Constructing a Constructability Review

Introductions

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Learning Objectives

- Identify why a constructability review should be implemented
- Develop an effective team of critical thinkers
- Discern financial benefits of a properly conducted review

Why Implement a Review
Why Implement a Review

PURPOSE

A *Constructability Review* provides a mechanism for effectively integrating both design and construction personnel's expertise and experiences to ultimately improve the quality of project plans.

Any project will benefit from a properly conducted review by reducing occurrences of change orders, claims, delays, and improving relations between owner, management, designer, contractor.

Objectives of implementing a review

- Enhance Early Planning
- Minimize Scope Changes
- Reduce Design Related Change Orders
- Improve Contractors Productivity
- Develop Construction-Friendly Specifications
Why Implement a Review

- Enhance Quality
- Reduce Delays / Meet Schedules
- Improve Public Image
- Promote Construction Safety
- Reduce Conflicts / Disputes
- Decrease Construction/Maintenance Cost

Developing a Comprehensive Team

- Owner/End User
  - PM, Operations, Maintenance, Staff
- A&E Firm/Design Team
  - Based on expertise and bid selection
- Agencies
  - Federal, State, Local, Special Permits (Fire Marshal)
- Construction Management/Inspection
- Contractor
  - Estimator, Superintendent, Foremen
Developing a Comprehensive Team

The Team should be multi-disciplinary
- Should include more than one professional from each required discipline
  - Checks by individuals with the same expertise often find simple errors and omissions and offer valuable suggestions.
- Include individuals with direct construction field experience
  - Early involvement of a construction management and inspection team can provide insight from the view of field technicians who have often provided services on similar projects.
  - Critical Path Scheduling provides a tool to assure the project has sufficient allowances for manufacturing, construction, and should allow simultaneous activities for delay claim avoidance.

Retain services of retired staff
- Both field and office staff may be available to share expertise during a review.
  - Suggested involvement
    - Environmental design/reviewer
    - Maintenance/Operator Staff
    - Retired departmental employees

Lesson learned reports
- Agencies should require this on conclusion of all projects.
- Afford the opportunity to examine where previous bid document errors and omissions occurred and adjust current design.
Constructive & Critical Thinking

DEVELOPING PROJECT PLANS

Conception
♦ Intent of project developed
♦ Implement new technology

Initial Design
♦ Site Investigation
♦ Feasibility studies
♦ As-built research
♦ Test borings
♦ ROW Investigation

30% Plans
♦ Preliminary Project Schedule
♦ Identify any work required to accommodate project
   - Utility relocation, poles, underground utilities
   - Use RFID Technology, BIM, Envision (Innovative)

50% Plans & Project Specifications
♦ CPM Schedule development
♦ Developing practical timeline
♦ Solicit work needed to be done by others
Bid/Selection/Award of CM/I
- Identify Key Staff and disciplines
- Field visit, analysis of existing conditions
- Begin initial formal constructability study included with technical proposals. (Innovative)
- Investigate free review comments

75% Plans & Specifications
- Roundtable session to review changes
- Further refining of Projected CPM Schedule
- Solicit Contractor Input
- Begin work to be done by others

90% Quality Control/Quality Assurance
- Comments from Permitting offices addressed
- Verification of cost estimates
- Roundtable discussion of changes
Constructive & Critical Thinking

- 100% Project Plans
  - Last roundtable review
  - Advertise, pre-bid, Addendum

EXCELLENT
MY WORK HERE IS DONE.

Constructive & Critical Thinking

- THE REVIEW IS NOT DONE

- Construction
  - CPM,
  - Field Engineering,
  - PCO analysis

- Close out / Warranty
  - O&M, As-Built

- Lessons learned
  - Build on experiences for future project betterment

1.) What could happen?
2.) What will we do in response?
3.) What can we do in advance to prepare?
Constructive & Critical Thinking

AVOID PITFALLS

Verify design address ambiguous phrases
- Examples include
  - “Provided by others”, “See Structural”
  - “work done by others”, “as required”, “as needed”
  - “The A/E assumes no responsibility for the completeness of the plans for bid purposes…”

Cut and Paste
- Avoidance of the common practice, to cut and paste specifications and details from similar projects.

Site Investigation
- Requirements of any governing agency
- Existing infrastructure conditions
- As-Built and stakeouts of all utilities
- Sufficient Easements
- Test pit critical crossings
- Cuts/Fills, verify topo data
Constructive & Critical Thinking

Submittal log

♦ The addition of a required submittals and shop drawings serves as a built in review. By thoroughly investigating these requirements the specifications and drawings should be combed to assure all materials are identified.

Cost Estimating

♦ Avoid the reliance on published general cost data.
  ❖ Agencies should keep a real time cost analysis of projects currently in construction or recently completed to be used for estimation comparison.

♦ Construction Management and Inspection firms can also provide regional and valuable data based upon current and previous projects.
Constructive & Critical Thinking

GENERAL QUESTIONS

- Are areas available for, stockpiled materials, laydown, equipment, field offices?
- Are relocated utilities shown in the proposed new locations and referenced to vertical and horizontal controls used on the project?
- Are the pay items in the bid tabulation apparent in the specifications and plans? If items are combined is it clear in the specifications?

Constructive & Critical Thinking

- Will weather and seasonal conditions play a factor on the project schedule due to time of advertisement and start of construction?
- Where practical, have materials been standardized?
  - Increases productivity, allows volume purchases, simplifies material procurement, reduces design time.
Constructive & Critical Thinking

- **EARTHWORK & GRADING**
  - Has the site been investigated for underlying rubble and debris commonly hidden in vegetative overgrowth?
  - Where adequate soil borings done within the limits of disturbance to determine topsoil thickness, suitable soils, possible necessity of select or borrow materials?

