Modularization

Introduction

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Modularization

1. Modularization drivers
2. Module types
3. Installation methods
4. Engineering and Procurement impacts

Turner Industries

5. Logistics
6. Module Fabrication
7. Critical success factors
Introduction
To
Foster Wheeler
International Engineering Firm (EPC)

with over 100 Years of

Dedicated Services to the

Process and Energy Industries
A global business: over 10,500 highly skilled people

A global network of high-quality resources, enabling us to deliver local service and local content, and to access local labor markets
FOSTER WHEELER LIMITED

ENERGY EQUIPMENT
FW Energy International
FW Energy Corp.

ENGINEERING AND CONSTRUCTION
FW USA Corp.
FW Energy Limited - U.K.
FW Continental Europe
FW Asia Pacific

2006 Revenue: $2.8 Billion   Backlog: $5.4 Billion
| ENGINEERING & CONSTRUCTION SERVICES (EPC or EPCm) | Refining  
Petrochemicals  
Chemicals  
Hydrogen / GTL / Gasification  
Oil and Gas  
Power  
Pharmaceuticals and Fine Chemicals  
Build Own and Operate |
|-------------------------------------------------|-------------------------------------------------|
| EQUIPMENT SUPPLY | Fired Heaters  
Coke Drum Unheading Systems  
Steam Generators  
Boilers  
Condensers  
SCR’s |
- 200+ Hydroprocessing Units
- 200+ Crude Units
- 200+ Vacuum Units
- 80+ Catalytic Reforming Units
- 100+ FCC Units
- 80+ Cokers
- 40+ Alkylation Units
- 50+ Deasphalters
- 20+ Catalytic Polymer Units
- 30+ Aromatics units
- 20+ Lube refineries
- 50+ Hydrogen Plants
- 80+ Sulfur Plants

Reactors Regenerator Assembly with UOP VSS Technology at Premcor FCCU, Memphis, TN
<table>
<thead>
<tr>
<th>Location</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>1,300</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>3,200</td>
</tr>
<tr>
<td>Italy</td>
<td>1,200</td>
</tr>
<tr>
<td>France</td>
<td>500</td>
</tr>
<tr>
<td>Spain</td>
<td>650</td>
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<tr>
<td>Singapore</td>
<td>400</td>
</tr>
<tr>
<td>Thailand</td>
<td>600</td>
</tr>
<tr>
<td>China</td>
<td>900</td>
</tr>
<tr>
<td>Other worldwide</td>
<td>1,750+</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10,500+</strong></td>
</tr>
</tbody>
</table>
- FW Houston presence since 1940s
- Since 1994, U.S. EPC Center for Oil & Gas, Refining, and Petrochemical Projects
- Office space in 3 buildings
- Capacity for over 1200 Engineering and Design Staff
- Fully Integrated Design Systems (CAD) and Communications Technology
End market diversity of backlog

December 29, 2006
Total: $5.4 billion

- Oil & Gas: 16.6%
- Refining: 32.0%
- Chemicals: 29.0%
- Power Equip. & Services: 17.2%
- Pharmaceuticals: 2.0%
- Power Plant Ops, Other & Eliminations: 3.2%

Backlog includes flow-through costs
Modularization

1. Modularization drivers
2. Module types
3. Installation methods
4. Engineering and Procurement impacts
Modularization execution benefits:

1. Cost reductions
2. Schedule reductions
3. Risk reductions
Modularization

**Cost Downside**

- Increased cost of steel
- Increased cost of shipping
- Potentially - increased cost of transport and installation
Modularization

**Cost Downside**

- Increased cost of steel
- Increased cost of shipping
- Potentially - increased cost of transport and installation
- Increased cost of engineering
Modularization

**Cost Upside**

- Move labor cost offsite to cheaper labor supply
- Reduce indirect costs (camp, construction supervision, consumables etc at the site rates)
- Improved productivity (weather, flexible workforce, site accessability etc)
- Reduced schedule - reduces construction indirects
- [Positive impact to NPV if revenue stream begins earlier]
## Cost Benefits

### Economic Productivity Factor

<table>
<thead>
<tr>
<th></th>
<th>On-site</th>
<th>Off-site</th>
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</thead>
<tbody>
<tr>
<td>Labour Productivity</td>
<td>1.70</td>
<td>1.2</td>
</tr>
<tr>
<td>Composite Manhour cost</td>
<td>$105.00</td>
<td>$55.00</td>
</tr>
<tr>
<td>Relative manhour cost c/w Gulf Coast</td>
<td>$178.50</td>
<td>$66.00</td>
</tr>
<tr>
<td>Economic productivity ratio</td>
<td>2.70 : 1</td>
<td></td>
</tr>
</tbody>
</table>
## Cost Benefits

Economic Productivity Factor using Far East Yards

<table>
<thead>
<tr>
<th></th>
<th>On-site</th>
<th>Off-site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour Productivity</td>
<td>1.70</td>
<td>3.5</td>
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<tr>
<td>Composite Manhour cost</td>
<td>$105.00</td>
<td>$12.10</td>
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<tr>
<td>Relative manhour cost c/w Gulf Coast</td>
<td>$178.50</td>
<td>$42.35</td>
</tr>
<tr>
<td>Economic productivity ratio</td>
<td>4.21</td>
<td>1</td>
</tr>
</tbody>
</table>
Modularization

MODULE vs STICK COST DIFFERENTIALS

Modular versus Stick built costs
Existing Project Data
(Note – All projects have different cost drivers)

Millions $

Installation cost Δ
Shipping cost Δ
Const. Mgmt cost Δ
Foundation cost Δ
Steel cost Δ
Engineering cost Δ
Camp cost Δ
labor cost

