SCHEDULING

HOW TO AVOID DELAY, ACCELERATION, IMPACT AND INEFFICIENCY

For
Northwest Construction Consumer Council

Construction Conference & Exposition
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Seattle, Washington

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Presented By:

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NW Region, Tualatin, OR
HOW TO AVOID DELAY, ACCELERATION, IMPACT AND INEFFICIENCY

OUTLINE OF PRESENTATION

Morning - Scheduling
Overview
Procedures
Conflicting Objectives
Differing Definitions
WBS / Cost Coding
Level of Detail
Logic
Resources
Critical Path & Float
Constraints & Targets

Afternoon - Scheduling Claims
Change Order Requests & Claims
Time Impact Analysis vs. Would-Have-Been Schedules
As-Planned & As-Built Schedules
Detailed As-Builts & Other Tools
Would-Have-Been Schedule
Owner Defenses & Counterclaims
Damages
Inefficiency
Negotiation
INDUSTRY TRENDS

CONSTRUCTION DISPUTE TRENDS:
- More Competition, Reduced Margins & Tighter Schedules
- Contractor Claims-Consciousness & Owner Risk-Avoidance
- Weakened Relations between Contractors and Subcontractors
- New Contract Forms – Design/Build, CM/GC, & Build/Operate
- Changed Design Quality and Designer Responsibility
- Dispute Avoidance and Resolution Trends – the ‘90s
- Partnering
- Dispute Management Programs

SCHEDULING TRENDS:
- Owner-Required CPM Specs
- Relatively Easy-To-Use Software on PC’s
- Better Understanding of CPM
- Tighter Schedules
- Recognition of Schedule Importance & the Cost of Delays
SUGGESTED SCHEDULING SPECIFICATIONS

♦ CPM Schedule (not bar chart)

♦ Tabular Report with activity number, description, duration, early/late start and finish, logic (priors or successors), lag/leads, constraints, and float

♦ Timescale Logic Diagram or Connected Bar Chart

♦ Identify Subcontractor/Crew, Work Area, and Pay Item

♦ Specified Activity Durations and Number of Activities (maximum duration of 1 month, separate activities for each subcontractor, maximum detail with one activity per crew)

♦ Separate Activities for Procurement

♦ Sorts by Activity Number and Float/Early Start

♦ Preliminary Schedule at Pre-Construction Conference - with details of first 60-days and summary to completion

♦ Complete Schedule within 60 days, Approval within 90

♦ Monthly Updates and Narrative with Pay Requests - Updates w/actual start/finish dates, percent complete and days remaining.

♦ Revised Schedule When Delayed or Requested by Owner

♦ Reduced Payment if Failure to Comply with Specs
1. **Initial Review Upon Receipt Prior to Meeting**

2. **Joint Meeting with Contractor's Scheduler** (and Superintendent)
   - Presentation by Contractor, Ask Questions, Take Notes
   - Review Critical Path in Sequence -- Logic, Crew, Qty …
   - Check Work Quantities, Production Rates, & Durations
   - Check Critical Crew Chases (crane, equipment fleet, …)
   - When Done, Brainstorm for Improvements

3. **Approve at the Meeting** or as soon as possible afterwards

4. **If Reject** - state exactly why and require re-submittal by a specific date. Offer to discuss – to ensure you get what you need.
REASONABLE LOGIC AND ACTIVITY DURATION

♦ Missing logic ties
♦ Excess/duplicate logic ties
♦ Weather compatibility
♦ Crew chases that will control progress
♦ Excessive resource peaks and fluctuations
♦ Reasonable logic for efficiency
♦ Avoid crew stacking in limited work areas
♦ Reasonable durations (based on crew size/capacity)
♦ The effect of working under traffic
♦ Extended durations for startup or weather impact
♦ Contract-specified durations
♦ Check long-lead procurement times
♦ Overly tight schedules (multiple critical paths)
♦ Potential safety problems
♦ Conditions of railroad agreements
♦ Utility relocations by others
♦ Soil conditions, terrain, groundwater, etc.
♦ Contractor’s capacity, approach, crew and work load
ADEQUATE LEVEL OF DETAIL

♦ Normal maximum activity duration of 1 month
♦ Number of activities for size and complexity of project
♦ Separate activities for each subcontractor
♦ Maximum level of detail: one activity per crew
OTHER ISSUES

♦ Anticipate potential delays and problems (complete weather-sensitive work before winter weather)

♦ Risk analysis of critical delays (push critical path activities into environmental no-work windows)

♦ Obtain expected crew sizes for critical activities and for each subcontractor

♦ Check for excess demands on owner’s resources (inspection, surveying, etc.)

♦ Check on available access, public notice requirements, permit requirements
MONITORING PROGRESS

- **Maintain Good Records** – record start-and-finish dates, delays and the reason why, crew sizes, etc.

