Well Intervention and Well End-Of-Life
Remember.....

No job is so important and No service is so urgent, that we cannot take time to perform our work safely.
The Well Life Cycle

Seismic Data | Drilling Operation | Evaluation | Completion | Production | Intervention

New Reservoirs
- Hot Zones
- Deeper Zones
- Remote Access
- Complex Differentiability
- Velocity Flow

Depleting Reservoirs
- Formation Damage
- Fluid Circulation Issues
- Differential Sticking
- Production Failures
- Poor Production Recovery

Intruding $\text{H}_2\text{O}$
- Oxidation of Metals
- Reservoir Management
- Sand Access
- Production Differentiability
- Bypass Reservoir
Decommissioning / Well Abandonment

Offshore Operation

Land Operation

H₂O

Well Plugging and Abandonment
- Government Views
- Guidelines
- Likely Options
- Removal Fleet
- Disposal Options

Groundwater Aquifer
- Water Quality Questions
- Groundwater Pollution
- Depth to Various Aquifers
- Channel Contaminants
- Ground Water Monitor
A **well intervention**, or 'well work', is any operation carried out on an oil or gas well during, or at the end of, its productive life, that alters the state of the well and or well geometry, provides well diagnostics or manages the production of the well.
USA Oldest Producing Well?

McClintock No. 1 (Quaker State Corporation)

- **Location:** Pennsylvania, PA, United States
- 12 barrels a month since drilled in August 1861 (152 years) = $665M X 3% royalties $20M
Production Management Systems

1. Capture the measurements

2. Production Database
   Securely store in a collaborative environment

3. Turn data into meaningful information

4. Make the data available for analysis, optimization

5. Enable correct decisions for the asset management
Production Issues and how they are Identified

Finding the PROBLEM?
- Asset Monitoring
- Well Diagnostic Logging
- Intelligent Completion
- Production Improvements

Intervention
- Water and Gas Influx
- Wax
- Hydrates
- H2S
- Scales
- Brown Field Development
- Accessing New Reserves
- Retrieval (Fishing)
- Operation
- Technology

Decommissioning
Well Completion Design & Production Issues

Standard Gas Configuration

- Gas production decreased?
- Producing water or sand?
- Increase or decrease pressure?
- Production STOPPED?

I need to get my well producing! How do I fix it? What’s wrong?

I need to start with a wireline log for a diagnostic Examination.

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Well Completion Design & Production Issues

Oil Pump Jack

- Oil STOPPED?
- Sand, scale or paraffin problems?
- Pump not working?
- High oil viscosity?
- Rod parted?

I need to get my well producing! How do I fix it? What’s wrong?

I need to start with a Remedial workover.
Some PROBLEMS

- Wax
- Hydrates
- H2S - hydrogen sulfide
- Fines migration
- Phase related permeability changes
- Scales
- Obstructions
- C02 Corrosion

Well interventions have a large opportunity to enhance well production if correctly designed and implemented. Conversely, they can have a large negative impact on production if they’re not.
Well Intervention Conveyance Methods

- Rig based workovers
- Coiled tubing
- Hydraulic workover
- Wireline (slickline & e-line)
- Intervention in sub-sea wells (Rig and mono-hull vessel techniques) with horizontal and conventional trees
- Deepwater Drillship
Well Testing Methods

- **Service Units – Land & Offshore**
- **Well Losses vs. Aquifer Losses**
  - Observed drawdown in a pumping well
- **Well Efficiency**
  - Characterize the behavior of oil and gas reservoirs, and to predict their future performance
  - Being due to flow through the well screen
- **Specific Capacity**
  - Well fluid analysis
  - Normally obtained from a step drawdown test
Wireline Conveyance and Intervention Methods

- Service Units – Land & Offshore
- Free Point / Backoff Services
- Pipe Cutting Services
- Pipe Recovery
- Mechanical Services
  - Bridge Plugs
  - Packers
  - Cement Dumping
- Logging Services
  - Cement Bond Log
  - Gamma Ray Log
  - Neutron Log
  - Temperature Log
  - Noise Log
  - Casing Caliper Log
  - Stuck Pipe Log
- Perforating Services
Wireline Conveyance and Intervention Methods

- Identify completion components?
- Identifying downhole issues quickly?
- Wireline fishing techniques?
- Wax cutting and scale chipping?
- Nipple setting for plugging zone?

Wireline tractor can support high deviated wells

Pipe Cutting Services

Logs
Coil Tubing Conveyance and Intervention Methods

- Service Units – Land & Offshore
- Reduced Operational Footprint
  - The ability to intervene without a rig
  - Offer a highly effective and cost-efficient alternative
- Well Cleaning
- Multi-Zone Solution
- Stimulation & Fracturing
- Weight Kill Fluids
- Acid Stimulation/Nitrogen Pumping
- Fishing, motor milling and drillout of plugs, Pipe Cutting Services
- Mechanical Services
  - Bridge Plugs
  - Packers
  - Cement Dumping
- Logging Services
  - Cement Bond Log
  - Gamma Ray Log
  - Neutron Log
  - Temperature Log
  - Noise Log
  - Casing Caliper Log
  - Stuck Pipe Log
- Perforating Services
- The global oil and gas industry is using coiled tubing for an ever-increasing array of well intervention projects.

