CHANGE ORDERS & PRODUCTIVITY

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AGENDA

- SCOPE CREEP = CLAIMS
- BIASES
- THEORY VS. PRACTICE
- QUALIFICATIONS
- CUMULATIVE IMPACT
- MARKUP
CLAIM

Ingredients – Fixed Price Contracts

Poor Scope Definition: Extensive Growth / Rework

Acceleration: Overtime / Congestion

People: no communication and no TRUST

TRUST

➢ BETWEEN PROJECT PARTICIPANTS

➢ WITHIN THE PROJECT TEAM
Most Common Causes of Overrun
(Linkin discussion)

- Scope Creep
- Inadequate Change Management
- Poor Estimates /PM /Project Teams
- Lack of communication
- Ineffective Project Controls

Why Benchmarking in Alberta

- Alberta was experiencing major cost overruns on its mega-projects

- Many of these mega-projects were in Alberta’s oil sands sector

- Oil sands are an important and growing sector of Alberta’s economy
Alberta Report

- In 2003 the Construction Owners Association of Alberta (COAA), in partnership with the Government of Alberta, undertook a benchmarking initiative with CII, taking into account the unique features of Alberta mega projects (many of which are in Alberta’s oil sands)

- 37 (out of a total of 78) projects were analyzed in August 2008 resulting in the “Alberta Report”

- 27 of the 37 oil and gas, half are grassroots

- Total installed costs range from less than $5M (Cdn) to over $100M (Cdn), with eight projects over $1B (Cdn). Average = $368M (Cdn)

Top 5 Factors

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cost</th>
<th>Schedule</th>
<th>Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amount of Unplanned Overtime</td>
<td>% Engineering completion prior to Construction Start</td>
<td>% Engineering completion prior to Construction Start</td>
</tr>
<tr>
<td>2</td>
<td>% Engineering completion prior to Construction Start</td>
<td>Business Market Conditions</td>
<td>Amount of Unplanned Overtime</td>
</tr>
<tr>
<td>3</td>
<td>Business Market Conditions</td>
<td>Craft Labour Skill</td>
<td>Business Market Conditions</td>
</tr>
<tr>
<td>4</td>
<td>Craft Labour Skill</td>
<td>Quality of Field Level Supervision</td>
<td>Quality of Field Level Supervision</td>
</tr>
<tr>
<td>5</td>
<td>Coordination with Plant Shutdown</td>
<td>Weather Conditions</td>
<td>Craft Labour Skill</td>
</tr>
</tbody>
</table>
Industrial Megaprojects
Edward Merrow

“It is far more important to be carefully monitoring engineering than construction! When problems start to show up in engineering, it actually may be possible to do something about them. If the problems are not seen until construction, it is usually too late”
FACT OR FICTION

- Contractors like changes
- Contractors make $$$ (gouge) on changes
- Productivity impact (?) can be quantified on each change
- Contractors make money on the markup in change orders
PROCEEDING WITHOUT AUTHORIZATION

The Conflict between Contract and Practice

CHANGE DIRECTIVE

1.) Make up of Group Do you work for a:

<table>
<thead>
<tr>
<th></th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner organization – buyer of service</td>
<td>19</td>
</tr>
<tr>
<td>Engineering organization – design of service</td>
<td>0</td>
</tr>
<tr>
<td>Contractor organization – builder</td>
<td>14</td>
</tr>
<tr>
<td>Firm that consults to one or more of the above...</td>
<td>13</td>
</tr>
<tr>
<td>Totals</td>
<td>46</td>
</tr>
</tbody>
</table>

41.30%  0%  30.43%  28.26%  100%
2.) Inflation in Claim What is the general level of inflation in claims?  

<table>
<thead>
<tr>
<th>Response</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% higher than actual value</td>
<td>6</td>
</tr>
<tr>
<td>30% higher than actual value</td>
<td>18</td>
</tr>
<tr>
<td>60% higher than actual value</td>
<td>12</td>
</tr>
<tr>
<td>100% higher than actual value</td>
<td>8</td>
</tr>
<tr>
<td>200% or more than actual value</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>44</strong></td>
</tr>
</tbody>
</table>
3.) **Inflation in Extras** What is the general level of inflation in extras?

<table>
<thead>
<tr>
<th>Response</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% higher than actual value</td>
<td>7</td>
</tr>
<tr>
<td>30% higher than actual value</td>
<td>23</td>
</tr>
<tr>
<td>60% higher than actual value</td>
<td>9</td>
</tr>
<tr>
<td>100% higher than actual value</td>
<td>6</td>
</tr>
<tr>
<td>200% or more than actual value</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>

**Responses** 15.56%, 51.11%, 20%, 13.33%, 0%
COST COMPONENTS

- DIRECT COST (CAN BE ESTIMATED)
- IMPACT ON SCOPE (IMPOSSIBLE TO PRICE)
  NEED TO QUALIFY
- INDIRECTS (USUALLY MORE THAN ALLOWANCE IN CONTRACT)

Example

This proposal is based solely on the usual cost elements such as labour, material, and normal markups, and does not include any amount for changes in the sequence of work, delays, disruptions, rescheduling, extended overhead, acceleration, and/or impact cost. The right is expressly reserved to make claim for any and all of these, and related items of cost, prior to any final settlement of this contract.
CHANGE QUOTATION

The price quoted is only for the direct cost of the change. We reserve the right to seek compensation for the impact on contract work and/or the cumulative effect of changes when these costs (if any) can be quantified.

