Estimating Construction Cost

- Construction Estimation
  - Compilation and analysis of items that contribute to the cost of the project.
  - Requires detailed study of bidding documents.
- Construction estimating is a crude process
  - Lots of variables
  - Personal factors.

Pre-Design or Conceptual Estimate

- Can be Based Upon:
  - SF of Building
  - CF of Building or Facility
  - Number of Units
  - Desks, beds, rooms, work-stations, production units, seats, Number of Widgets, etc.
  - Carries ±20% margin of error with regard to the actual project cost.

Pre-Design or Conceptual Estimate

- Parameter or Parametric estimating – an estimate involving unit costs, called parameter costs, for each of several different building components or systems.
- Take into account
  - Type of construction
  - Type of materials to be used
  - Quality of construction desired
  - Project location, etc.
- Must be realistic
- Must always have a reality check!

Learning Objectives

- The student should be able to:
  - Explain Parametric Estimating.
  - Define the elements of Cost, Direct and Indirect, and explain their significance.
  - Describe the generalized steps for developing a Detailed Estimate.
  - Define “Unbalanced Bidding” and explain how it may help, and hurt.
  - Define “Owning & Operating Costs”.
  - Explain “Bid Ethics” and “Bid Rigging”.

Cost Estimating & Bidding

- Must be realistic
- Take into account

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Cost Estimating & Bidding

- Must be realistic
- Take into account
Other Types of Conceptual Estimates

- Time Referenced Cost Estimates:
  \[ C_2 = \frac{\text{Index}_2}{\text{Index}_1} \times C_1 \]

- Cost-Capacity Factors:
  \[ C_2 = \frac{Q_2}{Q_1} \times C_1 \]

- Component Ratios:
  Total Facility Cost = Equipment Cost x Factor

Construction Cost Indices

- Trend of price changes associated with construction costs
- ENR Building Cost Index (BCI)
  “66.38 hours of skilled labor at the 20-city average of bricklayers, carpenters and structural ironworkers rates, plus 25 cwt of standard structural steel shapes at the mill price prior to 1996 and the fabricated 20-city price from 1996, plus 1.128 tons of portland cement at the 20-city price, plus 1,088 board-ft of 2 x 4 lumber at the 20-city price.”

Construction Cost Indices

- ENR Construction Cost Index (CCI)
  “200 hours of common labor at the 20-city average of common labor rates, plus 25 cwt of standard structural steel shapes at the mill price prior to 1996 and the fabricated 20-city price from 1996, plus 1.128 tons of portland cement at the 20-city price, plus 1,088 board-ft of 2 x 4 lumber at the 20-city price.”
1. Review the Scope of the Work of the Project
2. Determine the Quantities of each type of Work by doing a Material Quantity Takeoff
3. Obtain price quotation from suppliers
4. Determine your cost for Materials from your Vendors, extend to find Material Cost
5. Determine your cost for Labor from your Direct Labor Rates, extend to find Labor Cost
Detailed Estimate for an Activity – Jobsite Visit

- Information needed on:
  - Subsurface soil, rock, and water conditions
  - Underground obstructions and services
  - Transportation and freight facilities
  - Conditions affecting the hiring, housing, and feeding of workers
  - Material prices and delivery information from local material dealers
  - Rental of construction equipment
  - Local subcontractors
  - Wrecking and site cleaning
  - Environmental concerns

Endangered Plant and Animal Species in Kentucky

- Gray bat, Indiana bat, Virginia big-eared bat, Catspaw, Clubshell, Combshell, Blackside dace, Reclit darter, Bald Eagle, Cumberland eel, Fanshell, Winged mapleleaf (mussel) Pink mucket (pearlymussel), Rough pigtoe, Orangefoot pimpleback (pearlymussel), Piping plover, Puma, Northern raffleshe, Kentucky cave shrimp, Pallid sturgeon, White wartyback, Red-cookaded woodpecker, Price's Potatose-bean, Braun's Rock-cress, Cumberland sandwort, Cumberland rosemary, Eggert's sunflower, White-haired goldenrod, Virginia spiraea, Running buffalo clover....