- **Enforce Contract** – Schedule Updating/Revision Requirements

- **Meet** to Discuss Delays, Impact, or Claims

- **Promptly Respond** to Questions or Notices

- **Continue to Partner**
The schedule reviewer should note and record the following information:

✦ **Actual Start and Finish Dates**

✦ **Periods of Intermittent Progress** with restricted or no work (and the reason)

✦ **Days Remaining or Percent Complete** of partially complete activities

✦ **Minor Revisions** to durations and logic

✦ **Correction of Logic** for out-of-sequence work

✦ **Delays** to the scheduled start of non-critical activities
INFORMATION TO BE RECORDED

♦ Work started, completed, interrupted, in progress; its location and quantities
♦ Concrete pours - where, how much
♦ Tests conducted and their results, if known
♦ Crew sizes, equipment and work by general contractor - by trade
♦ Crew size, equipment and work by subcontractors
♦ Material delivery, on-site, being used and needed
♦ Contractor questions and responses given
♦ Directives to Contractor and action taken
♦ Summary of discussions with Contractor
♦ Delay or acceleration, the cause and impact
♦ Problems occurring, pending or developing; their impact and resolution
♦ Acceleration: directed, constructive, or contractor-initiated
♦ Changes in scheduled dates
♦ Changed conditions discovered or impacting work
♦ Accidents and their impact on work
♦ Restricted access and any impact
Damage to previously installed work
Defective work being done, discovered, or reported
Repairs to defective work, the effort expended and any impact on other work
Extra work or protested work being done and any impact on other work
Labor disputes, shortages, excess
Problems with subcontractors
Poor condition and control of subcontractors
Changes in productivity, rate of progress, etc.
Insufficient equipment capacity, poor operation, or inefficient layout
Equipment delivery, removal, in use, on standby (not needed or need repair)
Visitors to site
Insufficient or inadequate labor or equipment
Weather and its impact
Other site conditions and impacts - mud stream flow, traffic conditions
Change order work, RFIs, etc. and their impact
SCHEDULING RECOMMENDATIONS FOR CONTRACTORS

1. Train Key Personnel – in scheduling, record keeping and claim avoidance
2. Train an In-house Scheduling Guru

3. Prepare Preliminary CPM Schedules for All Estimates
4. Submit and Discuss Schedule at Pre-Construction Meeting
5. Prepare Monthly Schedule Updates and Narratives
6. Tie Short-Interval Schedules to Project Schedule - show Plan vs. Actual

7. Prepare Time Impact Analyses for Changes
8. Develop and Distribute a “Jobsite Overhead Cost Sheet”
9. Selectively Accelerate Low “Cost-Slope” Activities – to lower total project costs

10. Maintain Better Records – superintendent’s daily reports, RFIs, telcons, etc.
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<th>ACTIVITY DESCRIPTION</th>
<th>START DEP</th>
<th>END DUR</th>
<th>PRIOR ACTIVITIES</th>
<th>SUCCESSOR ACTIVITIES</th>
<th>START START</th>
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**Gantt Chart Diagram**

- **Critical Task**: Critical tasks are marked with a different color or symbol to indicate their importance in the project timeline.
- **Summary**: The summary bar represents the overall project timeline.
- **Rolled Up Task**: These are tasks that have been collapsed into a single bar for simplicity.
- **Rolled Up Milestone**: Milestones are shown as vertical bars at specific dates to track progress.
- **Rolled Up Progress**: Progress bars indicate the percentage of task completion.
HOW TO GET PAID FOR CLAIMS

BE PREPARED

- Understand Industry Trends
- Understand Contracts and Contract Law
- Implement A Change Order Management Program
- Partner the Project and Adopt a Partnering Approach

Chapters 2 - 4

SUBMIT CHANGE ORDER REQUEST

If Unable to Settle

Chapter 5

1 - SELECT CLAIM PREPARER

- Decide Whether To Use In-House Expert or Consultant
- Identify Experts, Select, and Negotiate Agreement

Chapter 6

2 - CONDUCT PRELIMINARY ANALYSIS

- Initial Briefing
- Define and List Issues and Recovery Theories
- Define Strategy, Work Plan, Budget, and Schedule
- Prepare Preliminary Analysis and Estimate Recovery
- Present Findings Internally and Decide How To Proceed

Chapter 7

3 - OBTAIN AND ORGANIZE DOCUMENTS

- Obtain Documents and Organize Chronologically
- Interview Witnesses and Visit Site

Chapter 8

4 - CONDUCT DETAILED ANALYSIS

- Understand the Project, Dispute and Pertinent Law
- Review Chronological Files and Determine the Facts
- Analyze The Issues: Facts, Entitlement
- Identify Potential Additional Claims & Counterclaims
- Analyze The Schedule and Compute Damages
- Summarize Your Findings and Conclusions
- Get Internal Approval and Authorization to Proceed

