Battling the Enemy of Predictable Projects

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Exposing the Enemy

Unit rate contractor to drive 20,000 piles on the project in the first six months of construction, planned completion of foundations in two years

An excellent piling contractor was hired and delivered as promised for $8.9MM on a unit rate contract – big win
Success?

Finished Piling – Waiting for Foundations
Projects are naturally unstable and unpredictable

Why?
Variability
- Weather
- Unplanned carry over
- Incidents / accidents
- Labor interruptions
- Discovery
- Rework
- Missing components
- Missing or unclear drawings

“No plan survives contact with the enemy”
- Von Moltke
Agile Replanning Required

Project Production Control

Should Do

Project Controls

Can Do

Did or Did Not Do

Execute work as per production plan

Production Planning

Production Scheduling

Standard Processes

Production

Scheduling

Execute work as per production plan
Audience Poll

On average what percentage of craft work planned one day in advance is actually completed?

A. 80-100
B. 60-80
C. 40-60
D. 20-40
E. 0-20
Agile Replanning Required

Project Production Control

Should Do

Project Controls

Project Production Control

Can Do

Production Scheduling

Production Planning

Execute work as per production plan

Did or Did Not Do

Standard Processes
Most variability results from decisions made and human nature to protect ourselves.

- Fabricate
- Deliver
- Install

Inventory (finished drawings/specs) to decouple engineering from fabrication enabling optimization of technical and fabrication capacity/materials utilization — may also be required by outside stakeholders.

- Engineer
- Fabricate
- Deliver
- Install

Inventory (finished goods) to decouple fabrication from site installation enabling optimization of capacity use including transportation.

Work-in-process (inventory) and/or time to decouple operations between trades or crews enabling optimization of capacity onsite.

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Self inflicted variability degrades performance

Execution Complexity
Complex designs
Matrix engineering
Scope differences at contractor interfaces
Different rates of work between trades or contractors
Design changes
Differences in construction methods
Complex contracting strategies
Complex compensation
Carry over
Case Study

High Execution Complexity
Seeking Lowest Cost

Equipment suppliers

Engineering

Equipment Ocean Transport

Modules Ocean Transport

Modules Inland Waterway

Module Fabrication

Steel
Pipe
Cable
Execution Simplified
Lower Variability ➔ Lower Ultimate Cost

Equipment Transport:
- Rail
- Truck
- Barge

New Module Fabrication Facility

Engineering
Equipment suppliers
What are the implications for Energy Transition Projects?
Energy Transition - Two Kinds of Projects

Giga Scale

- **Color**
  - GREY HYDROGEN
  - BLUE HYDROGEN
  - TURQUOISE HYDROGEN
  - GREEN HYDROGEN

- **Process**
  - SMR or gasification
  - SMR or gasification with carbon capture (85-95%)
  - Pyrolysis
  - Electrolysis

- **Source**
  - Methane or coal
  - Methane or coal
  - Methane
  - Renewable electricity

Distributed Large & Small Scale “Deployment”
Unique Challenges

- Marginal economics
- Startups companies without capabilities to commercialize
- Small “mom and pop” EPC’s that don’t know how to deliver
- Big players inability to innovate
- Volatile supply chain due to geopolitical issues
- High product demand
- Low owner / contractor capacity and competence
- Competition with other sectors for resources
- Technology gaps - what is available today vs what is needed
- Private Equity’s seeking high returns
Deployment Projects Are Surprisingly Complex
<table>
<thead>
<tr>
<th><strong>GI GA SCALE</strong></th>
<th><strong>DEPLOYMENT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>One location / jurisdiction</td>
<td>Multiple locations / jurisdictions</td>
</tr>
<tr>
<td>Dedicated design firm</td>
<td>Numerous design firms</td>
</tr>
<tr>
<td>One permit</td>
<td>Numerous permits</td>
</tr>
<tr>
<td>Engineered to Order</td>
<td>Typically, standard product that is localized</td>
</tr>
<tr>
<td>Many suppliers feeding to one location</td>
<td>Many suppliers feeding to numerous locations</td>
</tr>
<tr>
<td>Single lead contractor</td>
<td>Multiple contractors</td>
</tr>
</tbody>
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Strategies to Manage Variability

- Startups partner with majors to commercialize
- Work with suppliers in a very different way. Align their production systems with program needs
- Standardize designs and customize only for local requirements
- Manage to an optimal level of WIP
- Standardize work sequence and work flows so local contractors can work effectively
- One design team
- Simplify design as much as possible even at apparent increased initial cost
- Strong owner involvement
- Use simple / straightforward contracts
- Manage as a program not individual projects
- Map, model and control the portfolio of similar investments
Production System Modelling – A Powerful Tool
What was the probability that the subassemblies would arrive at the fabrication yard in time for the sequence of integration?

A. 80-100
B. 60-80
C. 40-60
D. 20-40
E. 0-20
Production System Modelling – A Powerful Tool

“Even in the case of almost perfectly reliable flows (99% reliable, by the agreed upon lead time), the probability (that subassemblies) arrive to the fabrication yard or assembly points just in time ready for integration is 60% (P=0.99^50 = 0.6), meaning a 40% percent chance of failing due to supply chain complexity. However, we know supply reliability is not near 99% and probably ranges between 50%-70%, which results in 99.99% probability of failure to arrive when needed for integration.”
Five Levers Work Together

“No free moves”
Balanced Work Rates

Reduce Variability
Manage WIP

Drive Piles
Crop Piles
Install UG Piping
Form Foundations
Pour
Strip

Drive Piles
Crop Piles
Install Underground Piping
Form Foundations
Place Rebar
Pour
Strip

ECC PerspECtive
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PPI 10th Annual Symposium
09 November, Houston