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Webinar 8. Production Optimization
for Artificial Lift
Rajan Chokshi & Bill Lane
Mar 3, 2015
Weatherford
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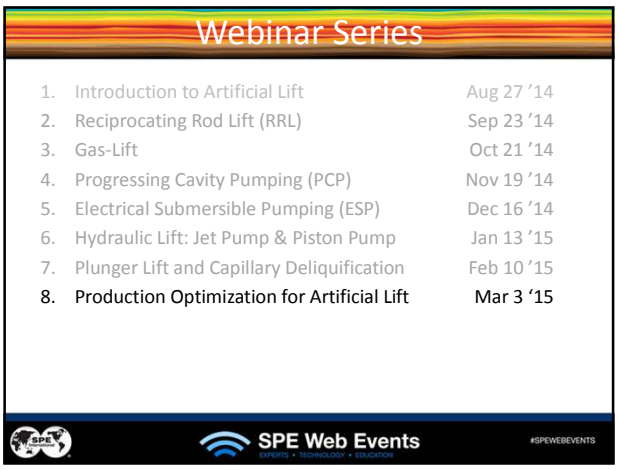
Webinar Series
1. Introduction to Artificial Lift Aug 27 '14
2. Reciprocating Rod Lift (RRL) Sep 23 '14
3. Gas-Lift Oct 21 '14
4. Progressing Cavity Pumping (PCP) Nov 19 '14
5. Electrical Submersible Pumping (ESP) Dec 16 '14
6. Hydraulic Lift: Jet Pump & Piston Pump Jan 13 '15
7. Plunger Lift and Capillary Deliquification Feb 10 '15
8. Production Optimization for Artificial Lift Mar 3 '15
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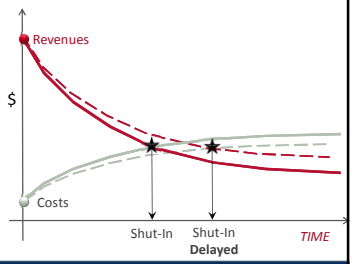
Contents

- Production Optimization (PO)
  - What, Why
  - How: Appraise, Select, Design, Monitor, Analyze, Adjust
  - Frequency
- Digital Oil Field: PO Enabler
  - What, Major Components
  - Progression to Integrated Asset Management
  - KOC Case study
- Results achieved from Production Optimization

What is Production Optimization?

The process of managing the production decline curve of assets to maximize profits over time.

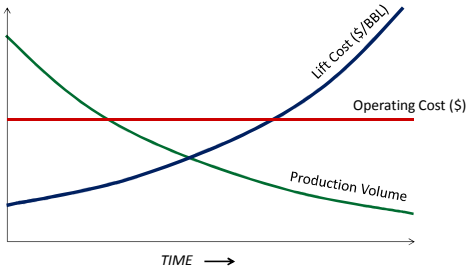
- Maximizing oil production over the life of the well
- Reducing downtime
- Minimizing operating costs
- Improving HSE



Why Optimize?

If operating costs are constant over the life of the well, as production declines what will be the effect on lift cost *per barrel*?

$$\text{Lift Cost} = \frac{\text{Op Cost (\$)}}{\text{Production (BBL)}}$$



Why Optimize?

$$\text{Lift Cost} = \frac{\text{Op Cost (\$)}}{\text{Production (BBL)}}$$

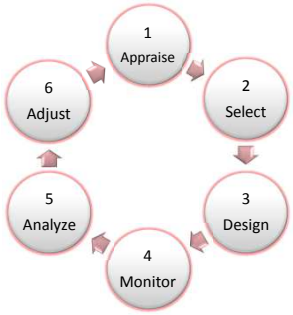
If lift volumes remain constant as production volumes decline:

- Wells pump off (run dry) causing equipment damage, downtime, and lost production. ($↑)
- Energy costs are higher than needed. ($↑)
- Excessive pressure draw-down can cause formation damage. ($↑)
- Excessive pressure draw-down can cause water coning. ($↑)
- Unnecessary wear on equipment. ($↑)
- Unnecessary exposure of personnel to operating equipment. (☹$↑)

∴ *If lift volumes are not managed as production declines the well may become uneconomic sooner.*

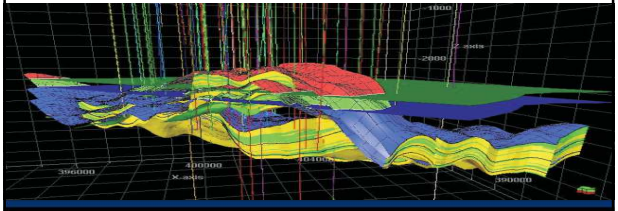
Production Optimization (PO) Process

How?