The Great Debate

Owners
Absolutely refuse to accept qualification

Contractors
Need to qualify so as to preserve their right to discuss productivity
**Design and/or Fabrication error**

- Crews tries to make it fit
- Crews stands down waiting for direction / clarification
- Foreman seeks direction from Engineer and tries to get crew working productively
- Demob to an other work face
- When direction is received remob to initial work face
According to Construction Industry Institute (CII) Study (1995):

“generally ... projects with a high % change experience lower craft productivity than projects with little or no change”

Normal?

- As a ratio of Completed Cost to Original Cost Estimate (U.S. Studies 1974-1985)
  - 5 - 10%

- Construction Industry Institute Survey 1995 where Change = Increase in Scope
  - up to 9% (Design-Build projects)
  - up to 15% (Design-Bid Build projects)
LEONARD STUDY

This study determined that:

• 1) The number of change orders issued was not an accurate indication of productivity loss

• 2) The average size of change orders was also not correlated with productivity loss.

• 3) There was a high degree of correlation between loss of labor productivity and the percentage of change orders hours to total contract hours.
% Change orders =

Actual Contract Hours = Total Actual Hours less Change Order Hours and less Unproductive Hours due to Contractor Inefficiencies

\[
\frac{\text{Change Order Hours}}{\text{Actual Contract Hours}} \times 100
\]

Effect of Change Orders on Civil and Architectural Work

Loss of Productivity (%) vs. % Change Orders

- Changes only
- Plus 1 major cause
- Plus 2 major causes

Legend:
- Changes only
- Plus 1 major cause
- Plus 2 major causes
Leonard (1988) - Effect of Change Orders on Electrical and Mechanical Work

<table>
<thead>
<tr>
<th>% Change Orders</th>
<th>Impact on Spent Contract Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spent CH 1,000</td>
</tr>
<tr>
<td>0</td>
<td>Spent CH 1,000</td>
</tr>
<tr>
<td>10</td>
<td>Extra 200</td>
</tr>
<tr>
<td>20</td>
<td>Productivity 180</td>
</tr>
<tr>
<td>30</td>
<td>Extra 200</td>
</tr>
<tr>
<td>40</td>
<td>Total 1,200</td>
</tr>
<tr>
<td>50</td>
<td>Total 1,380</td>
</tr>
<tr>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>
Electrical and Mechanical Work

Construction Productivity Index

% Change Orders

Leonard - Changes only
Leonard - Plus 1 major cause
Leonard - Plus 2 major causes
Ibbs (2005)
Ibbs and Allen (1995)

• This study expanded on the research of Leonard and analyzed projects both impacted by change and non-impacted by change

• Determined that loss of productivity also related to:
  • timing of change: more loss of productivity later in project
  • amount of change: amount of change defined by the number of changes and % change.
  • This study found change as % of change order hours divided by estimated base hours was more significant than % of actual hours (Leonard)

OTHER STUDIES - MECHANICAL CONSTRUCTION
A.S. HANN AND J. RUSSELL (1999)*

Mechanical Construction

Other Studies - Electrical Construction

Electrical Construction

Same authors studied electrical construction and found different variables that affected labor productivity for projects with significant change.

- The number of years of experience of the project manager
- The estimate of change orders as a percentage of the original estimate (expressed in logarithmic units)
- The estimate of change orders expressed in logarithmic units

COMMENT

Lost productivity associated with the cumulative effect of changes is one of the most difficult claims to quantify thoroughly and persuasively (even for the very experienced).

Productivity losses can impact both the changed work and the unchanged (base contract) work.

There is no universally accepted method available at this time to quantify the cumulative losses. Current methods are subject to scepticism and criticism.
Elements of an Effective Change Control System

1. Written change control procedure

2. Accountability to follow procedure

3. Planning input from all stakeholders

4. **Detailed & Realistic** Performance Measurement Baselines

5. Defined approval process
   - Easy for essential changes
   - **Painful** for nice-to-have changes

6. Early communication of a probable change to all affected parties

7. All changes documented

8. Impact analysis (cost, schedule, resources, etc.)

9. Implementation & follow-up

10. Timely
WHEN DOES
CONTRACTUAL MARKUP
COVER THE COSTS OF:
- CHANGE ORDER
PREPARATION
- FIELD OVERHEADS
- HOME OFFICE OVERHEADS

EXTRA WORK
BREAK-EVEN POINT

DIRECT COST VALUE OF CHANGE
CHANGE ORDER PREPARATION

➢ ESTIMATING
➢ PURCHASING
➢ CLERICAL
➢ ADMINISTRATION
➢ COORDINATION
  ➢ SUB-TRADES
  ➢ CONSULTANTS
  ➢ SITE

FIELD OVERHEADS

➢ FIELD COORDINATION
➢ TEMPORARY FACILITIES
➢ ADMINISTRATION
  ➢ MEETINGS
  ➢ CORRESPONDENCE
  ➢ COST CONTROL
HOME OFFICE OVERHEADS

- UTILITIES
- BUILDING
- COMPUTERS
- ADMINISTRATION
- MANAGEMENT
- FINANCING
- INSURANCE
- BONDING
- EXTENDED WARRANTY
- BUSINESS DEVELOPMENT

How does Contractor recover Overheads on Contemplated Changes which do not proceed
RECOGNIZE; REAL COSTS IN DIRECT COST QUOTATION

General Conditions

- Supervision
- Estimating
- Temporary Facilities
- Field Support
- Temporary Utilities
- Construction Equipment
- Special Conditions