Estimating and Scheduling

Practical Tips and Techniques for Construction

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May 2020
Today’s Discussion:

- Scheduling techniques & CPM
- Basics of schedule review and analysis
- Current and Future Trends in Scheduling
- Cost Estimating Principles
- Why Do Projects Need a Cost Estimator
- Strategies to Maintain Budget and Scope
- What The Owner Can Do To Assist
What is Time Management?

Project Time Management Includes the Processes Required to Manage Timely Completion of the Job!
What is Time Management?

Most often delivering projects on time is the biggest challenge for CMs.

Time has the least amount of flexibility; it passes no matter what

Schedule issues are one of the main reasons for conflict on projects
Importance of Time Management

Good initial schedule development and continued ongoing maintenance is paramount to:

- More Control
- Avoiding claims
- Providing a solid basis for quantifying time impacts
Importance of Time Management

- Serves as a plan to complete the project.
- Communicates the plan to the project team.
- Measures progress against the plan.
- Proves the contract completion date.
Scheduling Definitions & Basics

• CPM Scheduling:

A Management Technique by which a project can be broken down into a number of identifiable tasks (activities) and assigned various resources (i.e. time/duration, cost, etc.) The tasks are then sequentially interconnected based on interdependence. The result of this process is a critical path.
Terminologies:

- Activity
- Constraints
- Milestone
- Critical Activity
- Critical Path
- Early Start Date
- Late Start Date
- Early Finish Date
- Late Finish Date
- Total Float
- Logic (Relations)
- Predecessor
- Successor
Activity

A basic element of work, task or measurable amount of work that must be accomplished in order to complete a project.

An activity occurs over a given period of time, utilizes resources and produces a deliverable for the project.
Milestone

An activity that represents a significant point in time but has no duration. Milestones can indicate the start or the end of a series of related activities or an accomplishment in the course of a project.

Second Floor Substantial Completion – 0D
Constraints

• Imposed restrictions (such as dates) used to reflect project requirements that cannot be built into the logic.

• Aid in building a schedule that more accurately reflects the real world aspects of your project.

• Provide added control in the schedule.

Start No Later Than.....
Logic (Relationships)

◆ Start-to-Finish

◆ Start-to-Start

◆ Finish-to-Finish

Hard Logic Vs. Soft Logic
Start & Finish

- **Early Start (ES):** The earliest time that one activity can start without affecting the successors.
- **Early Finish (EF):** The earliest time that one activity can finish without affecting the successors.
- **Late Start (LS):** The earliest time that one activity can finish without affecting the successors.
- **Late Finish (LF):** The latest time that one activity can finish without affecting the successors.
- **Free Float (FF):** Delay allowance for one activity without causing any delay on the immediate successors.
- **Total Float (TF):** Delay allowance for one activity without causing any delay on the project completion date.
Network Diagram

Shows how the project tasks are connected and will flow from beginning to end.

<table>
<thead>
<tr>
<th>ES</th>
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<tbody>
<tr>
<td>Activity</td>
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<td>LS</td>
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Critical Path

It is the **longest continuous path** (in terms of duration) in the network from start to finish of the project and determines the **shortest** time to complete the project.
Float

The number of work periods the start or finish of an activity can be delayed without affecting the project finish date.

(Total) Float is measured in hours, days, weeks, or months depending on the project’s planning unit, and can have negative, zero, or positive values.

(TF=LS-ES or TF=LF-EF)
# Network Diagram Calculations

The following table and diagram illustrate the calculations for an activity in a network diagram:

<table>
<thead>
<tr>
<th>Activity</th>
<th>ES</th>
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<th>LS</th>
<th>OD</th>
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</table>

**Calculations:**

- \( EF = ES + OD - 1 \)
- \( LS = LF - OD + 1 \)
- \( TF = LF - EF \) or \( TF = LS - ES \)

![Network Diagram](image-url)
Network Diagram Calculations

**Forward Pass**

1. **ES**  |  **EF**
   1 | 3
   A | B
   2 | 7

2. **LS**  |  **OD**  |  **LF**  |  **TF**
   1 | 3 | 5 | 6 | 8
   2 | 2 | 5 | 6 | 10

3. **Critical Path**
   1) A-B-D-F  11
   2) A-C-E-F  13
   3) A-C-D-F  12

**Calculations**

- **EF** = **ES** + **OD** - 1
- **LS** = **LF** - **OD** + 1
- **TF** = **LF** - **EF** or **TF** = **LS** - **ES**

(highest value)
Network Diagram Calculations

Forward Pass (highest value):

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>A</td>
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Backward Pass (lowest value):