Chapters 9-12

- If litigating or arbitrating

Chapter 13

5 - PREPARE EXHIBITS AND FINALIZE CLAIM

- Prepare Scheduling and Cost Exhibits
- Finalize Claim Document
- Prepare Executive Summary and Cost Summary
- Review and Get Final Internal Approval

Chapter 14

- If litigating or arbitrating

Chapter 15

6 - PRESENT CLAIM AND NEGOTIATE

- Present Goals, Research, Strategy, Tactics
- Make Initial Presentation
- Follow-up
- Negotiate Settlement

Chapter 16

RECEIVE PAYMENT
HOW TO ANALYZE SCHEDULE CLAIMS

Understand The Project
Chapters 7 - 9

1. Verify or Modify The As-Planned Schedule
Subsection E.3

2. Complete or Create The As-Built Schedule
Subsection E.4

3. Create The Would-Have-Been Schedule & Compute Excusable Delay
Subsection E.5

4. Determine Compensable Delay & Differing Work Conditions
Subsection E.6

Issue Analyses
Chapt. 9

Prepare Claim Document & Exhibits
Chapter 13

Damage Calculations
- Escalation
- Extended Overhead
- Equipment Standby
- Impact & Inefficiency

Chapters 11 & 12
HOW TO VERIFY (or create) AN AS-PLANNED SCHEDULE

1. If No As-Planned Schedule Exists, Create One
   1. Base it on reasonable expectations at the start of work and actual progress to date.
   2. Document all assumptions, references, and computations.

2. If A Bar Chart, Convert It Into A CPM Network
   1. Identify and draw relationship lines on the Bar Chart.
   2. Add detail as required.
   3. Computerize.

3. Plot The As-Planned Schedule As A Timescaled Network
   For easier review and better understanding, plot the As-Planned Schedule as a Timescaled Network Diagram showing the activities scaled to a calendar and the relationships shown between activities.

4. Verify Adequacy And Accuracy, And Modify If Required
   1. Examine the job logic, activity durations, available resources, etc.
   2. Add missing activities and relationships, show overlapping activities or intermittent progress, and correct patent (obvious) errors.
   3. If necessary, modify the As-Planned Schedule for comparison with the As-Built.
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1. If No As-Built Activity Exists, Create One
   1. Base it on actual progress as noted in the job records.
   2. If necessary, create a Detailed As-Built Schedule and condense it to the same level of detail as the As-Planned.

2. Verify The Accuracy Of The As-Built Schedule Updates
   1. Examine the records to determine if the schedule was updated regularly.
   2. If Short-Interval Schedules exist, compare them with the As-Built Schedule.
   3. Check the accuracy of the start and finish dates and job logic.
   4. If significant shortcomings exist, check all critical and near-critical activities.

3. Modify The As-Built Schedule, If Necessary
   1. Correct for errors and logic changes, add missing activities and detail (if required.)
   2. Use the Short Interval Schedules, the daily field reports, and other records.
   3. If necessary, create a Detailed As-Built Schedule and then condense it to be compatible and with the same level of detail as the As-Planned Schedule.
**EXCAVATION**

- Shoot grade on Monday
- Stripped lot
- Digging, hauling away
- Haul in gravel, shoot grade
- Dig footings
- Digging, hauling away
- Bring in gravel
- Compaction app'd [SL-04]
- Leveling [HEJ]

**FOUNDATION/CONCRETE**

- Stake out corners
- Compact gravel back up to grade & stake corners
- Spreading gravel & compaction back to grade
- Shoot grade, lay out ftngs, spread gravel & compact
- Layout or footings
- Setting footings
- Setting forms for footings
- Receiving & setting rebar
- Tying rebar in the footings
- Footings inspected
- Pouring footings
- Setting forms on footings & foundation
- Strip poured footing
- Setting forms on footings & foundation
- Pouring footings

**MOBILIZATION**

- Power pole removed
- Ready to hook up office
- Santi-Can arrived
- Got power & phone to office
- Security fence.

**CARPENTRY**

- Start Framing Walls
- Framing exterior walls

**Source of data, if not Daily Report**

**FRAGMENT OF DETAILED AS-BUILT SCHEDULE**

Copyright © 2000 Pinnell Busch, Inc.
DETAILED AS-BUILTS
Advantages And Disadvantages

For Analysis
♦ Explains apparent contractor errors
♦ Identifies additional issues
♦ Can generate productivity rates and damages
♦ Offers convenient display and access to other data
♦ Provides information for issue analyses and reports
♦ Provides all the above simultaneously