PO Process Step 1: Appraise

1. **Appraise**
   - Understand/predict reservoir potential performance.
   - Understand production constraints
   - Establish target production levels and conditions.



PO Process Step 2: Select

2. Select

– Eliminate technically infeasible lift technologies.
- Required performance
- Support infrastructure (power, skill base, etc.)

	Gas Lift	Foam Lift	Plunger	Rod Lift	PCP	ESP	Hyd Jet	Hyd Piston
Max Depth	18,000 ft 5,486 m	22,000 ft 6,705 m	19,000 ft 5,791 m	16,000 ft 4,878 m	8,700 ft 2,652 m	15,000 ft 4,572 m	20,000 ft 6,100 m	17,000 ft 5,182 m
Max Volume	75,000 bpd 12,000 M³/D	500 bpd 80 M³/D	200 bpd 32 M³/D	6,000 bpd 950 M³/D	5,000 bpd 790 M³/D	60,000 bpd 9,500 M³/D	35,000 5,560 M³/D	8,000 bpd 1,270 M³/D
Max Temp	450°F 232°C	400°F 204°C	550°F 288°C	550°F 288°C	300°F 149°C	482°F 250°C	550°F 288°C	550°F 288°C
Corrosion Handling	Good to excellent	Excellent	Excellent	Good to Excellent	Fair	Good	Excellent	Good
Gas Handling	Excellent	Excellent	Excellent	Fair to good	Good	Fair	Good	Fair
Solids Handling	Good	Good	Fair	Fair to good	Excellent	sand<40ppm	Good	Fair
Fluid Gravity (°API)	>15°	>8°	>15°	>8°	8°<API<40°	Viscosity <400 cp	≥6°	>8°
Servicing	Wireline or workover rig	Capillary unit	Wellhead catcher or wireline	Workover or pulling rig	Wireline or workover rig		Hydraulic or wireline	
Prime Mover	Compressor	Well natural energy		Gas or electric		Electric	Gas or electric	
Offshore	Excellent	Good	N/A	Limited	Limited	Excellent	Excellent	Good
System Efficiency	10% to 30%	N/A	N/A	45% to 70%	50% to 75%	35% to 60%	10% to 30%	45% to 55%

PO Process Step 2: Select

2. Select

– Eliminate technically infeasible lift technologies.
- Required performance
- Support infrastructure (power, skill base, etc.)

– Economic evaluation
- Cost of acquisition, installation, & training
- Operating cost
- Reliability
- Repair/replacement
- Residual value

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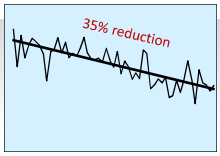
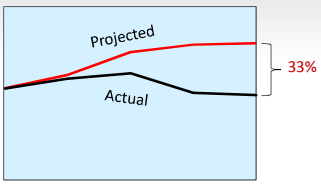
Focus on Reliability = Lasting Value

Service Jobs per Well



Total Service Cost



Savings = $9.6 million/yr

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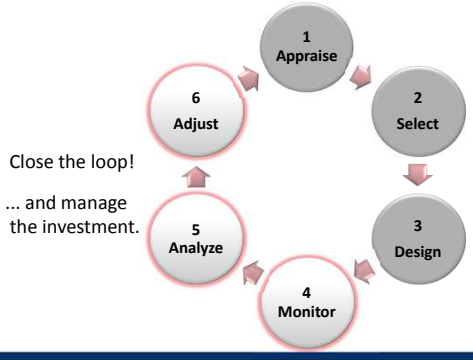
PO Process Step 3: Design

3. Design

Lift Technology	Software
Reciprocating Rod Lift	Rod Star, SROD, XROD, QROD, others, WFT csBeamDesign, LOWIS
PC Pump	CFER PC Pump, WellFlo, WFT proprietary
Gas-Lift	Prosper, Pipesim, Well Evaluation Model (WEM), VALCAL, Valve Performance Clearinghouse (VPC), Dynalift, WellFlo, i-DO, LOWIS
Hydraulic Lift	Guiberson Piston Pump, SNAP, JEMS, WellFlo*
ESP	SubPUMP, WEM, supplier proprietary, Borets-WFT proprietary, WellFlo
Capillary/Plunger Lift	WEM, WFT proprietary, WellFlo

After installing equipment



Close the loop!