<table>
<thead>
<tr>
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<tr>
<td>A</td>
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<td>B</td>
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<td>C</td>
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<td>E</td>
<td>9</td>
</tr>
<tr>
<td>F</td>
<td>12</td>
</tr>
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</table>

\[ EF = ES + O D - 1 \]
\[ LS = LF - O D + 1 \]
\[ TF = LF - EF \text{ or } TF = LS - ES \]
Types of Schedule

- Master Schedule
- Preliminary Schedule/Initial Contract Schedule (90 day)
- Contract Baseline Schedule
- Contract Update Schedule
- Short Interval Schedule
- As-Built Schedule
Scheduling Specifications

• Establishing appropriate Scheduling Requirements in the Project Specifications is necessary to be able to manage the project and contractor with respect to time.

You must specify exactly what you want and need!
Scheduling Specifications

Consider:

- Software requirements
- Acceptance of contractor’s schedule
- Early completion
- Float ownership
- Weather Clauses: appropriate for location and type of work.
- Liquidated damages clause
- Part of Pay Application Process
Scheduling Specifications

Consider:

• Short Interval Schedules
• Cost & Resource Loading
• Number & Length (15 days max.) of Activities
• Submittals/Rev/App/Procurement Included in schedule
• 15-25% of the Activities Critical or Near Critical
• Owner Furnished Equipment Identified
Schedule Review

- Compliance with specification requirements.
- Do milestone dates and contract completion dates comply with contract?
- Is there any negative float?
- Are all work items included?
- Does the overall sequencing and logic make sense?
- Are durations reasonable? Limited to 15 days?
- Is the critical path reasonable? 15-25% of tasks?
Schedule Review

- Is Float accurate (inflated durations, forced finish dates, unnecessary logic, ...)?
- Regulatory requirements
- Is schedule Cost & Resource Loaded (if required)?
- Are Owner items identified (equipment, materials)?
- Is Weather addressed per specification requirements?
- Are the Punch List and other close-out items included?
- Are Submittals, Reviews, and Procurement identified?
Baseline Vs. Update

What do you look for?

• Update Accuracy (Duration and Logic)
• Negative float
• Critical and Near Critical Paths
• Ways of making up any negative float.
  • Concurrent activity
  • Reduced durations / Additional resources
  • Accelerated submittal/review or procurement activities
Delays Evaluation

Owner Responsibility
- Errors and Omissions
- Changed and Unforeseen Conditions
- Owner added work

Contractor Responsibility
- Mismanagement by contractor
- Defective workmanship
- Non compliance with contract provisions

Other
- Force Majeure – Weather, etc. (Force beyond control)
Delays Evaluation

Three Types of Delay:

1. **Critical** – Impacts milestones or completion dates.
2. **Non-Critical** – Impacts activities without impacting milestones or completion dates.
3. **Concurrent** – Separate and simultaneous delays.
Delays Evaluation

The 3 “KEY Questions:

1. Was the “event” a **Delay**? Did it impact an activity on the critical path such that the project completion date was delayed?

2. Is the delay **Excusable**? Was it caused by the Owner or was it outside of the control of the contractor?

3. Is the delay **Compensable**? Was it within the control of the Owner?
Current and Future Trends

1. Scheduling In The Field With Tablets and Smart Phones
2. Schedule Data in Cloud
3. Artificial Intelligence
4. Data Mining to identify Trends
5. Integration of Schedule with Risk
6. 4D Scheduling
7. Location Based Scheduling (GIS)
Any Questions?
Construction Cost Estimating

• Cost Estimating Process
• Why do Projects Need An Estimator?
• Strategies to Maintain Budget and Scope
• What the Owner Can Do to Assist
• Questions
Client First Question: “How Much Will My Project Cost?”
Estimator Response: “It Sounds Expensive”
Client Reaction: Initial Sticker Shock “What Can We Do To Make It Work”
Construction Cost Estimating

Typical client/estimator – initial contact scenario
• Client inquires if we have information on how much his project will cost.

We discuss parameters:
• Location
• Size
• Functionality
• Complexity
• Structure type
• Site restrictions
• Site development and gross area
• Schedule
• Client budget

Finish discussion, and let client know we will be back in touch soon, once we have completed our research and due diligence.
Construction Cost Estimating

• Estimator conducts research of current and historic data of similar type projects to determine the cost per square foot. Estimator looks for projects with parameters similar to the client’s.

• Estimator calls the client back and gives them a range of costs. Typically ((+/-) -10% on the low side and +15% on the high side) of expected cost/square foot (SF).

