Front-End Engineering and Design: Influence Over a Project’s Outcome

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TCM - Cost Engineering on My Mind

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OWN.02

AACE® International’s 54th Annual Meeting
Atlanta, Georgia
Author Biography

• **Degree:**
  – B.S. Civil and Architectural Engineering
  – Minor and Certificate of Business

• **University:**
  – University of Texas at Austin

• **Years of Experience:**
  – Less than 1 Year

• **Professional Field:**
  – Project Management & Project Controls
    with Journeyman Construction

• **Something you do not know about me:**
  – I am currently on the project team for a Courthouse Restoration in Amarillo, TX
  – Hobbies/Interests include:
    • Hiking and Mountain Biking the beautiful trails around central Texas
    • Playing City League Sports
    • Following my alumni Texas Longhorns sports teams
Author Biography

- **Degree:**
  - Bachelor of Science: Mechanical Engineering

- **University:**
  - University of Kansas

- **Years of Experience:**
  - 32

- **Professional Field:**
  - Cost Engineering Consultant: Benchmarking

- **Something you do not know about me:**
  - Rock/Blues artist: www.youtube.com/user/deepblueharp

- **DeepBlueHarp**

- **Walk Away**

- **Caught Between Earth and Glory**

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Focus on Personnel

- Not Systems
- Not Checklists
- Not Processes
- Not Procedures
- And I am NOT going to address:

The Holistic Characterization of Project Dynamics and the Affect on Cost and Schedule from a Statistical View after Normalization of Project Variables within the Subset of Applicable Project Management Drivers…
Schedule Gantt Chart

Total Project Cycle Duration

FEED Duration

Execution Duration

- FEED: 10.97
- EPC: 24.97
- Engineering: 15.97
- Procurement: 17.97
- Construction: 17.93
- Startup: 1.97

Figure 1
Definitions

- **PM**: Project Management: controls project scope (Owner)
- **EM**: Engineering Management: controls project scope (contractor)
- **Engineering Discipline**: develops scope into deliverables
  - Drawings
  - Specifications
  - Procurement
  - Schedules
  - Estimates
  - Engineering Discipline hours do not include EM hours
- **Construction**: builds the asset
- **Construction Management**: controls construction objective
- **Total Office Hours**: PM, EM, Engineering Discipline hours
Critical Success Factors

- FEED Duration is where leadership is most important to set the objectives of the project
- FEED is inefficient by non-germane activities
  - Piping Isometrics before scope of project is determined
  - High risk of engineering items that lock down scope pre-maturely
  - Out-of-sequence work causing rework later in detailed engineering or construction
- FEED should be staffed by high-end professionals

Is our Project Management System Optimized?
Are we accomplishing what we set out to do?
Are we leaders?
### Definitions: Critical Success Factors

<table>
<thead>
<tr>
<th>Metric</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEED Duration Percent of Total Project Cycle</strong> Duration</td>
<td>FEED Duration</td>
</tr>
<tr>
<td>Duration</td>
<td>Total Project Cycle Duration</td>
</tr>
<tr>
<td><strong>Percent of Engineering Discipline hours</strong></td>
<td>FEED Detail Eng Hrs</td>
</tr>
<tr>
<td>complete at Full Funding</td>
<td>FEED Detail Eng Hrs + Execution Detail Eng Hrs</td>
</tr>
<tr>
<td><strong>FEED Percent of Office Hours</strong></td>
<td>FEED hrs (PM + Eng Detail + EM)</td>
</tr>
<tr>
<td></td>
<td>Total Hrs (PM + Eng Detail + EM)</td>
</tr>
<tr>
<td><strong>PM and EM Percent of FEED Office Hours</strong></td>
<td>FEED Hrs (PM + EM)</td>
</tr>
<tr>
<td></td>
<td>FEED Hrs (PM + Eng Detail + EM)</td>
</tr>
</tbody>
</table>

**Table 1: Critical Success Factors**
Key Performance Indicators

- Evaluation of cost and schedule compared to industry average (expressed as an index)
- This is not predictability which is growth (accuracy) from estimate to actual (expressed as a percentage)
- A project can have great performance and lousy predictability
  - The goal is to get both right on target
- Obviously, you have to have a LARGE DATABASE
  - Ours has several thousand projects to perform this type of research
  - We want to roll out a deepwater study at AACE

An Indicator is NOT a guarantee of outcome.
### Definitions: Key Performance Indicators

