CONQUERING THE SUMMIT
ASPIRING TO FLAWLESS PROJECT DELIVERY

45TH

ECC CONFERENCE
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Modularization: When Is It Effective?

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Project Director; Fluor
Modularization
Overview

- Introduction
- When is Modularization Effective?
- Industry Implementation of Modularization
- Industry Terminology
- When Modularization Decision Needs To Be Made
- Execution Approach Differences
- Benefits of Modularization
- Challenges
- Market Trend
- Conclusion
- Q&A
Modularization

Introduction

- Modularization is an execution approach for design, procurement, contracting and construction that shifts site construction hours away from the site.
- Includes skids, pre-assemblies, entire process structures, machines, and other structures including bridges.
Modularization

Introduction – Very Large Module (>600Tons)
Modularization
Introduction – Small Truck-able Module (<60Tons)
Modularization
Introduction – Pipe Rack Modules
Modularization
Introduction – Ship Mounted Module
Modularization
When is Modularization Effective?

• Client business drivers supporting module design:
  – Remote site access
  – Severe site weather constraints
  – Schedule-driven improvement
  – Limited availability of regional skilled labor/ imported construction labor/ man camps
  – Extensive Factory Acceptance Testing (FAT) desired
  – High module potential / repeatable facility construction
  – High density piping areas
  – May be the only option
Modularization
Industry Implementation of Modularization

• Modular facilities world-wide
  – Fixed and floating offshore applications
  – Onshore production and pipeline projects

• Remote arctic & temperate locations
  – Remote from tidewater, with constraints of land transport logistics and cost

• Global Industries using Modularization
  – Infrastructure (bridge sections, buildings)
  – Power (HRSGs, equipment and piping, piperacks)
  – Manufacturing and life sciences (process buildings)
  – Mining (process facilities, piperacks)
  – Upstream (offshore installations)
  – Downstream (process equipment, piperacks)
## Modularization

### Industry Terminology

<table>
<thead>
<tr>
<th>Module Type</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Large Modules (VLMs)</td>
<td>&gt; 600 tons</td>
</tr>
<tr>
<td>Large Modules</td>
<td>100 to 600 tons</td>
</tr>
<tr>
<td>Intermediate / Medium Modules</td>
<td>60 to 100 tons</td>
</tr>
<tr>
<td>Small / Truckable Modules</td>
<td>60 tons or less</td>
</tr>
<tr>
<td>Piperack Modules</td>
<td></td>
</tr>
<tr>
<td>Skid-mounted Equipment Modules</td>
<td></td>
</tr>
<tr>
<td>Hybrid Modules</td>
<td>Partially in the fab. Yard Finished and assembled on site</td>
</tr>
<tr>
<td>Barge / Ship Mounted Modules</td>
<td>Such as FPSO, FSOs, FLNG</td>
</tr>
</tbody>
</table>
1. Define Business Drivers
2. Accumulate Information
3. Strategic Evaluation
4. Develop Alternative Cases
5. Decide Level of Modularization and Complex Preassembly
6. Develop Estimates, Quantities, and Schedules
7. Complete Project Execution Plan
When Modularization Decision Needs To Be Made

- The decision to modularize on a project needs full and early commitment from all stakeholders.
Modularization
Execution Approach Differences

- Early Engineering
- Early Procurement
- Activities Sequence
- Fabrication Organization
- Interface Management
- Operations & Maintenance
Modularization

Benefits of Modularization

- Safety
- Cost
- Schedule
- Project Risks
- Projected Results
Modularization
Benefits of Modularization

• Safety
  – Work shifted to controlled shop environment
  – Reduced total site hours
  – Reduced work at high elevations
  – Potential reduction in crane usage
Modularization
Benefits of Modularization
Modularization

Benefits of Modularization

• **Cost Savings**
  - Reduced quantities for smaller footprint
  - Productivity gain for work shifted to module yard
  - Reduced indirects with less field hours
## Materials Quantities Comparison *

<table>
<thead>
<tr>
<th>Prime Account</th>
<th>Quantity Delta (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavation, Backfill &amp; Piling</td>
<td>-5</td>
</tr>
<tr>
<td>Concrete</td>
<td>-30</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>45</td>
</tr>
<tr>
<td>Mechanical Equipment</td>
<td>0</td>
</tr>
<tr>
<td>Piping</td>
<td>-15</td>
</tr>
<tr>
<td>Electrical</td>
<td>-20</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>0</td>
</tr>
<tr>
<td>Insulation</td>
<td>-15</td>
</tr>
</tbody>
</table>

*Maximized Process Units and Pipe Racks Modularization*
# Modularization

## Benefits of Modularization

<table>
<thead>
<tr>
<th>Labor Relocation to Module Yard(s)</th>
<th>Percent Work in Module Yard(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct Field Cost</strong></td>
<td></td>
</tr>
<tr>
<td>Civil</td>
<td>0%</td>
</tr>
<tr>
<td>Concrete</td>
<td>0%</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>80%</td>
</tr>
<tr>
<td>Buildings</td>
<td>30%</td>
</tr>
<tr>
<td>Mechanical Equipment</td>
<td>30%</td>
</tr>
<tr>
<td>Piping</td>
<td>63%</td>
</tr>
<tr>
<td>Electrical</td>
<td>20%</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>20%</td>
</tr>
<tr>
<td>Insulation</td>
<td>65%</td>
</tr>
<tr>
<td>*<em>Average</em></td>
<td><strong>44%</strong></td>
</tr>
</tbody>
</table>
Modularization Challenges

• Increased Planning
  — Logistics
  — Engineering / Procurement
• Early Engineering / Procurement
• Increased Cost of Engineering
• Increased Shipping Cost
• Increased Steel Quantities
• Increased Equipment damage potential
• Additional rigging / lifting requirements
• Module plan interfaces
Modularization
Market Trend

• Modules are becoming more condensed
• Dependence on fit for purpose designs to drive down costs
• Start up times after minimized Shipping solutions are very creative, nothing to big or too small
• Project & risk management overcoming challenges to deliver success
Modularization
Conclusion

• When is it efficient to Modularize?
• Decision Timing & Planning
• Modularization Benefits and Challenges
• Owner operations personnel to be involved from start
• Design takes longer, but installation at site means overall project schedule improvement
• Complete project team buy-in and alignment