Detailed Estimate for an Activity

1. Material Quantity Takeoff
   - Calculation of exact quantities of the components by each activity.
   - From plans and specifications, e.g., 1500 CY
   - Take into account waste.
   - Check all estimates of subcontractors or vendors (rebar, structural steel, etc.)

2. Select Method of Construction
   - Based on experience – e.g., "Place Materials from stockpile using 5T hydraulic crane and (3) laborers"

Detailed Estimate for an Activity

3. Estimate Labor & Equipment (Crew) Production Rates
   - Crew Hours/Unit required to install each component.
   - e.g., 0.25 crew hrs/ CY for
     - (3) laborers,
     - (1) operator,
     - (1) crane

Detailed Estimate for an Activity

4. Costing (Pricing)
   - Cost per unit of material (delivered to site, no taxes)
     - e.g., $ 32/CY
   - Cost per unit for labor and equipment
     - 3 laborer @ $15/hr = $45/hr
     - 1 operator @ $18/hr = $18/hr
     - Labor = $63/crew hr
   - Crane rental
     - $200/day (8 hrs/day) = $25/hr
     - Operating Costs = $3/hr
     - Equipment = $28/crew hr

Detailed Estimate for an Activity

4. Costing (pricing) cont’d.
   - Extend the units to get unit costs
     - Labor: (0.25 hr/cy)($63/hr) = $15.75/cy
     - Equipment: (0.25 hr/cy)($28/hr) = $7.00/cy

Species in Kentucky

- Endangered Plant and Animal Species
  - Combshell, Blackside dace, Reclit darter, Bald Eagle, Cumberland eel, Fanshell, Winged mapleleaf (mussel) Pink mucket (pearlymussel), Rough pigtoe, Orangefoot pimpleback (pearlymussel), Piping plover, Puma, Northern raffleshe, Kentucky cave shrimp, Pallid sturgeon, White wartyback, Red-cookaded woodpecker, Price’s Potatose-bean, Braun’s Rock-cress, Cumberland sandwort, Cumberland rosemary, Eggert’s sunflower, White-haired goldenrod, Virginia spiraea, Running buffalo clover....
Detailed Estimate for an Activity

Extensions – to get Total Direct Cost
- Multiply quantities of each of the components by the material, labor and equipment unit costs.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Material Unit CY</th>
<th>Material Total $/CY</th>
<th>Labor Unit CY</th>
<th>Labor Total $/CY</th>
<th>Equipment Unit CY</th>
<th>Equipment Total $/CY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,500</td>
<td>32.00</td>
<td>48,000</td>
<td>15.75</td>
<td>23,625</td>
<td>7.00</td>
<td>10,500</td>
</tr>
</tbody>
</table>

Summary Sheets

Lump-Sum Bid:
- Quantity survey totals & their units.
- Material unit prices & extensions
- Labor unit prices & extensions
- For lump-sum bids equipment costs for entire project are computed separately.

Unit Price Bid:
- One summary sheet per pay item.
- Each summary sheet includes several different work categories.
- Includes columns for material, labor, equipment, and subcontracts.

Classification is based on the company’s standard cost account number system or CSI Masterformat.

Summary Sheets are fed into the Recap Sheets.
Recap Sheets ~ Purpose

- To summarize the entire project on a single sheet.
- To find the total cost by simple addition of component costs.
- To apply project markup:
  - G&A Overhead
  - Bonds, Insurance, & Taxes
  - Contingency & Profit
- To allow for easy adjustments.