... and manage the investment.

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Production Optimization Process

4. **Monitor** to determine ***what*** is happening.
   - Surveillance
   - Measurement
   - Key Performance Indicators
5. **Analysis** to determine ***why*** it is happening
6. **Adjust -** Design to improve performance

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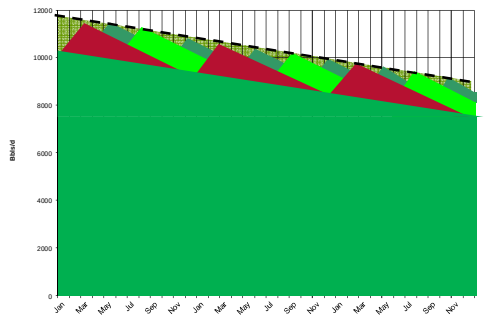
Importance of Optimization Frequency



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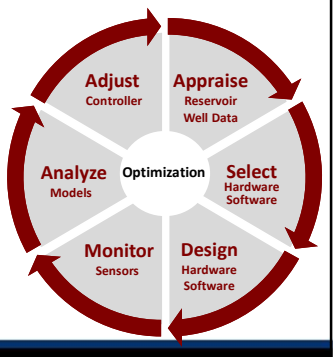
Artificial-Lift Optimization

- Complex cycle
  - Multiple steps
    - Interconnectivity, seamless communication between different components
  - Subject matter experts (SMEs)



eField, iField, Fields of Future....

DIGITAL OIL FIELD

Digital Oilfield (DOF)

- **What is Digital Oilfield?**
  - Evolution and convergence of digital control techniques coupled with standardized communication overlaid with analytics
  - Simple explanation:
    - Can I capture my data remotely?
    - How do I convert captured data into actionable information?
      - Process it and analyze it in order to
        - » Diagnose problems remotely w/o sending my people out
        - » Prevent problems/failures from occurring
        - » Predict performance &
        - » Optimize
    - Make it a sustainable & repeatable process

Digital Oilfield

- Objectives
  - Faster and better decision making through the availability of accurate data, distributed to the right people at the right time in the right environment
  - Streamline of current operations through use of latest technology, well-defined processes and appropriate people interactions
  - Increased production at a reduced financial cost

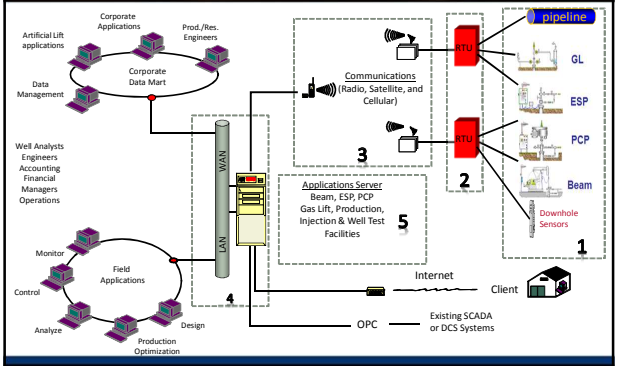
Major Components

- Field instrumentation and automation at the well head
- Remote monitoring and control of field instruments
- Software modeling of wells, surface network, production plant
- Integration with other software systems for completion data, well test data, reservoir data, etc.
- Optimization software for artificial lift solutions
- Collaborative Environments

DOF: Step-by-step Progression

Transformation to Innovation	• Integrated Asset Management • Expert systems • Collaborative Solutions
Optimization: Intervention in Real-Time	•Lift Optimization: QGinj, plunger arrivals, soap optimization, ESP/PCP/Pumping unit speeds •Workover Services management •Integrated Production Optimization •Collaboration Room •Predictive Maintenance
Analysis: Information in Real-time	•Real-time information for operators •Visualization & Facilitation •Central control center •Smart alarm systems •Guided Workflows
Surveillance	•Sensors at wellsite, downhole and at the facilities •IT & Comm infrastructure for Connectivity from wellsite to field office to the central location •SCADA •Dashboards •Activity monitoring

