or decreases from what the data is showing as average, the cost per unit increases or decreases.

In general, larger projects can be built more efficiently than smaller projects because materials can be bought in larger quantities and productivity generally increases as workers "learn" the job.

Referring to figure 5-2, the typical high quality (3/4) motel unit would be 620 square feet. Therefore:

Motel's size = 620 sq. ft. x 50 unit = 31,000 sq. ft.

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Conceptual Estimate – Adjustments 2/10

Figure 5-3 Project size modifier table.

In the project size modifier table (figure 5-3), the typical motel equals 27,000 sq. ft. Therefore the cost multiplier for the size adjustment can be calculated as follows:

Size factor = Proposed building area/Typical building area
Size factor = 31,000/27,000 = 1.148

Using a size factor of 1.148 (round off to 1.1), read from the graph on figure 5-3 a cost multiplier of 0.99.

Therefore for the motel project, the price adjusted to size equals:

Size adjusted cost = Base cost x Cost multiplier
Size adjusted cost = $2,035,000 x 0.99 = $2,014, 650

This price reflects the cost of a high quality motel, adjusted to a slightly lower unit price since the motel is slightly larger than normal.

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Conceptual Estimate – Adjustments 3/10

Another adjustment that may have to be made is for:

2- Quality (Already adjusted by using Fig. 5.1)

3- location.

Adjustments can be made for location by comparing the price of common building materials and labor from one city to another.

Figure 5-4 shows tables for a few of the over 200 cities throughout the US and Canada for which Means has complied the cost of construction.

Indices have been established for material, installation and total cost, broken down by building system.

This allows the estimator to analyze specific project elements, such as a subcontractor package, as well as look at material purchasing costs and the cost of labor relative to a particular location.

Conceptual Estimate – Adjustments 4/10

In this table the national average city would have a total index equal to 100.

A material index of 111.2, indicates that the cost of material is 11.2% above the national average.

Many projects are built in areas without a readily available city cost index. In that situation the estimator must analyze the project and create the proper adjustment.

Companies that do a lot of work in the same location usually develop their own location index.

Conceptual Estimate – Adjustments 5/10

To adjust the model to three cities: New York, Columbia, Spokane, a ratio could be set us as follows:

Estimated cost/100 = Adjusted cost for city/City index

New York City:

2,014,650/100 = Adjusted New York Cost/133.8
New York Cost = $2,695,601

Columbia:

2,014,650/100 = Adjusted Columbia Cost/77.9
Columbia Cost = $1,569,412

Spokane:

2,014,650 = Adjusted Spokane Cost/99.9
Spokane Cost = $2,012,635

Conceptual Estimate – Adjustments 6/10

This example illustrates the importance of location to the cost of construction. As can be seen, the cost of constructing the motel in New York is more than $1 million over the estimated cost in Columbia.

The last adjustment that will be made for this estimate is for time.

4-Time

This estimate was prepared using 1995 data (early 1995).

A project set to begin in early 1997 would have to be adjusted for expected increases in labor and material.

Conceptual Estimate – Adjustments 7/10

Indices for past projects can be adjusted to the present by comparing actual past project costs to the index of the year as compared to the index of today.

Two indices could be used (1) Means or (2) Engineering News-Record (ENR)

(1) Means

Assuming a 1980 project cost of $2 million, calculation of the same project cost in 1995 would be figured as follows:

$$\frac{\text{Past project cost}}{\text{Index past year}} = \frac{\text{Current project cost}}{\text{Index 1995}}$$

Fig. 4-5

2,000,000/59.5 = Current project cost/100

Current project cost = $3,361,344

Conceptual Estimate – Adjustments 8/10

(2) ENR

Another source of cost index information is *Engineering News Record (ENR)* which publishes on a weekly basis cost indices dating back to 1913 (the year which has been set as the base year).

Indices are published for:

- **Construction cost.**
- **Building cost.**
- **Common labor.**
- **Skilled labor.**
- **Materials.**

ENR indices can be used just as the Means indices to adjust a project for time.

Conceptual Estimate – Adjustments 9/10

Example:

To construct a roadway in August 1994 that cost $5 million in August 1981, the adjustment would be figured as follows:

From figure 5-5:

Construction Cost Index (ENR) Aug. 1981 = 3,575.

From figure 5-6:

Construction Cost Index (ENR) Aug. 1994 = 5,433.

$$\frac{\text{Past project cost}}{\text{Index past year}} = \frac{\text{Current project cost}}{\text{Index 1995}}$$

5,000,000/3,575 = Construction cost 1994/5,433

Construction cost 1994 = $7,598, 601

Means base line 1975 = 100

ENR base line 1913 = 100 ,thus the two tables can not be mixed and one must be used.