<table>
<thead>
<tr>
<th>Metric</th>
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</thead>
<tbody>
<tr>
<td><strong>Project Cost Growth</strong></td>
<td>Total Project Cost – Budget at Full Project Funding</td>
</tr>
<tr>
<td></td>
<td>Budget at Full Project Funding</td>
</tr>
<tr>
<td><strong>Project Execution Schedule Growth</strong></td>
<td>Actual Exec. Duration – Predicted Exec. Duration at Full Project Funding</td>
</tr>
<tr>
<td></td>
<td>Predicted Exec. Duration at Full Project Funding</td>
</tr>
<tr>
<td><strong>Total Project Cycle Duration Index</strong></td>
<td>Total Project Cycle Duration_</td>
</tr>
<tr>
<td></td>
<td>Industry Average total cycle duration</td>
</tr>
<tr>
<td><strong>Execution Duration Index</strong></td>
<td>Execution Duration (EPC Duration)_</td>
</tr>
<tr>
<td></td>
<td>Industry Average Total EPC Cycle Duration</td>
</tr>
<tr>
<td><strong>Cost Index</strong></td>
<td>Project Actual $TIC gross_</td>
</tr>
<tr>
<td></td>
<td>Industry average cost</td>
</tr>
<tr>
<td><strong>Rework</strong></td>
<td>(Actual Eng. end date - Actual Constr. start date)</td>
</tr>
<tr>
<td></td>
<td>(Actual eng. duration)</td>
</tr>
</tbody>
</table>

*Table 2: Key Performance Indicators*
Figure 2: Cost vs. Schedule Driven Execution Duration

- **Duration Index**
- **Cost Index**

**Trade-Off Point**

- **Schedule Driven**
- **Cost Driven**

- **Execution Duration**
- **Cost**
Study Focus Areas

FEED (or FEL)

Project Management

Engineering
FEED

Metrics
Before I go any further: a Reminder

- MY DATA
- MY ANALYSIS
- MY CONCLUSIONS
Figure 3

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Figure 9

% Total Office Hours in FEED vs. Predictability

Schedule Growth vs. Cost Growth

Schedule Growth

Cost Growth

Figure 9
A good decision can be made at 10%.
• A good decision can be made with
  – 30% of the Total Project Duration devoted to FEED
  – 10% of the Total Office hours devoted to FEED HOURS
• This is a “leading indicator”
Figure 6

- Blue: Total Project Cycle Duration
- Green: Execution Duration
- Red: Cost
**Conclusion**

- **FEED**
  - Longer FEED = Improved Performance & Lower Eng Hr Growth
  - More FEED Management = Improved Performance
  - More FEED Discipline Engineering = Less Competitive Performance
  - Better to have more Subject Matter Expert engineers

- **A good decision can be made with**
  - 30% of the Total Project Duration devoted to FEED
  - 10% of the Total Office hours devoted to FEED HOURS

- **This is a “leading indicator”**
Project Management Metrics
If you let them continue, they will grow the project.

Figure 11

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PM and EM % of Total FEED Hours vs. Performance

Figure 12

- Total Project Cycle Duration
- Execution Duration
- Cost
• Project Management
  - Figure 11 indicates that there may be little benefit of having more than 20% of the PM and EM total hours expended during FEED
  - However, Figure 12 indicates that more effective use of high-end professional hours (not hours only) may be driving cost and schedule to better performance

  Better scope definition leads to
  Better the project performance

  Invest in PEOPLE
Engineering Metrics
Of Course the Predictability is OK, the estimate is still in revision

Figure 7
For the same cost, a project could have been generating revenue MUCH SOONER than it did.
• **Engineering**
  
  – More Engineering during construction is a large indicator of **REWORK**
  
  – Rushing engineering, shortening FEED work, and pushing engineering to the field (fast track projects) makes the project duration significantly **LONGER**
  
  – **PLAN MORE!**
Conclusion

• **FEED**
  - Is where leadership is most important to set the objectives of the project
  - Is inefficient by non-germane activities
  - Should be staffed by high-end professionals

• **A good decision can be made with**
  - 30% of the Total Project Duration devoted to FEED
  - 10% of the Total Office hours devoted to FEED HOURS

• **Project Management**
  - More effective use of high-end professional hours (not hours only) may be driving cost and schedule to better performance

• **Engineering**
  - More Engineering during construction is a large indicator of REWORK
  - Rushing engineering, shortening FEED work, and pushing engineering to the field (fast-track projects) makes the project duration significantly LONGER
  - Freeze the Scope before starting detailed engineering
Final Word and We’re done…

- Up to 7% longer FEED 2/3 Cycle
- 1 to 5% longer FEED 3 Cycle

- 2 months prior to end of FEED 3
- 15% shorter FEED 2/3 Cycle

20%

40%

N = 73

N = 12

Over Run
FEED > 5

Under Run
FEED Index <= 4.25

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