Project Production Institute
Challenges and Myths of Offsite Fabrication for Mega Projects

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How did we get here and why is there a need for change in project delivery?

• Increasing non-standard projects with challenges
  – Technology (deep water, pre-salt, Arctic)
  – Organization (multiple owners)
  – Geopolitical (location, non-commercial interests)

• Performance is declining despite:
  – Best in class process (FEL and Stage Gate)
  – Best in class systems (sophisticated & proprietary)
  – Best personnel

• Risk is being declined by the EPC contractors
  – Performance incentives have minimal effect
  – Risk increasingly carried by owners

• Pressure to improve ROC or Capital Efficiency
What has been the industry response to increasingly poor project performance

• Increasing owner supervisory staff numbers
• Increasing detail and assessment for front end loading
• Non-standard custom intervention on projects
• Global procurement
• Changes in methods (Modularization)
3rd level Modular Site Envelope Statistics

Traditional 320,000 m²

2nd level 200,000 m²

3rd Level 84,000 m²
3rd Level Modularization
Quantities Impact

QUANTITY DELTA 2nd GEN TO 3rd GEN

<table>
<thead>
<tr>
<th>COST ACCOUNT</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation &amp; Piling</td>
<td>-35%</td>
</tr>
<tr>
<td>Concrete</td>
<td>-60%</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>+50%</td>
</tr>
<tr>
<td>Buildings</td>
<td>0%</td>
</tr>
<tr>
<td>Mechanical Equipment</td>
<td>-20%</td>
</tr>
<tr>
<td>Piping</td>
<td>-20%</td>
</tr>
<tr>
<td>Electrical</td>
<td>0%</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>0%</td>
</tr>
<tr>
<td>Insulation</td>
<td>-20%</td>
</tr>
</tbody>
</table>
3rd level Modularization
Quantities, Effort Hours and Cost Impact
3rd Level Modularization
Execution/Engineering Differences

• “Modularization drives layout”, not the layout driving modularization
• Integration required across the entire supply chain
• Vendor data is critical to support the design
• Engineering must work as a totally integrated team
• Interconnecting pipe racks not used
• Offshore design practices utilized where practical
• Weight and dimension management critical to success
Case Study

3rd Level Modularization Cost Impact

• When Modularization applied to 75% of the total project:

• Cost savings resulting from:
  − Reduced quantities due to smaller footprint
  − Productivity gain for work shifted to shop
    ○ Average 40% decrease in hours for module assembly vs. equivalent scope in the field
  − Reduced indirect costs with less field hours
Modularization Integrated Planning, Supply Chain Management and Project Execution

Modular engineering has additional constraints
  • Module boundary defines available volume
  • Effective layout dependent on component dimensions

Engineering work packages are more detailed
  • Certified vendor data required earlier
  • Parallel multi-discipline collaboration
  • Vertical distributed execution with New Delhi

Fabrication work packages are highly structured
  • Modeling more detailed
  • Compilation of documents required earlier
  • Fabrication shop input during design
  • Material delivers critical

Work face planning
  • Dependent on receipt of information and materials
Case Study
Modularization Execution Differences

Design and Module Assembly
• Module fabricators participated in constructability reviews
• Complete E&I installation pre-module shipment
• Module shop completions and pre-commissioning activities
  – Hydro-testing and flushing
  – Insulation
  – Vessel inspection and final closure
  – Cold alignment
  – Continuity testing and motor run-ins
  – Instrument calibration
• Complete turnover packages at module shop
Case Study
Modularization Execution Differences

Material Management
• Early focus on all POs for vendor data
  − Engineering only release of initial POs
  − Commercial protection (cancellation, pricing and escalation)
• Supply agreements
  − Equipment (client preferred vendors) incl. electrical
  − Structural steel
  − Piping bulks
  − Electrical cables
  − Controls Systems
  − Main automation contractor
• Material planning and control
  − Same process as steel and piping for 2nd Generation
  − Extend to E&I
  − Use of material management system
  − Expediting for specific module needs
• Solid Logistics and Weight Management Plan
Case Study
Modularization Execution Differences

Site Construction
• Construction sequence firmly established in FEED
• Modularization schedule based on construction sequence
• Engineering deliverables based on modularization schedule
• Shifted the work to the module yard
• Significantly smaller CM team
• E&I shop work dramatically reduces back-end completion scope and complexity
• Reduced risk
  - Enhanced safety (Key selection criteria on module bidders)
  - Improved operations and maintenance
  - Less winter schedule issues
  - More work in controlled environment
  - Reduced schedule once modules in place
  - Cost and schedule certainty with reduced E&I field scope
Challenges
• Engineering design is more complex
• Competent modular design skills in short supply (offshore skill)
• Full Integration of team is vital
• Design information is required in different and more complete form
• Global supply chain exponentially increases difficulty
• Integrated vendors are beginning to have competitive advantage
• Requirement for manufacturing production skills
• Logistic evaluation a key deliverable

Myths
• Saves money – total lifecycle cost is higher as focus is shifted
• Can be managed by construction staff and labor
• Less problems during execution
• Changes can be incorporated
Ultimate modularization
Shell Prelude
Questions?