Conceptual Estimate – Adjustments 10/10

- The difficulty often faced in conducting estimates is that indices are not available for future years, so past and current trends must be looked at and projected to the future.
- Means often suggest in the historical index table an escalation rate for future years
- So for our example of the motel- see Fig. 4 5
- If the motel will be constructed in New York city starting in 1997
- Assuming an increase of 2.5% per year –As shown in Fig. 4 5
- Thus, the 1995 New York price of $ 2,695,601 would increase 5% to 2,830,381 ,thus this price reflects a 50 units ,high quality motel built in New York with major construction occurring in 1997.
- (This price is based on Means 1995 data)

Conceptual Estimate – Presentation 1/1

- In presenting any estimate, it is important to consider the purpose of the estimate as well as understand what is included and not included in the price.
- It is also important to understand all of the underlying assumptions and the accuracy of the data.
- Conceptual estimates are the first costs that are presented to the owner.
- It is important to identify information that has to be adjusted for.
- In the motel example, the cost of land and design fees have not been included in the price and would have to be added.
- The estimate did not consider any an unusual design features, special code requirements and a highly level of site work.

Square Foot Estimate – Approach 1/5

The method of assembling a square foot estimate is similar to that used for a conceptual estimate except more information is required and costs are tabulated per square foot, not by service unit.

The estimate is still used primarily by the owner for budgeting purposes and still conducted during the conceptual stage of the project.

Cost data can be taken from outside data sources or can be developed by the designer, owner, or construction company.

Adjustments are made the same as in the rough order of magnitude (ROM) estimate.

These estimates take slightly longer than ROM estimate and should provide an accuracy in the plus or minus 15% range.

Square Foot Estimate – Data 1/5

Companies that have information for ROM estimates should also have the data needed for square foot estimates.

If information is not available in-house, Means has two square foot data books, each published utilizing different source material.

(1) The Assemblies Cost Data book. (Figure 5-7)

Bases its costs on actual completed projects as reported by owners, designers, and contractors.

This is the same source of information used in the conceptual estimate, only broken down on a square foot basis.

It uses the same ¼, median, and ¾ quality distinction and it is based on 11,500 projects.

Square Foot Estimate – Data 1/5

Advantages of the Assemblies Cost Data book:

The reported costs are derived from actual projects that have built around the country.

The costs have been localized to the national average.

These are true costs reflecting actual contractor costs including overhead and profit.

Disadvantages of the Assemblies Cost Data book:

Specific project conditions are not known, thereby making it difficult to know exactly what the square foot cost includes.

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Square Foot Estimate – Data 1/5

(2) The Square Foot Data book. (Figures 5-8, 5-9)

Based on stereotypical models that have been created for different project types. This allows Means to determine the quantities of materials and labor required to build each project at the sizes tabulated. With the quantities held constant, each year the unit prices are adjusted to reflect current costs for labor and materials

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Square Foot Estimate – Data 1/5

Advantages of the Square Foot Data book:

The modeled data is more specific

It identifies the costs associated with different combinations of structural and exterior closures.

It allows specific pricing for common project additives such as basements, and adjustment for story height and building perimeter.

The perimeter adjustment factor allows the estimator to properly figure the added cost associated with unusually shaped buildings.

This data book also provides a detailed breakout of the model for the project. The detail breakout allows the estimator to make small adjustments for items in the model by deleting or adding line items as necessary.

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Square Foot Estimate – Data 1/5

Using the Reported Square Foot Data

What is the cost of a 15,000 sq. ft. library? Assume median quality and 1995 data.

Using Figure 5-7

Total cost = size in sq. ft. x cost per sq. ft.

Total cost = 15,000 sq. ft. x $87.7/sq. ft.

Total cost = $1,315,500

Square Foot Estimate – Data 1/5

Using the Modeled Square Foot Data

What is the estimated cost of a 15,000 sq. ft. library? Assume face brick with concrete block back-up and a reinforced concrete frame, using 1995 data.

Using Figure 5-8

Total cost = size in sq. ft. x cost per sq. ft.

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Square Foot Estimate – Data 1/5

Using the Modeled Square Foot Data

Determining the cost per sq. ft of the library, the table shows the following estimates for given sizes:

13,000 sq. ft. = $89.00
16,000 sq. ft. = $87.00

For a 15,000 sq. ft. building, interpolate to a cost of 87.67 per sq. ft.

Total cost = 15,000 sq. ft. x $87.67 = $1,315,050

Both approaches have provided us with a square foot price that at this point is unadjusted and therefore is good for the national average city in the data year.

Square Foot Estimate – Adjustment 1/5

Reported Square Foot Prices

To make adjustments to the reported square foot prices, the same method is used as in a ROM estimate.

Example:

To design and build a median quality, 15,000 sq. ft. library in Orlando, Florida, with construction to begin in May 1995.

