Reaching Asset Potential – A Multiple Level and Time Horizon Optimization Problem

Gerardo Mijares
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Asset Potential
# Asset Potential – Work Process View

<table>
<thead>
<tr>
<th>Asset / Investment Potential</th>
<th>Planning and Development Work Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed Potential</td>
<td>Maintenance &amp; Logistics Work Processes</td>
</tr>
<tr>
<td>Current State</td>
<td>Operations Work Processes</td>
</tr>
<tr>
<td>Operating Potential</td>
<td>Maintenance Planning</td>
</tr>
<tr>
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</tr>
<tr>
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</tr>
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Objective: desired (maximum) NPV, ROI
Assess / Measure: historical performance and future projection

Define desired development actions:
- Production / injection profiles
- Enhanced recovery mechanisms
- Infrastructure modification / expansion
Implement Field Development / Re-development Plan

Objective: desired (maximum) daily production while considering current operating constraints
Assess / Measure: measured or estimated production

Define desired operating conditions:
- Choke valve positions
- Compressor suction pressure
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Objective: maintain level while observing constraints and production targets
Assess / Measure: measure separator level and calculate difference in actual to setpoint level

Define desired operating conditions:
- Separator inflow / outflow
- Flow rate or valve position
- Well choke valves
Implement changes in operating conditions:
- Flow rate controller setpoint
- Choke valve position setpoint
Optimization Problem - Challenges

**Work Process**
- Portfolio Management & Optimization
- Field Development Planning
- Short Term Production Plan
- Advanced Process Control

**Constrains**

**Operating Targets**
- High Frequency
- Low Frequency

**Multiple non-Integrated Data Sources**
Optimization Problem - Challenges

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<tr>
<td>Portfolio Management &amp; Optimization</td>
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<td>Integer / Discrete</td>
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<tr>
<td>Field Development Planning</td>
<td>Years</td>
<td>Month – Years</td>
<td>Integer / Discrete Dynamic</td>
</tr>
<tr>
<td>Short Term Production Plan</td>
<td>Day – Month</td>
<td>Seconds – Hours</td>
<td>Steady state</td>
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<td>Advanced Process Control</td>
<td>Minutes - Hours</td>
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<th>Process Time Constant</th>
<th>Process Nature</th>
<th>Optimization / Modeling Approach</th>
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<tr>
<td>Portfolio Management &amp; Optimization</td>
<td>Years</td>
<td>Instantaneous</td>
<td>Integer / Discrete</td>
<td>Event Driven Linear Programming</td>
</tr>
<tr>
<td>Field Development Planning</td>
<td>Years</td>
<td>Month – Years</td>
<td>Integer / Discrete</td>
<td>Transient + Event Driven</td>
</tr>
<tr>
<td>Short Term Production Plan</td>
<td>Day – Month</td>
<td>Seconds – Hours</td>
<td>Steady state</td>
<td>Steady state behavior consideration</td>
</tr>
<tr>
<td>Advanced Process Control</td>
<td>Minutes - Hours</td>
<td>Minutes - Hours</td>
<td>Dynamic</td>
<td>Transient behavior consideration</td>
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Digital Twin

Physical System

Asset Digital Twin

- Infrastructure
- Network
- Wells
- Reservoir
Digital Twin

- Model of Record
- Evergreen
- Total Implicit Solution
- Right Tradeoff - Model Complexity / Data
Digital Twin - Model of Record

- Portfolio Management (capacities and constraints)
- Field Development (full reservoir dynamics)
- Business Plan - Forecasting (simplified reservoir dynamics)
- Short Term Production Planning (no reservoir dynamics)
- Advanced Process Control (data driven)
Digital Twin – Evergreen Model

Model Updating and Reconciling

Model Update
Wells / Facilities

New / intervened wells
New Facilities

Reservoir Static Representation

Model Reconciliation
Reservoir Dynamic Representation
Well
Network
Facilities

Work Process Execution

Well Tests
Network Pressure Drop
Compressor Performance

Historical Production
Historical Injection

Logs
Cores
Seismic
Digital Twin – Total Implicit Solution

Implicit vs Non-Implicit

*SPE-192893-MS
Digital Twin – Right Tradeoff – Model Complexity / Data

Advanced Process Control
Digital Twin

- Model of Record
- Evergreen
- Total Implicit Solution
- Right Tradeoff – Model Complexity / Data
Thank You
Your feedback is very important to us. Please open the LIFE2019 app to answer a few short questions on this presentation.
Anatomy of a Work Process - Challenges

- Assess / Predict Performance Against Business / Operational Objective
- Determine Plan / Corrective Action
- Implement Plan / Corrective Action