For Presentation
♦ Easier to understand
♦ Refutes alleged concurrent delay
♦ Allows quick response to unanticipated questions
♦ Establishes credibility
♦ Provides a foundation for conclusions
♦ Intimidates opposing witnesses
1. Plot As-Planned vs. As-Built Comparison Bar Chart – evaluate differences
2. Review Time Impact Analyses – of individual delays (if existing)
3. Examine the Detailed As-Built Schedule – if one was created
4. Review Issue Analyses and Chronological Summary Notes
5. Create an ELIPSE Schedule – integrating RFIs, extra work, the schedule
6. Look at Labor & Equipment Use
7. Optionally, Prepare What-If Analyses and Computer Simulations
8. Create the Would-Have-Been Schedule:
   - One activity at a time, from the beginning
   - Based on the contractor’s intent as evidenced by the as-planned schedule and subsequent documents (correspondence, schedule updates, etc.)
   - Adjusting the job logic, when appropriate, to what the contractor probably would have done under the circumstances
   - Using actual durations for un-impacted activities, after adjusting for the working conditions when the work would have been done.
   - Using computed durations for impacted activities, based on an analysis of planned duration, actual duration, actual vs. would-have-been working conditions, crew size and productivity rates, etc.
9. Include Excusable but Non-Compensable Delays - e.g. weather
10. Record Assumptions and Calculations
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The diagram on the right side of the page shows various components and connections, with symbols indicating the flow and connections between different parts. The diagram appears to be related to plumbing and water systems, with arrows indicating the direction of flow or movement. The numbers and symbols on the diagram correspond to the numbers and activities listed in the table above, suggesting a technical or engineering context.
<table>
<thead>
<tr>
<th>NUM</th>
<th>WORK &lt;AS-PLANNED SCHEDULE&gt;</th>
<th>&lt;--------WOULD-HAVE-BEEN SCHEDULE--------&gt;</th>
<th>&lt;--------CHANGES--------&gt;</th>
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This activity was increased from 3 to 4 days, in spite of being scheduled in September when no rain fell. This was to adjust for the larger excavated area caused by the three sanitary sewer line taps (a change to the contract). This was probably overly conservative. The actual work took 8 days from 240ct to 2Nov, but of those days experienced rain with a total of 1.59" in addition to the substantial rains before work started.

| 1026 | CMU - 1ST FLOOR A 3 110CT90 150CT90 3 10CT90 30CT90 3d1.43 | 0 -8 -8 |          |
COMPARE THE WOULD-HAVE-BEEN TO THE AS-BUILT SCHEDULE
To Determine Compensable Delay and Different Working Conditions

As-Planned Schedule
Notice To Proceed
Substantial Completion

As-Built Schedule
Notice To Proceed
Substantial Completion

Would-Have-Been Schedule
Notice To Proceed
Examine Difference in Working Conditions To Determine Impact And Inefficiencies
Substantial Completion
Identify Weather & Other Excusable but Non-Compensable Delays

Delay
Contractor Delay
Excusable Delay
Compensable Delay
Total Time Extension
# Mobilization & Foundation Construction

**As-Planned vs. As-Built Schedule Comparison**

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**Timeline Indicators:**
- **2 Wks Delay**
- **1 1/2 Months Delay**

Legend:
- Original As-Planned
- Revised As-Planned
- As-Built
OWNER DEFENSES AND COUNTERCLAIMS

♦ **Lack of Entitlement** – disputed contract interpretation or other failure to prove the contract or contract law entitles the contractor to extra payment or time extension

♦ **Concurrent Delay** – due to weather delays, contractor error in prosecuting other activities, etc.

♦ **Failure to Re-Sequence** – overlap relationships, expand level of detail, break non-essential logic links, re-sequence activities, add labor or equipment to eliminate resource constraints, etc.

♦ **Faulty Scheduling** – poor or impractical as-planned schedule, overly optimistic as-planned activity durations, inaccurate or insufficiently detailed as-built schedule, incorrect or inadequately supported would-have-been schedule logic and durations

♦ **Erroneous Analysis** – lack of causation, improper allocation of delay, unsupported computation of damages

♦ **Liquidated or Consequential Damages** – for non-excusable delays and consequential delays to repair defective work

♦ **Defective Work** – out-of-spec work product
HOW TO COMPUTE DAMAGES

FORWARD PRICING ESTIMATE

1. Confirm Scope & Collect Relevant Data
2. Select Pricing Method
   - Unit Cost or Unit Price
   - Catalog (mech/electrical, specialty)
   - Sub/Vendor Costs
   - Crew/Productivity Rate
3. Prepare Quantity Taken

FORCE ACCOUNT PRICING

1. Define Work & Agree To Force Account
2. Record Daily Charges
   - Use Extra Work Order Form
   - Sign Daily
3. Compile Totals

AFTER THE FACT PRICING

1. Identify Cost Elements & Collect Records
2. Identify Source Documents
   - Cost Accounting Report
   - Reallocate Accounting Charges
   - Recompute From Daily Reports
   - Estimate After-The-Fact
3. Compile Effort Expended