Previously the cost for a median quality library at 1995 prices was determined to be $1,315,500.

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Square Foot Estimate – Adjustment 1/5

Reported Square Foot Prices

To make adjustment for size (see Figure 5-3).

Size factor = 15,000/12,000 = 1.25

Cost modifier = 0.98

Library adjusted for size = $1,315,500 x 0.98 = $1,289,190

To adjust for location:

Orlando index = 88.6

Estimated cost/100 = Adjusted cost for city/City index

Orlando cost = ($1,289, 190 x 88.6)/100 = $1,142,222

Square Foot Estimate – Adjustment 1/5

Reported Square Foot Prices

To adjust for time:

Assume a June 1995 construction start and a projected increase of 2.5% per year, thus add 1.25% to the above (early 1995) price.

Total project cost = $1,142,222 + ($1,142,222 x 0.0125)
Total project cost = $1,142,222 + $14,278
Total project cost = $1,156,500

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Square Foot Estimate – Adjustment 1/5

Reported Square Foot Prices

Design fee adjustment (See Figure 5-10)

A further adjustment would add in the design fee. That reference table shows that a library is in the same category as an apartment building. Therefore, read 7.3%, as this building's cost is close to $1,000,000.

Total project cost = $1,156,500 + ($1,156,500 x 0.073)
Total project cost = $1,156,500 + $84,424
Total project cost = $1,240,924

This represent a median quality 15,000 sq. ft. library in Orlando. Construction would begin in mid 1995, and the cost includes a 7.3% fee for design services.

Square Foot Estimate – Adjustment 1/5

Modeled Square Foot Prices

Adjustment is somewhat different from the Reported Square Foot approach, because data from Means' Modeled Square Foot references does not include some common features that would be in a typical library.

These typical add-on features that have to be added in include:

- **Study carrels.**
- **Emergency lights.**
- **Furnishings (bookshelves, reading tables).**

Site work is not included but the architect's fee is.

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Square Foot Estimate – Adjustment 1/5

Modeled Square Foot Prices

The price determined previously, building with face brick with concrete block backup with a reinforced concrete frame, using 1995 data, was $1,315,050. Accounting for these project additives (See Figure 5-8).

(5) emergency lights @ 610 each = $3,050

(20) Study carrels @700 each = $14,000

(1) flagpole = $3,125

Bookshelves

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Assemblies Estimating - Approach

Assemblies estimating – also called systems estimating – is best accomplished concurrently with the design phase of a project.

This estimate is prepared by working with the system or assembly unit of a project.

In a ROM estimate a gross unit is established, for example the number of hospital beds required. In square foot estimating the estimator works with the project area.

In assemblies estimating the estimator will use more detailed units such as square feet of partition wall, numbers of plumbing fixtures, or square feet of carpet.

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Assemblies Estimating - Approach

Since the units are smaller, the estimate becomes more flexible and accurate, but it requires greater designer input and therefore takes longer to prepare.

The first system estimates will be accomplished during the schematic design stage and will generally take a day or longer, providing an accuracy in the plus or minus 10% range.

In an assemblies estimate quality is now treated by the specific material or design method chosen, and no longer by using ranges as ¼ or ¾ .

Provided good data is available, the designer should be able to look at the costs of different alternatives and make a selection based on cost as well as durability and owner value.

Example:

Consider the decision as to what type of floor covering to use in an office building:

Floor area = 10,000 sq. ft.

The three best alternatives seem to be:

Total

Woven wool carpet (42 oz) with padding = $6.68/sq. ft. $66,680

Nylon carpet (26 oz) = $3.06/sq. ft. $30,600

Resilient asphalt tile = $1.57/sq. ft. $15,700

As can be seen, the project cost savings of choosing resilient flooring over the high quality carpet is over $50,000. However, initial cost is only one factor to consider.

There are also ongoing maintenance issues to look at, along with aesthetics, acoustic and intended usage.

The systems estimate also provides a yardstick for the comparison of the costs of different subsystems within a project.

Example:

A commercial building project is estimated by following what is called the uniformat breakdown (see Figure 5-11).

By comparing the twelve divisional calculated costs with the average for past projects, the estimator can verify the estimate's accuracy both overall and by division, as well as get a since of the scope of the project.

If a division (as a percent of the project total) is much higher than normal, the estimator should investigate why.

Assemblies Estimating - Approach

Table 5-12 provides a typical twelve-division breakdown for a general commercial building.

Many projects are large and are designed by large design teams. The process of using the systems estimate to check and verify the design to date should serve to keep the project balanced and within budget and responsive to the owner's needs.

Assemblies Estimating - Data

The information needed for a systems estimate must be available in a form that can be quickly itemized on a system by system basis.

