Modularizing SAGD Plants
Paradigm Shifts

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Executive Director
Subject Matter Expert Modular Execution
And 3rd Gen Modular Execution℠

APEGA SAGD FORUM
Presentation Outline

- Fluor Canada Introduction
- The Current Status of Modular Design and Execution
- 3rd Gen Modular Execution™ Design and Execution
- Questions
Fluor Overview

- Fluor is the largest publicly traded engineering, procurement, construction, maintenance, and project management companies in North America
- Over 1,000 projects annually, serving more than 600 clients in 66 different countries
- Workforce of over 42,000 men and women executing projects globally
- Celebrated 100 years in 2012
Investment Risks in Oilsands Projects

“Oil sands production is expensive and faces significant risks associated with its environmental and social impacts,”
Ref: Globe & Mail, May 17, 2010, Investment risks rising in oil sands: report by RiskMetrics Group

“For the coming decade, Alberta could experience a labour shortage of approximately 114,000 workers.”
Ref: Employment Alberta 2010; Demand and supply outlook

“Companies have worked hard at ‘modularizing’ projects in order to maximize labour productivity”
Ref: University of Alberta School of Business, Rob Engelhardt and Marius Todirescu, February 10, 2005, “An Introduction to Development in Alberta’s Oil Sands”
Case for Industry Action

**Fact:** Historical step-change productivity gains by manufacturing & ship-building

Construction, Manufacturing & Total Industries Labor Productivity (1977-2007)

volume indices, 1977 = 100

"Items that were stick built in the field are now modularized. Typically, a few years ago, 35 to 40 per cent was modularized. Now 50 to 60 per cent of components are modularized,“

- ref: Alberta Construction Magazine 2006 Godfrey Budd “Better modular design prepares sector for turbo-charged activity”
% Modularization is currently at the maximum on SAGD Projects

- Note % Modularization: Total hours moved offsite divided by total construction hours in a stick build execution \(^{\text{Ref: CII RT 283 Definition}}\)

- SAGD Facilities have no space limitations. There is no lack of plot space available
Small or truckable modules.

Designed to fit a 13’ (4.0m) H x 13’ (4.0m) W x 60’ (18.3m) L envelope and weigh about 60 tons (54 tonnes).

Where high load corridors are established, the modules can be designed to fit a 24’ (7.3m) H x 24’ (7.3m) W x 120’ (36.6m) L envelope and weight up to 160 tons (145 tonnes).
The Current Status of Modular Design and Execution

◆ 1st Generation Modular Execution
  ▪ Piperacks or PARs

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The Current Status of Modular Design and Execution

◆ 2nd Generation Modular Construction Execution
  ▪ 1st Generation plus:
  ▪ Equipment or PAUs (Preassembled Units)
    – Equipment on module
    – Modules around equipment
  ▪ Pre-Dressed Vessels
  ▪ Improvement with Hours Moved Offsite:

<table>
<thead>
<tr>
<th>COST ACCOUNT</th>
<th>Hours Moved Offsite</th>
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<tbody>
<tr>
<td>STRUCTURAL STEEL</td>
<td>65%</td>
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<tr>
<td>EQUIPMENT</td>
<td>21%</td>
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<tr>
<td>PIPING</td>
<td>53%</td>
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<tr>
<td>ELECTRICAL</td>
<td>25%</td>
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<tr>
<td>INSTRUMENTATION</td>
<td>15%</td>
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<tr>
<td>INSULATION</td>
<td>50%</td>
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</table>
Need to Provide More Innovative Solutions

- To address client drivers of reduced capital cost for In-Situ Oilsands developments
- Improved predictability of project execution results for Oilsands Facilities constructed in Alberta
- Current project development and execution approaches are “traditional” with a significant level of site construction required. This adds cost to projects and puts more risk on predictability of results
- Fluor develops Modularization Improvement Initiative
Fluor has developed a 3rd Gen Modular Execution® Methodology

- Past modular projects evaluated
- Offshore design methods evaluated
- Facility interconnections evaluated
- Power and control distribution evaluated
- All available technologies evaluated

Patent Pending to protect intellectual property
The work process starts with process engineering, who conceptually divides the project into various process blocks (systems within a distinct geographical boundary).
Work Process Introduction
Process Block Concept