• If it was determined the cost of the building was $500/SF, the estimator would advise the client to predict a range of $450-$575/SF.
Caveat

Market Conditions

• Local labor and supply-chain restrictions will affect bidding markets and will likely have an adverse effect on construction costs. (Covid-19)

• Trade agreements or lack of will impact the cost of raw materials.

• Material availability – delay will impact schedule...time is money.

• Single source materials and equipment – could result in higher initial costs and possibly life cycle costs which includes running (energy costs) and maintenance (labor and material costs).

• Current trends – supply and demand creates market factor.

• Local labor agreements – need to meet contract requirements will impact costs.

• Skilled labor availability – ongoing and nearby projects with longer durations and large skilled labor requirements could offer added incentives for labor to remain with the competing project. Trickle-down effect will hurt your project.

• Volatile economic markets could affect bidding pool of general and sub-contractors, which could have an adverse effect on construction costs. (Covid-19)
Cost Estimating Process

Start early and engage the estimator as soon as possible. Earlier slides highlight how a phone call can help get the process moving.

Include the cost estimator in all design stages.

Design stages may include:

- Feasibility Studies – this may involve several sites, building options, and site development. *Estimating includes minimal information with high levels of contingencies carried within the cost estimate.*

- Conceptual Design – includes floor plate plans, rough renderings, and basis of design narrative. Typically, this phase will establish gross floor areas, site demising lines and initial project construction budget. *Estimating includes a high proportion of square foot costs of assemblies and systems with high level of contingencies carried within the cost estimate.*
Cost Estimating Process

• Schematic Design - includes floor plans, elevations sections, material selections and basis of design narrative. Follows the conceptual design where the estimating information includes a high proportion of square foot costs of assemblies and systems with high level of contingencies carried within the cost estimate.

• Design Development – interprets and adds to the information within the schematic design which establishes a project vision with increased level of design and detail. This design level should evaluate how the design intent, structure, systems and materials all connect and function. Cost estimating information and detail becomes more defined with increased line items and cost information, while reducing the contingencies as the design progresses.

• Construction Documents – design and detail are developed to a stage where the drawing information is suitable for bidding on and ultimately constructing with. All plans, sections, elevations and details have been validated and are concise and correct. Cost information is extremely well developed in line with the drawings and detail, has significant number of line items which quantify the elements and ultimately reflects the cost of construction in the current market-place.
Why Do Projects Need An Estimator?

Typical scenario without an estimator on the design team:
• Design team completes bid level design documents – 9 months assumed
• Bidding process – 2 months assumed
• Receive bids
• Project is over budget
• Project is delayed pending technical and cost review

Options available to client after bidding:
• Increase budget
• Reduce scope
• Re-design
• Cancel project
• Negotiate with low bidder
• Avoid all of the above by hiring an independent cost estimator at the beginning of the project design process
Why Do Projects Need An Estimator?

Perform independent cost management
- An independent cost estimator is retained to “Call It as They See It”
- Are not influenced by outside factors or bodies
- Works closely with the entire design team
- Produces cost estimates using recognized industry standards and methodology
- Accounts for market conditions and all other factors affecting the cost estimate
- Recommends alternatives and actions for change through design as needed

Hiring an independent cost estimator can help ensure design team remains on budget by:
- Help establish a recognized and achievable project budget based on the project parameters
- Completing an estimate at each stage of design will verify if the project is on budget or not.
- Budget does not confirm the project costs are at, or under budget.
- Over budget could emphasize that the project is over-designed
- Under budget could emphasize that the project is under-designed
- Being on budget intends that all agreed upon project needs, wants and wishes are being met through design
What Can We Do To Help The Project?

Strategies for reducing costs while maintaining scope

- Value engineering
- Reducing schedule of design phase
- Reducing schedule of construction phase
- Exclude single source equipment and products
- Include “or equal and approved” equipment and products assuming all meet performance and life-cycle requirements
- Reduce general contractor previous performance requirements for greater inclusion

How can the client help the design team meet project expectations?

In advance of the bid process:

- Understand the current construction climate in the immediate area and understand factors which will affect the bid process
- Know what other projects are bidding around the same time when the bid return date is being set
- Invite prospective general contractors and sub-contractors to a “town hall meeting” to learn about the project and meet the client team
- Determine if pre-approval of general contractors and sub-contractors will assist with the bid process
- Whet the appetites of all interested parties by helping them to understand the project better. Highlight the simplicity and challenges of the project
- Provide the project schedule as a look ahead for all
- Ensure it is advertised properly
34 - Flat roof area - canopy - 424 SF
174 - Membrane - 4,439 SF
175 - Tapered - 85 SF
176 - Reglet etc - 223 LF
177 - Coping - 421 LF
307 - Solatube - 7 EA
Any Questions?