Example:

The interior partition which will estimated per square foot, must include:

- **The cost of the metal studs.**
- **Drywall installation.**
- **Taping and finishing.**

It would be useful to have in the company data base partition options including:

- **Different fire ratings.**
- **Insulated vs. noninsulated partitions.**
- **Partitions finished both sides vs. only one side.**

Assemblies Estimating - Data

Estimating software packages (Timberline, for example) allow the estimator to create different assemblies.

The R. S. Means Company publishes an Assemblies Data book on an annual basis (See Figure 5-13 as an example).

The book is organized in accordance with the twelve uniformat divisions.

Referencing Figures 5-13 and 5-14, notice the information illustrated for an interior drywall partition system.

Assemblies Estimating - Data

The estimator must:

- Identify the partition system that will be used.
- Determine the number of square feet of partition that will be needed.

The estimator in conjunction with the designer must decide between:

- Wood vs. metal studs.
- Fire resistant vs. water resistant drywall on the face of the layer.
- Base layer dry wall type.
- Stud spacing.
- Whether or not insulation will be used.

Assemblies Estimating - Data

The corresponding cost for installation and material for each option can be read to the right.

These costs are the installation costs including overhead and profit for the installing contractor.

Example:

Assume that the drywall specified in line #6.1-510-1450 from the table in Figure 5-13 was selected for use in a 10,000 sq.ft. office area. At this point :

If drawings are available, the estimator can measure the partition square footage (linear foot x height).

By using an approximation or estimating aid such as Figure 5-15, arrive at the quantity of dry wall necessary for the project.

Assemblies Estimating - Data

Example:

Assuming a two-story 10,000 square building, and using the numbers from Figure 5-15:

10,000 sq. ft. / 20 sq. ft. per lf = 500 lf of partition
70% drywall = 350 lf
30% block = 150 lf

Assume a 12` height:

Sq.ft. drywall = 350 lf x 12` = 4,200 sq.ft.
Sq.ft block = 150 lf x 12` = 1,800 sq.ft.

Total drywall cost = Quantity drywall in sq.ft. x Cost per sq.ft.
Total drywall cost = 4,200 sq.ft. x $4.14 per sq.ft. =

Assemblies Estimating - Data

Existing drawings and/or estimating tools would be used to determine the quantities for all the project components.

Assembly cost data would taken from company historical records, from data books such as Means, from suppliers and vendors, or would be created by the estimator by the use of unit prices.

Once all of the quantities and system unit prices are determined, the total assembly estimate can be produced.

Assemblies Estimating – Compilation and Adjustment

Each of the major elements of the project would be quantified and priced by its major assemblies as the interior partition example.

For a commercial building project, the assemblies would be summarized as shown in Figure 5-16.

Div 1	*Foundation*	*Foundations and excavation*
Div 2	*Substructure*	*Slab on grade*
Div 3	*Superstructure*	*Floor and roof structures and superstructures*
Div 4	*Exterior Closure*	*Building envelope – windows, doors and walls*
Div 5	*Roofing*	*Roofing – membrane, insulation, and flashing*
Div 6	*Interior Construction*	*Partitions, interior doors, finish floors, and ceilings*
Div 7	*Conveying*	*Elevators, escalators, and dumbwaiters*
Div 8	*Mechanical*	*Plumbing, heating and cooling, and fire protection*
Div 9	*Electrical*	*Service, power and lighting*
Div 10	*General Conditions*	*General Conditions*
Div 11	*Specialties*	*Architectural equipments and furnishings*
Div 12	*Site Work*	*Excavation, roadways and parking, and landscaping*

Assemblies Estimating – Compilation and Adjustment

For projects other than commercial buildings the divisions would be organized differently, in accordance to the method in which the project is structured.

A highway project for example, might be organized along major elements such as:

- Clearing and grading
- Paving
- Drainage

As shown on the worksheet in Figure 5-16, the project should be adjusted for location as well as time.

If the estimate needs to reflect total project cost to the owner, the designer's fee needs to be added in as well.

Project contingency would be added in at the end to allow some room for adjustment in owner scope.

Assemblies Estimating - Presentation

An assemblies estimate might be done several times throughout the course of the design and should be an integral part of the design process.

A formal review of the estimate should occur at:

- The end of schematic design and
- The end of the design development phase.

It is important in the estimate presentation to highlight the design elements that are generating the greatest project cost, particularly work items that have some degree of flexibility as to owner choice.

Identifying these elements early provides the opportunity for cost savings or an early adjustments in the project's focus that may end up providing the owner greater value at less cost.

Required code items would have little flexibility.

The key, is to get an accurate, early budget for the project, verifying that the design is within or that it exceeds the owner's budget.

If the design exceeds the owner's budget:

- **Design alternatives may be investigated.**
- **The scope of the project may be reduced.**
- **Additional funding may be pursued.**

The earlier and more accurate the estimate, the greater the opportunity for such decisions to be made.