Constructive & Critical Thinking

- Where grade changes are proposed has consideration been given to accommodate grade changes to existing properties such as driveways, yard drainage?
- Based upon boring data can phasing accommodate site borrow?
- Define the limits of repair / how compensation made.
Constructive & Critical Thinking

- Do the plans provide **geotechnical solutions for unsuitable materials** and are there items to cover the expense?
- Have environmental boundaries been verified and the best practices of protection implemented?
- Is there any presence of **ground water** that may have to be pumped or drained during and after construction.
- Is there any requirement for reforestation, and is the land required available?

**PIPELINES & DRAINAGE**

- Are potential known conflicts identified and have they been relocated “by others” or has the contract provided allowance for the proposed relocation?
- Do the proposed underground utilities coincide with the project sequence and provide for service and or temporary service during construction?
- Are the native soils more conducive to trenching or boring? Does the underlying material require blasting?
Constructive & Critical Thinking

- Will **pump around** of existing utilities be required and is an acceptable plan with back up identified?
- If conditions allow have pipe slopes been designed to accommodate grade/slope changes in the event of **unforeseen conflicts**? Where tolerances are projected as extremely tight has testpitting been done to verify the elevations?
- Has pipe life cycle and soil conditions been considered and plan for.

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Constructive & Critical Thinking

- **STRUCTURES**
  - Are the soil conditions compatible with the bearing requirements?
  - Where field measurements taken of exiting conditions prior to the drawings specifying lengths and dimensions?
  - Will foundations require dewatering?
  - Can pier size be **standardized** for bridges to allow maximizing of form use?
Constructive & Critical Thinking

- When possible have irregular form shapes been avoided?
- Have the **MEP layers been turned** on with the Architectural drawing to assure they are all in conjunction? Has items such as plenum space been verified?
- If specifications are performance based have gaps been covered? ie... there are no fire sprinkler drawings but has consideration been given to the installation of flow switches?

Constructive & Critical Thinking

**TRAFFIC CONTROL**

- Are detours required and do they fit the design need and minimize disturbance to neighboring areas?
- Has the **affect on local business** been considered when establishing hours of operation?
- Does phasing allow for the conversion of traffic?
- Are work zones sufficient to allow traffic around working/swinging equipment zones?
- Have provisions been made for emergency vehicles?
Constructive & Critical Thinking

- Is the use of protective barriers required? Does the work require sand barrel cushions?
- Is the signing diagram clear and understandable and meet the requirements of each phase?

MAINTENANCE CONSIDERATIONS

- Can the finished product be accessed for routine maintenance such as storm water management ponds, grass cutting, drain cleaning?
- Are all drainage problems adjacent to site addressed and no new problem areas created?
- Can manhole structures be located to minimize exposure to traffic.
- Are proposed slopes minimized to eliminate erosion?
Constructive & Critical Thinking

- Provide conduits for future needs.
- Locate junction/pull boxes away from wheel path of roadways.
- Are current ADA codes implemented?
Discern benefits of a Review

Over-Budget Construction Projects In Comparison
Selected over-budget construction projects worldwide (in U.S. dollars)*

<table>
<thead>
<tr>
<th>Project</th>
<th>Planned</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Channel Tunnel</td>
<td>$21.1bn</td>
<td></td>
</tr>
<tr>
<td>Three Gorges Dam</td>
<td>$16.1bn</td>
<td></td>
</tr>
<tr>
<td>Boston's Big Dig</td>
<td>$13.4bn</td>
<td></td>
</tr>
<tr>
<td>Berlin Brandenburg Airport**</td>
<td>$3.2bn</td>
<td></td>
</tr>
<tr>
<td>Great Belt Fixed Link</td>
<td>$1.8bn</td>
<td></td>
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<tr>
<td>Denver International Airport</td>
<td>$3.1bn</td>
<td></td>
</tr>
<tr>
<td>World Trade Center Transportation Hub**</td>
<td>$2.0bn</td>
<td></td>
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<td>Montreal Olympic Stadium</td>
<td>$3.0bn</td>
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<tr>
<td>Budapest Metro Line 4</td>
<td>$1.6bn</td>
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<td>Millennium Dome</td>
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<tr>
<td>Wembley Stadium</td>
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<td>Elbphilharmonie**</td>
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<td></td>
</tr>
</tbody>
</table>

* Converted to US dollars and adjusted for inflation. ** Still not completed

@Statista @Source: PwC, Der Spiegel, NY Times

Discern benefits of a Review

Example – Cost Overrun Study

  - 70% of Contractors report > 80% of projects over budget - average 14% overrun

Percentage of Infrastructure Projects Completed Over Budget

Percentage of Budget Overrun (For Those Who Report Not Meeting Budget)

Average 10%  Median 15%


AACE International www.aacei.org
Conclusion

- The most qualified constructability reviewers are those individuals that have dealt with the bid document errors and omissions in the field. Managers, inspectors, or superintendents who have directly experienced unclear construction conditions and have settled claims or change orders usually have an excellent background for performing these reviews. Their knowledge is necessary for a comprehensive and successful constructability review.
Conclusion

- Although to this point it has not been mentioned, it is imperative that the designers are checking and back checking that agreed upon constructability comments are incorporated properly in the design.
- A constructability review will pay for itself, when conducted properly and focused on the issues that affect constructability. It can be sometimes difficult to quantify in dollars what a review has saved the owner. You need only to implement a few of the item we have discussed to uncover major and recurring issues to realize its value.

Comments / Questions