4. Calculate Direct Costs
5. Obtain Compensable Delay From Schedule Analysis
6. Compute Delay Costs
7. Examine Working Conditions From Schedule Analysis
8. Identify & Compute Impact of Other Costs
9. Compute Inefficiency
10. Add Markups
11. List Below The Line Costs
12. Prepare A Cost Summary
**Types of Damages**

**Direct Cost of Extra Work** -- From a change resulting in a project that is different and more costly.
- Labor
- Materials
- Equipment
- Subcontract
- Small Tools & Expendables
- Mark-up

**Impact from Change In Conditions** -- under which the work is done, which can be:
- Inefficiency -- of labor, equipment and subcontract costs in performing original bid work.
- Additional Tasks -- not leading to a scope change in the project, such as access road.
- Additional Materials -- such as extra base rock to allow working on wet subgrades.

**Delay** -- causing the project to take longer or be done later, resulting in:
- Extended Overhead -- of jobsite and home office overhead
- Escalation -- in the unit costs of labor, materials, equipment use, or subcontract costs.
- Equipment Standby -- while waiting for a problem to be resolved.
- Demobilization and Remobilization -- due to delay and the need to return later.
- Extended Warranty -- and other cost due to delay
- Change In Conditions with Impact (inefficiency, additional tasks and/or materials use).
- Lost Profits -- for projects that could not be bid, due to delay. No markup added.

**Acceleration** -- from having to complete earlier or with less time than anticipated, resulting in:
- Change In Conditions with Impact

**Other**
- Additional Overhead -- jobsite or home office for many claims or a specific claim.
- Change Order Preparation and Negotiation Costs -- separate from claim costs.
- Future Costs -- such as higher insurance or workers’ compensation premiums.

**Markup** -- for indirect costs added to direct costs
- Jobsite Overhead -- expressed as a percentage or direct costs.
- Home Office Overhead -- expressed as a percentage of jobsite costs.
- Profit -- expressed as a percentage of total job costs.
- Bond, Insurance Premium and Taxes -- computed as a percent of job cost plus profit.

**Below The Line Costs** -- added at the end, without markup:
- Retainage and Unpaid Contract Balances
- Interest -- for late payment of retainage, the claimed amounts, or progress payments
- Attorney Fees and Claim Preparation Cost
- Credit for Nonconforming and Unsatisfactory Work
UNIT PRICE ESTIMATE

Concrete  
100 cy @ $150/cy =  
$15,000.00

HTGP – Pg. 363
Crew and Productivity Rate Estimate
For Additional Footings

<table>
<thead>
<tr>
<th>No.</th>
<th>Hours</th>
<th>Hourly Base Rate</th>
<th>Subtotal Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Labor Daily Rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpenter foreman</td>
<td>1</td>
<td>8</td>
<td>18.13</td>
</tr>
<tr>
<td>Carpenter journeymen</td>
<td>2</td>
<td>8</td>
<td>16.99</td>
</tr>
<tr>
<td>Carpenter apprentice</td>
<td>1</td>
<td>8</td>
<td>16.70</td>
</tr>
<tr>
<td>Laborers</td>
<td>4</td>
<td>8</td>
<td>9.45</td>
</tr>
<tr>
<td>Operating engr. (crane)</td>
<td>1</td>
<td>8</td>
<td>16.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9 workers</td>
</tr>
</tbody>
</table>

2. Labor Burden (see Exhibit A)
FICA 6.20%
Medicare 0.80
Federal unemployment 0.80
Workers' compensation 7.40
State unemployment 1.35
Insurance 0.25
Health & welfare & pension 1.50

Labor Burden 18.95 /100 x $982.84 $186.25

3. Subtotal Labor Daily Rate $1,169.09 per day

4. Equipment Daily Rate
Hyundai Crane, Bucyrus -RT58D 1 day @$425.00* $425.00 per day
Rough Terrain Lift Truck – Bob’s Rentals $300.00 per day
Rental Rate Blue Book, 13-3

5. Small Tools
@ 5% of labor costs $1,169.09 x 0.05 $58.45 per day

DAILY COMPOSITE CREW RATE $1,952.54

6. Equipment Daily Rate $783.45 per day

7. Estimated Production Rate
Form & pour wall estimated @ 50 cy / day (100 cy / 50 cy / per day = 2 days) x 2 days

Concrete 100 cy $45.00 (quote attached) $4,500.00
Consumables @ 3% of labor cost $1,169.09 x 0.03 = 35.07 / day x 2 days 70.14
Safety Supplies @ 1% of labor cost $1,169.09 x 0.01 = 11.96 / day x 2 days 23.92