Multiple non-Integrated Data Sources

Time Horizon

Low Frequency

High Frequency
Title and Content (24pt Arial)

- 22pt Arial – First Bullet
  - 22pt Arial – Second Bullet
    » 20pt Arial – Third Bullet
  
  -
## Work Process Framework – an optimization problem

<table>
<thead>
<tr>
<th>Field Development Planning</th>
<th>Short Term Production Planning</th>
<th>Separator Level Control</th>
</tr>
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<tbody>
<tr>
<td><strong>Objective:</strong> desired (maximum) NPV, ROI</td>
<td><strong>Objective:</strong> desired (maximum) daily Production while considering current constraints</td>
<td><strong>Objective:</strong> maintain level</td>
</tr>
<tr>
<td><strong>Assessment:</strong> historical performance and future projection</td>
<td><strong>Assessment:</strong> measured or estimated production</td>
<td><strong>Assessment:</strong> measure separator level and calculate difference in actual to setpoint level</td>
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<tr>
<td><strong>Insight Requirement:</strong></td>
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| Define desired development actions:  
- Production / injection profiles  
- Enhanced recovery mechanisms  
- Infrastructure modification / expansion | Define desired operating conditions:  
- Choke valve positions  
- Compressor suction pressure | Define desired inflow / outflow flow rate or valve position |
| Implement Field Development / Re-development Plan | Implement desired operating conditions:  
- Choke valve positions  
- Compressor suction pressure | Implement valve position change |

**Automation Requirement:**
Work Process – an optimization problem

- Measure / Assess Performance Against Business / Operational Objective
- Determine Plan Action
- Implement Plan / Corrective Action
## Determine / Plan Action

<table>
<thead>
<tr>
<th>Work Process</th>
<th>Optimization Type</th>
<th>Model Requirement</th>
<th>Optimization Time Horizon</th>
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<tr>
<td><strong>Planning and Development Work Processes</strong></td>
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<tr>
<td>Project Portfolio Management</td>
<td>Deterministic Linear Programming</td>
<td>Steady State Capacities / Potential</td>
<td>Multi-year</td>
</tr>
<tr>
<td>Field Development Planning</td>
<td>Stochastic Nonlinear Mixed-integer</td>
<td>Dynamic Reservoir / Well / Network / Facilities</td>
<td>Multi-year</td>
</tr>
<tr>
<td>Business Plan</td>
<td>Deterministic</td>
<td>Dynamic Reservoir (coarsened) / Well / Network / Facilities</td>
<td>Multi-year (business plan horizon)</td>
</tr>
<tr>
<td>Maintenance Planning</td>
<td>Deterministic</td>
<td>Performance and failure probability prediction</td>
<td>Multi-year</td>
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<tr>
<td>Well Intervention Planning</td>
<td>Linear Programming</td>
<td>Yes</td>
<td>Multi-year</td>
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<td>Well / Network / Facilities</td>
<td>Current conditions</td>
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<tr>
<td>Advanced Process Control</td>
<td>Linear</td>
<td>Data Driven</td>
<td>Multi-step to steady state</td>
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<tr>
<td>Regulatory Control</td>
<td>Sequential</td>
<td>NA</td>
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Support Work Processes

- Model Update
  - Functional Scope
  - Implementation Scope
  - Frequency
Support Work Processes

- Model Rationalization – Static and Dynamic Model
  » Functional Scope
  » Implementation Scope
  » Frequency
Support Work Processes

- Model Rationalization – Well, Network, Facilities
  - Functional Scope
  - Implementation Scope
  - Frequency
### Asset Potential Framework - a Work Process View

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#### Installed Potential

- **High Frequency**
- **Low Frequency**
- **Time Horizon**

#### Operating Potential

- **Multiple non-Integrated Data Sources**
- **3rd Party Databases**
- **Unstructured Data**
- **Semi-Structured Data**
- **Real-Time Data**
- **Multiple non-Integrated Data Sources**
Work Process – An Optimization Problem

**Advanced Process Control**

**Objective:** maintain level while observing constraints and production targets
**Assessment:** measure separator level and calculate difference in actual to setpoint level

**Measure / Assess Performance Against Business / Operational Objective**

**Determine Plan Action (Optimize)**

**Implement Plan / Corrective Action**

**Field Development Planning**

**Objective:** desired (maximum) NPV, ROI
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**Short Term Production Planning**

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Digital Twin – Right Complexity

View of data stream with variations

Data Availability, Integrity, Quality

Model Complexity

Gas Reserve Relative Difference (MMMPC)

Thickness
Area
FR Gas
Porosity
Bgi