Recap Sheets ~ Lump Sum

<table>
<thead>
<tr>
<th>Item</th>
<th>Material</th>
<th>Labor</th>
<th>Subcontract</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 General</td>
<td>$565,320</td>
<td></td>
<td></td>
<td>$565,320</td>
</tr>
<tr>
<td>02 Sitework</td>
<td>15,072</td>
<td>15,072</td>
<td></td>
<td>30,144</td>
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<tr>
<td>03 Concrete</td>
<td>97,178</td>
<td>104,092</td>
<td>0.00</td>
<td>201,267</td>
</tr>
<tr>
<td>04 Masonry</td>
<td>212,724</td>
<td>0.00</td>
<td>0.00</td>
<td>212,724</td>
</tr>
<tr>
<td>05 Metals &amp; Rails</td>
<td>36,753</td>
<td>19,482</td>
<td>0.00</td>
<td>56,235</td>
</tr>
<tr>
<td>06 Doors &amp; Windows</td>
<td>36,827</td>
<td>0.00</td>
<td>0.00</td>
<td>36,827</td>
</tr>
<tr>
<td>07 Specialties</td>
<td>15,748</td>
<td>0.00</td>
<td>0.00</td>
<td>15,748</td>
</tr>
<tr>
<td>08 Doors &amp; Windows</td>
<td>15,748</td>
<td>0.00</td>
<td>0.00</td>
<td>15,748</td>
</tr>
<tr>
<td>09 Finishes</td>
<td>15,748</td>
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<td>0.00</td>
<td>15,748</td>
</tr>
<tr>
<td>10 Equipment</td>
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<tr>
<td>12 Heating</td>
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<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>13 Cooling</td>
<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
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<tr>
<td>14 Ventilation</td>
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<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>15 Electrical</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>16 Miscellaneous</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total Direct Cost</strong></td>
<td><strong>$605,311</strong></td>
<td><strong>$605,311</strong></td>
<td><strong>$605,311</strong></td>
<td><strong>$605,311</strong></td>
</tr>
<tr>
<td><strong>Material Tax</strong></td>
<td>30,265.70</td>
<td></td>
<td></td>
<td>30,265.70</td>
</tr>
<tr>
<td><strong>Laser Tax</strong></td>
<td>73,612.50</td>
<td></td>
<td></td>
<td>73,612.50</td>
</tr>
<tr>
<td><strong>Contingency</strong></td>
<td>0.00</td>
<td></td>
<td></td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Bonds &amp; Insurance</strong></td>
<td><strong>0.00</strong></td>
<td></td>
<td></td>
<td><strong>0.00</strong></td>
</tr>
<tr>
<td><strong>Profit</strong></td>
<td>278,413.38</td>
<td></td>
<td></td>
<td>278,413.38</td>
</tr>
<tr>
<td><strong>Total Bid Cost</strong></td>
<td><strong>1,261,804.99</strong></td>
<td><strong>1,261,804.99</strong></td>
<td><strong>1,261,804.99</strong></td>
<td><strong>1,261,804.99</strong></td>
</tr>
</tbody>
</table>

Recap Sheet ~ Unit Price

- Purpose and general layout are similar to Lump-Sum Recap Sheet ~ eg. Fig. 5.9, p. 114
- Differences:
  - List only the pay-items (bid items)
  - Quantities listed are Engineer’s estimates
  - Not actually used by the contractor (Unbalanced Bidding)

Recap Sheet ~ Unit Price

- Contains two additional columns, Bid Unit Price & Bid Total Price.
- Factors are used to increase the “Total Direct Costs” to include O/H & MarkUp to give the “Bid Total Price” for each pay item.
- Unit Price(Bid) = Total Price(Bid)/Quantity
- O/H & MarkUp are not separate items but are included in the Total Bid Cost of the pay items.
### Unbalanced Bidding

- **Unbalanced Bidding applies to unit bidding.**
- **Front-End Loading:**
  - Raises prices for pay items which occur early on in the project, and reduces prices for pay items that occur later on in the project.
  - Owner may accept front-end loading, if he/she feels it covers interest on money and legitimately includes the setup costs.
  - Unbalanced Bidding can take advantage of expected mistakes in A/E’s estimate.

### Disadvantages of Unbalanced Bidding

- If changes are made, they can have quite an unrealistic impact on the pricing situation – the contractor can gain or lose a lot.
- Unrealistic Unit Prices can adversely affect the owner’s or A/E’s decisions.
  - Quantities at higher price may be drastically reduced and those at lower price may be conversely increased.
  - A bid may even be rejected if thought to be unfair or irresponsible.