Modular Cost
Stick built Cost
Savings

15 August 2007
Modularization

COST DRIVEN MODULAR PROJECT

SCHEDULE DRIVEN MODULAR PROJECT

COST DRIVEN STICK BUILT PROJECT

Modular versus Stick built costs

Modular versus Stick built costs

Modular versus Stick built costs

Cost driven modular project

Schedule driven modular project

Cost driven stick built project

Installation cost

Shipping cost

Steel cost

Engineering cost

Camp cost

Labour cost

Modular Cost

Stick built Cost

Modular Cost

Stick built Cost

Modular Cost

Stick built Cost
# Modularization

## Schedule benefits

- **Stick Built Project**
  - Civils
  - Mechanical, E & I
  - Commissioning

- **Modular Project (Early Start)**
  - Civils
  - Mechanical, E & I
  - Commissioning
  - Shop fab

- **Modular Project (Late Start)**
  - Civils
  - Mechanical, E & I
  - Commissioning
  - Shop fab
Modularization

Schedule Comparison – Modular vs Stick Built

Progress %

Duration - Months

- Order Placement
- Engineering
- Construction

Modular

Stick Built
Modularization

1. Modularization drivers
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Module Types

1. Pre – Assembled Units (PAU’s)

Multi disciplined modules including:

- tagged and non tagged items, steel, piping, electrical, instrumentation, fireproofing, insulation
Module Types

1. Pre – Assembled Units (PAU’s)
Module Types

1. Pre – Assembled Units (PAU’s)
1. Pre – Assembled Units (PAU’s)
Module Types

2. Pre – Assembled Racks (PAR’s)

Piping modules including:

- steel, piping, electrical cable tray, fireproofing, insulation
Module Types

2. Pre – Assembled Racks (PAR’s)
Module Types

2. Pre – Assembled Racks (PAR’s)
3. Vendor Assembled Units (VAU’s)

PAU’s assembled by a vendor
BHPBilliton – Module Types

3. Vendor Assembled Units (VAU’s)
Module Types

4. Vendor Package Units (VPU’s)

Complete packages purchased from a vendor
Module Types

5. Remote Instrument Buildings (RIB’s) Sub-stations etc
Module Types

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Modularization

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Installation Methods

Crane Installation
Installation Methods

Strand Jack Installation
Installation Methods

Transporter
Installation
Installation Methods

Transporter Installation
Installation Methods

Transporter Installation
Installation Methods

Jack-down Installation
Modularization

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Planning is Critical for Modular Projects

- Turnover & Commissioning schedule
- Construction area sequence
- Module installation sequence and schedule
- ROS dates for equipment and materials
- Engineering deliverables schedule
E & P Impacts

Differences can include
- Location of pumps

Modular

Stick built
E & P Impacts

Differences can include

- Pipe track to pipe rack
E & P Impacts

Differences can include

- Pipe track to pipe rack

Easy Install

Easy Ship
Differences can include
- Pipe track to pipe rack

Additional clearance can be provided where required
E & P Impacts

Piping design file layout

- Link files for pipe stressing
- Split files for quantity takeoff and procurement
E & P Impacts

Site based Loads, Clearances and Critical Dimensions

- Crane loads
- Module clearances
- Crane clearances
- Foundations to leave low
- etc
Transporter Installation
E & P Impacts

Loads applied to Modules

- Fabrication yard supports
E & P Impacts

Loads applied to Modules

- Transporting in the Module yard
Module yards
E & P Impacts

Loads applied to Modules

- Sea acceleration forces during shipment
E & P Impacts

Loads applied to Modules

- Sea acceleration forces during shipment
Type of ship – RO-RO, LO-LO, H/L
E & P Impacts

Loads applied to Modules

- Transporting on site
E & P Impacts
E & P Impacts

Logistics and therefore loads imposed is project specific
E & P Impacts

Loads applied to Modules

- Installing on site
E & P Impacts

Loads applied to Modules

- In-situ on foundations
Procurement Complexity

- Number of delivery locations impact ordering and material tracking
E & P Impacts

Procurement Complexity

Material Logistics for the modularized Project

- Modules and major equipment
- Bulk Materials and minor equipment

Module Fabrication Yard

Port

Dock

Transport

Module Deliveries

Equipment Deliveries

Install

Truck

Material Yard
E & P Impacts

– Potential to ship stick built materials in “dead space” on HL ships
E & P Impacts
E & P Impacts

Loads applied to Modules
Modularization

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Critical Success Factors include:

- Experienced team with tried and proven systems

<table>
<thead>
<tr>
<th>Client / Project</th>
<th># Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goro Nickel Project</td>
<td>625</td>
</tr>
<tr>
<td>Singapore Aromatics</td>
<td>213</td>
</tr>
<tr>
<td>TARP, Thailand (2X strategy)</td>
<td>65</td>
</tr>
<tr>
<td>Celanese, Singapore</td>
<td>25</td>
</tr>
<tr>
<td>ExxonMobil LSADO Altona (FEL)</td>
<td>13</td>
</tr>
<tr>
<td>SINCOR (FWUSA Shop)</td>
<td>10</td>
</tr>
<tr>
<td>Clark/Premcor, Texas</td>
<td>12</td>
</tr>
<tr>
<td>Shell, Deer Park, Texas</td>
<td>14</td>
</tr>
<tr>
<td>Mobil Coryton, UK</td>
<td>53</td>
</tr>
<tr>
<td>Statoil, Norway (1980s)</td>
<td>205</td>
</tr>
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