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Typical 3rd Gen Modular Execution SM
Process Facility Using Process Blocks
Typical 2nd Generation Modularized Plot Plan
Upstream Heavy Oil (In Situ) Facility

Approximate Plot Area = 200,000 Square Meters

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Typical 3rd Gen Modular Execution$^{SM}$ Plot Plan
Upstream Heavy Oil (Insitu) Facility

Approximate Plot Area = 84,000 Square Meters

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3rd Gen Design Site Envelope

- Traditional: 320,000 m²
- 2nd Generation: 200,000 m²
- 3rd Generation: 84,000 m²

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## Quantities Impact

<table>
<thead>
<tr>
<th>COST ACCOUNT</th>
<th>Quantity Delta 2nd Gen to 3rd Gen</th>
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<tbody>
<tr>
<td>Excavation, Backfill &amp; Piling</td>
<td>-35%</td>
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<tr>
<td>Concrete</td>
<td>-60%</td>
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<tr>
<td>Structural Steel</td>
<td>+20%</td>
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<tr>
<td>Buildings</td>
<td>-20%</td>
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<tr>
<td>Mechanical Equipment</td>
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<tr>
<td>Piping</td>
<td>-20%</td>
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<tr>
<td>Electrical</td>
<td>-30%</td>
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<tr>
<td>Instrumentation</td>
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<tr>
<td>Insulation</td>
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ref: a typical grassroots in-situ CPF facility
Cost Impact of 3rd Gen Modular Execution SM
Design and Execution

Cost savings from

- Reduced quantities for smaller footprint
  - Material savings
  - Labor savings

- Productivity gain for work shifted to shop

- Reduced indirect costs with less field hours
  - Construction management
  - Camp or LOA
Bridging Graph – 2nd Gen to 3rd GenSM (Onshore)

Indicated percentages are percent of 2nd Gen total project cost

1. Red bars indicate cost increase, green bars indicate cost reduction.
2. Indicated percentages are percentage of 2nd Gen TIC
Evolution of Modular Construction in Canadian Land Locked Locations

1st Gen Modularization
- Modularized P/R & rack piping

2nd Gen Modularization
- 60–70% steel & piping modularized
- P/R equipment pre-installed
- 20% electrical & instruments on modules
- Relocate 40% above ground field hours to module yard

3rd Gen Modularization
- Modularized process block
- 95% steel & piping on module
- Elimination of concrete foundation
- 85% electrical & 95% instruments on modules
- Cabling, wiring & testing in module yard
- Final loop check & "Plug & Play" at site
- Relocate 90% field hours to module yard

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Results of Implementing 3rd Gen Modular Execution℠

- Improved labour productivity and removed effort hours from Site to Shop
- Cost and Schedule Certainty
- Reduced TIC
- Improved Safety
- Improved Quality
- Improved Environmental Footprint
- Repeatable and Portable
- Enhanced Operations & Maintenance
### Integrated EPFC Solution Required

<table>
<thead>
<tr>
<th>Feasibility Study</th>
<th>3rd Gen Modular Execution™ Execution Gates</th>
<th>3rd Gen Modular Execution™ Work Process</th>
<th>FEED</th>
<th>Engineering &amp; Procurement</th>
<th>Fabrication</th>
<th>Construction</th>
<th>Commission &amp; Start-up</th>
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<td>Develop 3rd Gen Materials Handling Plan</td>
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### List of Fluor 3rd Gen Modular Execution™ Practices
- 3rd Gen Modular Execution™ Execution Plan
- 3rd Gen Modular Execution™ Design Guide
- 3rd Gen Modular Execution™ Installation Details
- 3rd Gen Modular Execution™ Fabrication/Construction Work Packaging Practice
- 3rd Gen Modular Execution™ Vendor Package Guideline
- 3rd Gen Modular Execution™ Material Management Practice
- 3rd Gen Modular Execution™ Material Handling Practice
- 3rd Gen Modular Execution™ Completions Practice and Checklist
- 3rd Gen Modular Execution™ Model Review Practice
- 3rd Gen Modular Execution™ Execution Gate Checklist Review Practice and Checklist

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Modularization – Alberta Oilsands

Advantages
- Lowers cost of labour
- Improved productivity in a controlled environment
- Reduced site indirects from lower staff/craft numbers
- Access to larger pool of labour resources

Risks
- Labour Availability
- Transportation and Access
Contact Information

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