### Direct/Indirect Costs

- **Direct Costs**
  - Costs that can be assigned directly to the work items.
  - Cause (work item) and Effect (direct cost) relationship.
  - The work item is incorporated into the finished product.

- **Indirect Costs**
  - Costs that can be assigned indirectly to the work items.
  - If the work item is deleted, indirect cost remains (still have to pay insurance, taxes, etc).

### Examples of Direct Costs

- Direct cost of the contractor’s own forces
  - Cost of labor placing reinforcing steel
  - Cost of placing concrete for slabs
  - Cost of installing doors, etc.

- **Subcontract costs**
  - Tile Installation Subcontract
  - Painting Subcontract
  - Elevators Installation Subcontract
  - Etc.
Examples of Indirect Costs

- Project Overhead (O/H)
  - Costs directly assignable to project but indirectly assignable to individual work items,
  - field supervision,
  - services,
  - office trailers,
  - field fabrication shops,
  - job site elevators,
  - job site crane,
  - etc.

- Indirect Costs
- Direct Costs - Basic wages

- Project Overhead (O/H)
  - Social Security, Unemployment Insurance & Workman’s Compensation Insurance
  - Fringes (Voluntary)
    - Health and Welfare Funds
    - Employee Insurance
    - Paid Vacations
    - Pension Plans
    - Apprenticeship Programs

Material Costs

- Material unit prices are needed for the estimate.
- Costs used in estimates include delivery to site, but they do not usually include taxes.
- This allows for comparison of prices from different locations or times.
- Contractor may:
  - Produce his own materials. e.g., aggregate for highway project, concrete for building, etc.
  - Use his own estimate for the cost of material.
  - Purchase material from the manufacturer, a representative, a vendor, a supplier, etc.

Labor Costs Divided Into Direct and Indirect Costs

- Direct Costs - Basic wages
- Indirect Costs
  - Payroll Taxes and Insurance (Required)
    - Social Security, Unemployment Insurance & Workman’s Compensation Insurance
  - Fringes (Voluntary)
    - Health and Welfare Funds
    - Employee Insurance
    - Paid Vacations
    - Pension Plans
    - Apprenticeship Programs

Equipment Cost Estimating

- Equipment used for construction vs. the Permanent Equipment incorporated into the Construction.
- Accuracy of cost estimates depend on importance of equipment
  - Major equipment - Detailed cost analysis
    - concrete plant, draglines, earthmoving machines
  - Minor equipment
    - pumps, concrete vibrators, power buggies
  - Very minor equipment
    - hand tools, power tools, wheel barrows, water hose, & extension cords

Major Equipment Costs

- Depreciation
- Interest Costs
- Insurance
- Operating Costs
  - Fuel
  - Lubricants, Grease, Filters
  - Tires
  - Repairs
  - Special Items
  - Operator’s Wages

Equipment Production Rates

- Very uncertain (traditionally).
- Depends on
  - weather, ground conditions, haul distances, slopes, rolling resistance, etc.
- Consult records, operators, handbooks, time & motion studies.
- Use average values, not spot values.
Engineering

**Equipment Expense**

- Need Hourly Equipment Costs and Production Rates
- Different cost rates used for different purposes
  - Hourly Costs = Ownership, or rental/lease costs, + Operating Costs
  - Cost/Unit of product produced
    - concrete or asphalt mixing plants, aggregate plants, etc.
- Equipment without production rates
  - prefabricated forms, air compressors, welding machines, cranes, scaffolds, etc.
- Mobilization and Demobilization Costs
  - Included in project overhead

**Allowances**

- A/E or owner designates a fixed amount to be included in contractor's bid to cover the cost of certain materials that has yet to be specified.
- Actual selection will occur as needed during the construction.
- Typical uses:
  - hardware, carpet, landscaping, cabinets, light fixtures, appliances, bathroom fixtures, tile, etc.

**Allowances**

- Allowances cover materials only if allocated for materials
- Payments for Allowances is based on actual monies spent supported by receipts or Subcontract invoices, i.e., landscaping
- Allowances normally do not cover Contractor labor, equipment, overhead & profit.
  - The Contractor should have included this in another part of his bid.
- Allowances are not the same as “Owner Supplied Materials”.