$7,234.06

8. Materials (see Exhibit B)
Form lumber 20 MFBM @ $240/M (invoice attached) $2,400.00
Form Hardware, lump sum estim. @ 10% of lumber cost 240.00
Concrete 100 cy $45.00 (quote attached) 4,500.00
Consumables @ 3% of labor cost $1,169.09 x 0.03 = 35.07 / day x 2 days 70.14
Safety Supplies @ 1% of labor cost $1,169.09 x 0.01 = 11.96 / day x 2 days 23.92

$7,234.06

9. Subcontract
P&J Concrete quote to place and finish concrete (attached) $2,000.00
R&R Steel quote to furnish and place rebar (attached) 1,275.00

$3,275.00

10. Recap by Cost Category
Labor (#3 x 2 days) $2,338.18
Equipment (#6 x 2 days) 1,566.90
Materials (#8) 7,234.06
Subcontract (#9) 3,275.00

Subtotal Direct Costs $14,414.14
**Delay Damages**

- **Extended Jobsite Overhead** – estimated or from cost accounting records – time dependent costs only
- **Extended Home Office Overhead** – Eichleay formula is applicable only when the contractor cannot obtain other work
- **Escalation** – normally minimal, except for union wage escalation

- **Standby** of Equipment and Labor
- **Under-Utilization** of Labor and Equipment
- **Subcontractor Demobilization and Re-mobilization**
- **Labor Layoff and Re-Hire**
- **Materials Storage, Extra Handling and Deterioration or Theft**

- **Interest** on Retainage and Pending Change Orders
- **Extended Warranty Liability**
- **Lost Profits** or Loss of Operating Business

- **Ripple Effects** of Consequential Delays, Impacts, and Inefficiency
- **Inefficiency** from Changed Working Conditions - e.g. pushing weather-sensitive work into winter
**EXTENDED JOBSITE OVERHEAD**

<table>
<thead>
<tr>
<th>General Conditions Item Description</th>
<th>Cost per Work Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Superintendent</td>
<td>$340</td>
</tr>
<tr>
<td>Carpenter foreman</td>
<td>311</td>
</tr>
<tr>
<td>Job Trailer</td>
<td>16</td>
</tr>
<tr>
<td>Phone/Pager</td>
<td>17</td>
</tr>
<tr>
<td>Fax</td>
<td>8</td>
</tr>
<tr>
<td>Copier</td>
<td>10</td>
</tr>
<tr>
<td>Weather Service</td>
<td>5</td>
</tr>
<tr>
<td>Travel</td>
<td>18</td>
</tr>
<tr>
<td>Storage Trailer</td>
<td>5</td>
</tr>
<tr>
<td>35 ft 4wd Reach Lift</td>
<td>105</td>
</tr>
<tr>
<td>Two 60 ft Boom Lifts (Ivy HiLift)</td>
<td>210</td>
</tr>
<tr>
<td>20 Ton Hydro Crane</td>
<td>720</td>
</tr>
<tr>
<td>Forming Material (Mason's Supply)</td>
<td>429</td>
</tr>
<tr>
<td>Planking Material (Ivy HiLift)</td>
<td>29</td>
</tr>
<tr>
<td>Safety Equipment (harness, lanyards, . . .)</td>
<td>50</td>
</tr>
<tr>
<td>Miscellaneous Tools and Equipment</td>
<td>599</td>
</tr>
<tr>
<td><strong>Total Daily Cost</strong></td>
<td><strong>$2,872</strong></td>
</tr>
</tbody>
</table>

The extended jobsite overhead cost is therefore:

33 days delay @ $2,872/day = $94,776
### Modified Eichleay Formula

- **Original Contract Amount**
  - Total Company Billings During Original Contract Period

- **Overhead Allocated to Project**
  - Overhead Allocated to Project

- **Daily Home Office Overhead Allocated to Project**
  - Days of Delay

- **Total Home Office Overhead During Original Contract**

- **Overhead Allocated to Project**

- **Original Contract Duration**

- **Days of Delay**

- **Extended Home Office Overhead Amount**

\[
\text{Original Contract Amount} \times \frac{\text{Total Company Billings During Original Contract Period}}{\text{Overhead Allocated to Project}} = \text{Overhead Allocated to Project}
\]

\[
\frac{\text{Overhead Allocated to Project}}{\text{Original Contract Duration}} = \text{Daily Home Office Overhead Allocated to Project}
\]

\[
\text{Daily Home Office Overhead Allocated to Project} \times \text{Days of Delay} = \text{Extended Home Office Overhead Amount}
\]
ACCELERATION DAMAGES

♦ Overtime or Shift Work Premium and Fatigue - with resulting inefficiency

♦ Mobiliation and Demobilization - additional/larger equipment, more personnel
♦ Crowding and Trade Stacking
♦ Excessive Activity Re-sequencing and Overlap - with increased conflicts
♦ Start-Stop Operation and Out-of-Sequence Work
♦ Additional Tasks - e.g. better or additional access roads
♦ Increased Errors and Rework - from rushing, insufficient time for layout, etc.