**Faster deployment method**, small and transportable with normally 1" to 3.25" in diameter continues coil tubing, rigless operations.
Multi-Stage Horizontal Fracturing

- TCP gun run on CT to perforate toe
- Hydraulic fracture stimulation for 1st stage performed
- Composite bridge plug/perforation gun assembly pumped down on WL
- Hydraulic fracture stimulation for next stage
- Process repeated until full horizontal section
Well Fishing & Intervention Methods

Fishing Services

The application of tools, equipment and techniques for the removal of junk, debris or fish from a wellbore. The key elements of a fishing operation include an understanding of the dimensions and nature of the fish to be removed, the wellbore conditions, the tools and techniques employed and the process by which the recovered fish will be handled at surface.
Well Fishing & Intervention Methods

Managing Drilling Risk

- Stuck Pipe Prevention
- Rock Mechanics
- Wellbore Stress
- Wellbore Instability
- Trend Recognition
- Hole Cleaning
- Differential Sticking
- Wellbore Geometry
- Tripping Practices

Unconsolidated Formations

Gradually, the situation will get worse...

The effect from differential sticking will gradually get worse, as more and more sticking mud will penetrate into the formations and form a growing nodule on the drillstring wall.

Junk
Well Fishing & Intervention Methods

Production Issues!!

- How long do I spend FISHING before I abandon the well?
- How much production can I afford to lose trying to fix this?
- What on Earth is down there?
- Is it riskier to fix this or drill a new well?

I need to get my well producing again; time is money!!!

- Production or drilling string
- Production equipment
- Downhole pumps
- Pipe or sucker rods
- Casing or liners
- Packers
Well Fishing & Intervention Methods

- The hydraulic Jar, single acting (Up only) is a high-impact, pressure and temperature compensated jar designed specifically for fishing operations.
- The Accelerator maximises jar impact regardless of depth because it either replaces drill pipe stretch as the energy source in shallow wells or supplements the pipe stretch energy in deeper wells when used in conjunction with the fishing jar.
- Bumper Sub provides a durable upward or downward bumping action for fishing operations.

Milling and Cutting

- Pilot Mills
- Multistring Cutters
- Washover Shoes
- Packer Retrieving Equipment
- Junk Mills
- Section Mills
- Underreamers

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Well Departure & Intervention Methods

Brown Field Development

Production Enhancement

Multilaterals Development

Open Hole Sidetrack

Casing

Whipstock

Cased Hole Sidetrack

Casing

Whipstock

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What is Decommissioning?

Decommissioning is a controlled process used to safely retire a facility that is no longer needed. During decommissioning, radioactive and hazardous materials, equipment or structures are cleaned or secured so that the facility does not pose a risk to public health or the environment now or in the future.

End-of-life (product)
Decommissioning / Well Abandonment

Expected cost for the overall decommissioning program for North West Hutton is $288 million.
What is Plug & Abandon (P&A)?

It is the first stage of the decommissioning process Definition

To prepare a well to be closed temporal or permanently

If logs confirms insufficient hydrocarbons is place

After production operations have drained the reservoir fluids

Most countries have their own regulations in place

Cement plug placement across fresh water aquifers, wellbore

Placement of bridge plugs to avoid higher density slurries from falling
Modern regulatory standards in all US jurisdictions require specific provisions for plugging and documenting oil and natural gas wells before they are abandoned. Plugging and abandonment (P&A) regulations vary to some degree among states and countries, but all regulations prescribe the depth intervals which must be cemented as well as the materials that are allowable in plugging practices.

<table>
<thead>
<tr>
<th>P&amp;A Regulations Overview</th>
<th>UK</th>
<th>Norway</th>
<th>USA</th>
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<tbody>
<tr>
<td><strong>Permanent Barriers</strong></td>
<td>Prim/Sec</td>
<td>Prim/Sec</td>
<td>As req'd. Min 2</td>
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<tr>
<td><strong>Cases</strong></td>
<td>Temp/Perm</td>
<td>Temp/Perm</td>
<td>Temp/Perm</td>
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<td>Yes</td>
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<td>Yes</td>
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<tr>
<td><strong>Heavy fluid required?</strong></td>
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<td>If possible</td>
<td>If possible</td>
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<td><strong>Wireline Evaluation needed?</strong></td>
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<td>If needed</td>
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<tr>
<td><strong>Permanent /Temporal Barrier testing Method?</strong></td>
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<td><strong>Conductor Casing Severance Requirement?</strong></td>
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<td>10-15 ft</td>
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<td><strong>Site Clearance</strong></td>
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<tr>
<td><strong>Marine Signs required after P&amp;A?</strong></td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
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<tr>
<td><strong>Well P&amp;A vs. License Expiry Date</strong></td>
<td>1 yr before</td>
<td>1 yr before</td>
<td>Now idle iron &gt; 5 yrs</td>
</tr>
</tbody>
</table>
Thank You!

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