**Alternatives**

- The Owner or A/E may designate a number of alternatives to the base bid.
- Normally, lump sum bids are solicited for alternate ways of achieving same or different project goals.
- The alternate is to be priced as lump sum addition or subtraction to the base bid.

**Alternatives**

- Lump Sum Prices submitted for alternates should be able to stand alone, including O/H & Profit.
- The selected contractor with the low bid may be determined by the alternative selected by the A/E, or the owner.
- Owner’s objective is to stay within project budget, or to make best selection of materials or process.

**Bidding Procedures**

- Advertisement for bids
  - Public vs private
  - Controlled by law
  - Advertisements in newspapers, magazines, trade publications, and other media
  - Plan service centers
  - Describes the nature, extent, and location of the project
Contractor Qualification

- Qualification is the process whereby only contractors is deemed capable (qualified) and thus are allowed to obtain:
  - bidding documents, submit proposals, or enter into contract for a project.
- Pre-Qualification:
  - the evaluation process that must be completed for the Contractor to receive the bidding documents and submit his bid.
- Post-Qualification:
  - the evaluation process that happens after the contractor’s bid is submitted (along with bid price, qualification of materials, etc.)

Qualification requirements

- Contractor must be licensed.
- Contractor submits detailed info about
  - Contractor owned equipment,
  - Construction experience,
  - finances,
  - jobs in progress,
  - personnel and staff, and
  - references.

Qualification Process

Public Highway Construction

- Pre-Qualification is required for all jobs.
- Highway contractors submit
  - a detailed questionnaire, and
  - are rated as to max contract capacity and
  - type of work
    - grading, paving, bridges, etc.

Private Construction - Similar to public process.

- In closed bidding the contractor may volunteer his company’s “advertising” type information along with bid to get job based on quality rather than price.

Bid Closing

- Bid closing should be selected carefully – to be in owner’s best interests.
- Afternoon, middle of week, with no conflicts with other bid closings.

Bid Opening

- For a public opening (public projects) is widely attended,
  - all prices are announced,
  - low bid is not determined until the A/E & owner study and evaluate bids.
- The contractor should communicate the bid opening results to his surety.
- For a closed bidding (private projects), the results are not made public.

Bid Closing

- When, where & how to submit a bid is submitted is specified in the instruction to bidders.
- The bid/proposal, with bid security and any other required bidding documents are to be placed in sealed envelope and delivered in person, by Mail - Fed Ex, Express Mail, Fax, etc.
- A late bid is usually disqualified.
Bid Security – Bid Bond

- Almost all public and many private projects require a guarantee.
- That, if selected, a contractor will enter into contract for specified bid price and the contractor usually will be required furnish a bid bond.
- This bid bond is later returned to the contractor, after contract execution, or other contractor selection.

Bid Bond

- Can also be a designated lump sum.
- Type of “bid bonds”:
  - “Liquidated Damages”:
    - Owner receives face amount of bid bond.
  - “Difference-in-Price”:
    - Owner receives difference between low and next highest up to the face value of the bond.

Bid Bond from a Surety

- In the case of default, the surety does not really pay.
- The contractor is liable and indemnifies the surety for any such claims by the owner.
- GC’s may require subcontractors to also submit a bid bond.
- The ability to get bid bond serves as a check of contractor’s financial stability.

Responsive Bidding – Acceptance Period – Rejection of Proposal

- To be acceptable a bid must be responsive (in form and substance) to the invitation to bid and the instructions to bidders.
- i.e., to do the work exactly as specified in the bidding documents.
- Any deviations in qualification or conditions, or variations in performance may render the bid non-responsive.

Bid Bond Alternatives

- Certified Check.
  - e.g., a $100,000 check for 2 weeks @ 6% interest costs $240.
- Cashier’s Check.
- Negotiable Security.
- These alternatives all tie up the contractor’s money.
Responsive Bidding – Acceptance Period – Rejection of Proposal

- Acceptance period is stated in the invitation to bidders (30-60 days) during which the contractor cannot withdraw bid without losing his/her bid bond.
- Be careful of owners asking for extension.
- Subcontractors and suppliers may not stand by their prices; escalation; schedule repercussions.