♦ Additional Overhead - to manage the additional work force
♦ Overloaded Supervision and Administration - more errors and less oversight

♦ Expedited Materials Delivery - vendor premiums, rushed procurement/shipping
♦ Additional or More Expensive Materials - that assemble or install quicker
REASONS FOR LOSS OF EFFICIENCY

♦ Adverse of Abnormal Environmental Conditions
♦ Acceleration
♦ Delay
♦ Disruption, Interference, And Change
♦ Inadequate Access and Work Space
♦ Supervision and Management Problems
♦ Resource Problems
♦ Poor Morale
♦ Safety Constraints
♦ Errors
♦ Other
## Reasons for Loss of Efficiency

### Adverse or Abnormal Environmental Conditions
- Rain
- Cold
- Wind
- Combination of Cold, Rain, and Wind together
- Snow
- Heat
- Noise
- Dust or Odors
- Humidity (intensifies effect of heat)
- Poor Lighting or Darkness

### Acceleration
- Overtimes
  - Premium labor rates
  - Fatigue – physical, mental, boredom
- Multiple Shift Operation
  - Overlap between crews
  - Poor lighting
  - Circadian rhythm disruption on swing shifts
  - Lighting for multi-shift operation
  - Shutdown to service equipment
  - Shift premium pay
- Rescheduling and Expediting

### Delay
- Idle Labor and Equipment
- Equipment Standby
- Stretch Out/Working at Reduced Pace – while waiting for delay to be resolved.

### Disruption, Interference, And Change
- Start-Stop Operation
- Fluctuating Labor Force
- Disruption of Work Flow
- Loss of Learning Curve Effect
- De-Mobilization and Re-Mobilization
- Out-Of-Sequence Work
- Crew Imbalance
- Frequent Changes
- Uncertainty
- Limited Flexibility
- Over-Inspection
- Directed Work by Owner

### Inadequate Access and Work Space
- Crowding
- Trace Stacking – crowding and trade conflicts
- Limited Access
- Inadequate Work Areas for laydown, fabrication or circulation

### Supervision and Management Problems
- Dilution of Supervision
- Excessive Supervision
- Poorly Skilled Supervisors
- Increased Supervision
- Overworked Supervisors
- Inadequate Instructions to Crews
- Layout Errors

### Resource Problems
- Shortage of Qualified Workers
- Undersized or Insufficient Equipment
- Excessive Personnel
- Logistics Problems – procurement or delivery of materials

### Poor Morale
- Uncertainty
- Frustration with Rework
- Absenteeism
- Theft
- High Turnover
- Deliberate Slowdown

### Safety Constraints
- Required Safety Measures
- Caution and Slowdown for dangerous conditions
- Disruption and Slowdown resulting from accident
- Increased Accidents

### Errors
- Increased Wastage
- Re-Work
- Increased Clean Up
- Increased Close-Out and Punch List Costs

### Other
- Additional Materials Handling Multiplicity of Changes

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METHODS OF COMPUTING INEFFICIENCY

- Expert Opinion and/or Survey
- Total Cost or Cost Plus
- Modified Total Cost – adjust for bid error, contractor mistakes or misfortune (abnormal weather, accidents, etc.)
- Measured Mile – adjust for learning curve effect
- Industry Studies – charts and formulas
- Scientific Methods – work improvement analysis
- Rational Analysis – a combination of the above
### Total Cost Claim:

\[
\text{CLAIM AMOUNT} = \text{ACTUAL COST} - \text{BID COST} + \text{MARKUP}
\]

Does not consider bid errors, contractor mistakes, or unfavorable conditions. (Seldom used.)

### Modified Total Cost Claim:

\[
\text{CLAIM AMOUNT} = \text{ACTUAL COST} - \text{BID AMOUNT} - \text{BID ERRORS} - \text{MISTAKE} + \text{MARKUP}
\]

Used when information lacking for using other methods.

### Cost Plus Claim:

\[
\text{CLAIM AMOUNT} = \text{ACTUAL COST} + \text{MARKUP}
\]

Used when the work performed is materially different from what was bid, so as to constitute a cardinal change and recovery as quantum meruit.
COMMON BID ERRORS

♦ Quantity Takeoff Errors

♦ Underestimating Difficulty of the work

♦ Underestimating Time to do the work

♦ Wrong Assumptions on manner and methods of doing work

♦ Underestimating Unit Costs of labor, equipment, or materials

♦ Forgetting a work item

♦ Substitutions -- that assume an "as equal" material quote will be acceptable to the designer
1. Identify Representative Periods of Impacted and Un-impacted Work.