Responsive Bidding – Acceptance Period – Rejection of Proposal

- The contract documents typically specifies that the owner has the right to reject any or all bids.
- The contractor will be rejected if he/she does not meet qualification requirements or if the bid is not responsive,
  - i.e., if all bids are > 10% above the engineer’s estimate then all bids are typically rejected.

Complimentary Bids

- The contractor gives a high bid, intentionally high enough to ensure that the bid will not be accepted.
- The contractor does not want to get the contract and is wanting to compete in the bid process, although appearing to be responsive to the request for bids.
- On the edge of collusion.

Bid Rigging

- Contractor A giving high bid price to contractor B so that B bids the project.
- B is safe but A may be prosecuted for bid-fixing, collusion, etc.
- Contractors meet and divide available projects among themselves by determining the low bidder and price for each.
- Contractor persuades others to bid who have no intention of winning the bid.
- Unlawful.

Mistakes in Bids

- Common Law “doctrine of revocability of offer to its acceptance” does not hold true after the deadline for receipt of proposals and during the acceptance period in construction.
- Withdrawal can mean loss of bid bond.

Mistakes in Bids

- According to the “doctrine of unilateral mistake” a contractor may withdraw his bid legally if the mistake is:
  - So major that enforcing the contract would be “unconscionable”, (unscrupulous, outrageous, not controlled by conscience).
  - The mistake relates to material feature of the contract (having real importance or great consequences).
  - Mistake not from violation of a positive legal duty or from culpable negligence, (culpable is defined as blameworthy; meriting condemnation, blame).
  - The owner is put in a status quo position to the extent that it suffers no serious prejudice.
Mistakes in Bids

- If this holds, and the mistake is excusable and one of fact if the error is of mechanical or clerical nature, and Contractor notifies the owner promptly
- “Excusable” clerical mistakes:
  - Arithmetic error (faulty addition, missing decimal, typos, transpositions), Transaction error, Leaving something out

Promissory Estoppel

- When the low-bidding prime contractor bases his bid on a subcontract bid, which is considerably lower than other bids, the subcontractor is prevented from withdrawing his bid by the doctrine of Promissory Estoppel.

Subcontractor bids

- Contractor selects sub-bids – He uses letters, cards, phone calls.
- Contractor receives bids – the deadline set is usually 2-3 hours before bid opening.
- Frantic phone calls to the Contractor: gives section of specifications, price, qualification on bid, sub’s name and person calling.
- The Contractor gets bids from subs and incorporates these into his bid.
- The GC must know the subs conditions of bid and the assumptions made: availability of crane, supply of water, heat, electricity, material storage area, ...

Mistakes in Bids

- Examples of “inexcusable” mistakes:
  - Errors in judgement, Not visiting the site, Incorrect rough estimate
  - If the contractor verifies his bids, and the contractor starts work, there is no required relief for a contractor mistake.

Promissory Estoppel

- Promissory Estoppel can bind a sub to its bid price if prime can prove:
  - That it received a clear and definite offer from sub
  - That the sub could expect that the prime would rely on the offer
  - That the prime actually did rely on the offer and such reliance was reasonable
  - That the reliance worked to the prime’s detriment
Subcontractor Relationships – Bid Peddling

- Subs sometimes take advantage of a known price to be submitted then give a reduced price.
- Hard to detect – “all’s fair in love and war” concept.
- Subs know which GC is the lowest bidder and his price.
- They may also find out the low sub-bid price
- They then call the GC to get him to use them instead.
- Thus supplanting the other subs.
- GC should not do this: “It takes two to tango.”

Subcontractor Relationships – The Relationship

- General Contractor Needs:
  - Several subbids on each item to be competitive
  - To establish good working relationships with several subs associated with each work specialty
  - Contractor should use lowest responsive bid
  - If sub’s bid is defective or incomplete, the GC is not bound to use it.
  - Concept of interdependence.
  - Prime/subs depend on each other.

Cost Estimating & Bidding

End of Lecture