2. Determine the Productivity During Each Period – in hours or cost per unit of work accomplished using:
   - Weekly Labor Reports – from the cost accounting system
   - Monthly Progress Payments Monthly – adjust for over/under-billing
   - Other Job Records – e.g. crew size and work accomplished on daily reports
   - Videos, Sequential Still Photographs, or Timelapse Photography
   - Historical Records from Similar Projects
   - Revised Estimates – based on a composite crew and productivity analysis
   - Detailed Work Improvement Analysis

3. Adjust the Un-impacted Work for Learning Curve Effects

4. Compute the Difference in Productivity

5. Compute the Total Loss of Productivity
INDUSTRY STUDIES

- Overtime and Fatigue - Bureau of Labor, NECA, Corps of Engineers
- Crowding and Trade Stacking - Corps of Engineers
- Overstaffing (Oversided Crews) - Corps of Engineers
- Task Reassignment - Corps of Engineers
- Multiple Changes - the Leonard Study
- Environmental Conditions - Temperature, Wind, Humidity
- Rain and Show - no data available
- Combination of Effects - generally not additive
## Labor Inefficiency - Difference in Value

<table>
<thead>
<tr>
<th>Study</th>
<th>50 hr/wk, %</th>
<th>60 hr/wk, %</th>
<th>70 hr/wk, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. Bureau of Labor Standards</td>
<td>92</td>
<td>84</td>
<td>78</td>
</tr>
<tr>
<td>Foster Wheeler</td>
<td>87</td>
<td>73</td>
<td>----</td>
</tr>
<tr>
<td>NECA Survey</td>
<td>88</td>
<td>85</td>
<td>78</td>
</tr>
<tr>
<td>C.F. Braun</td>
<td>87</td>
<td>73</td>
<td>58</td>
</tr>
<tr>
<td>Proctor &amp; Gamble – 12 weeks</td>
<td>84</td>
<td>64</td>
<td>----</td>
</tr>
<tr>
<td>Proctor &amp; Gamble – 4 weeks</td>
<td>90</td>
<td>84</td>
<td>----</td>
</tr>
<tr>
<td>U.S. Army MIEG – 4 weeks</td>
<td>96</td>
<td>79</td>
<td>63</td>
</tr>
<tr>
<td><strong>Average Value</strong></td>
<td><strong>89%</strong></td>
<td><strong>77%</strong></td>
<td><strong>69%</strong></td>
</tr>
</tbody>
</table>
TECHNIQUES FOR ANALYSIS AND FOR FINDING IMPROVEMENTS

- Movable roller conveyors
- Lumber stored on inclined, elevated stands
- Cut pieces stacked by size
- Tunnel rail for cutting

Flow diagram and crew-balance chart for revised method.

*Note: This time either waiting time or pulling down next piece when extra time is required.
Expected range of construction operations

Cost, dollars or man-hours

Number of units

90 percent

70 percent
Cost, dollars or man-hours

Number of units

Expected range of construction operations

90 percent

70 percent

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HOW TO PRESENT & NEGOTIATE CLAIMS

Plan Ahead & Understand Human Behavior

- Adopt a Partnering Approach to Relationships and Conflict
- Understand the Relative Strengths of the Parties
- Understand Human Behavior -- Personality, Conflict & Power
- Develop Skills in Verbal Communication and Negotiation
- Implement a Dispute Management Plan

1. Prepare For Negotiation

   Section C
   - Understand the Issues & Determine the Facts (Chapt. 6-13)
   - Understand the Owner's Policy, Objectives, and Position
   - Develop a Strategy for Negotiation
   - Decide Who Will Negotiate and with Whom
   - Select Tactics to Fit the Strategy and Circumstances
   - Prepare Agenda and Script
   - Prepare Special Exhibits and Handouts
   - Rehearse

2. Make Initial Presentation

   Section D
   - Personally Present Claim At Scheduled Meeting
   - Start With An Overview Of Claim
   - Present Each Issue and Summarize At End
   - Use Exhibits to Communicate and Complement Oral Presentation
   - Ask for Question and Answer Period
   - Listen to Counter-Presentations by Owner's Representative
   - Agree to Facts and Exchange Information
   - If Possible, Negotiate and Document Your Agreements

3. Follow-Up

   Section E
   - Send Minutes of Meeting with Cover Letter
   - Answer Questions and Provide Supplemental Information
   - Conduct Follow-up Meetings to Resolve Questions
   - Respond to Owner's Counter-Arguments
   - Schedule and Track Status of Negotiations

4. Negotiate A Settlement

   Section F
   - Maintain Control of Process
   - Implement Strategy and Tactics
   - Record Negotiations and Document Agreements
   - Take Prompt Action, If Impasse is Reached
   - Close the Deal, If Possible
   - Proceed to Mediation if Negotiations Fail