Field Installation



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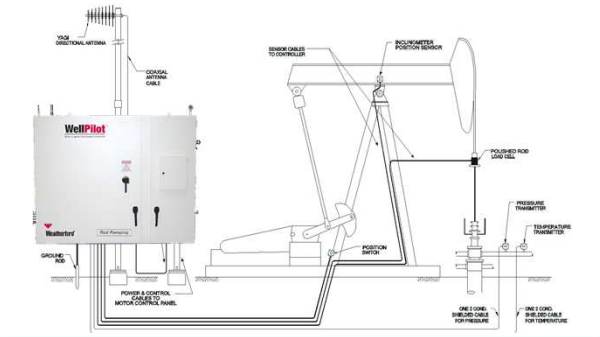
Rod Pump Wellsite Optimization



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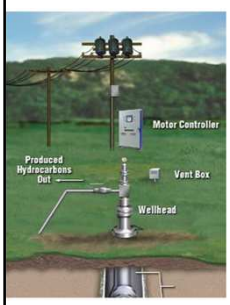
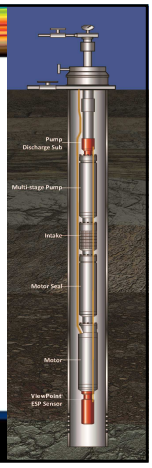
ESP Optimization



- Surface Variable Speed Controller Drive
- Downhole P, T, Vibration sensors



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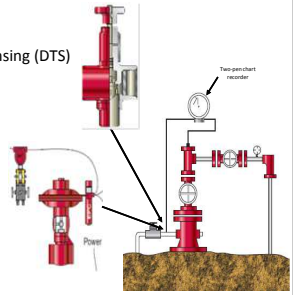
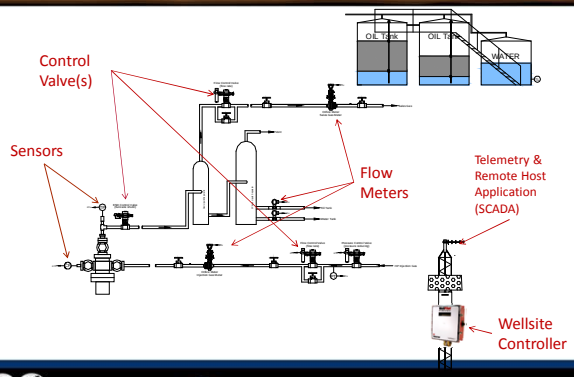
Gas-Lift Wellsite Equipment

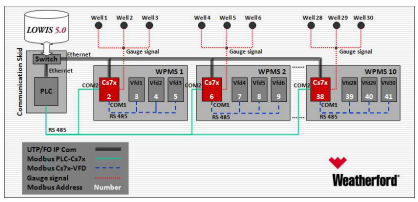
- Adjustable choke valve; Time Cycle controller and/or choke valve
- Gas Rate controller
- Downhole Distributed Temperature Sensing (DTS)

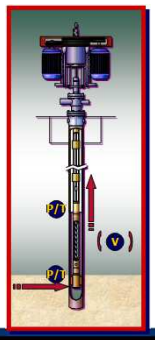


Gas-Lift Wellsite & Field Controls



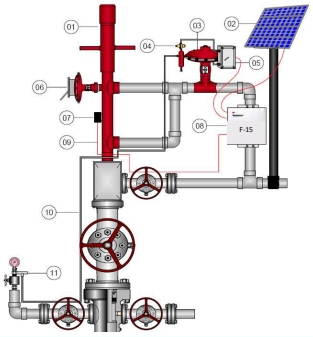
PCP Lift Optimization
with Downhole Gauges for multiple wells





Plunger Lift Wellsite Optimization

1. Lubricator
2. Solar Panel
3. Motor Valve
4. Drip Pot / Regulator
5. Latching Valve
6. Auto Catcher
7. Arrival Sensor
8. F-15 Controller
9. Sensor Wiring
10. ¼" Control Line
11. Casing Pressure Sensor



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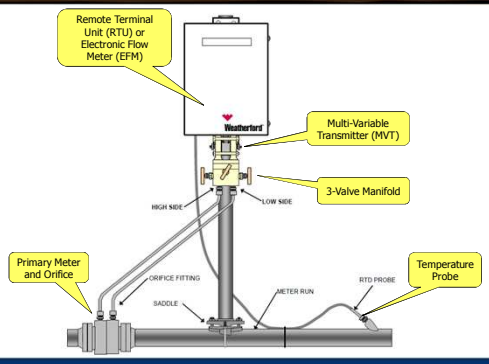
Electronic Gas Flow Measurement



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Field Optimization : Multiphase Meters

Replace this...

..with this

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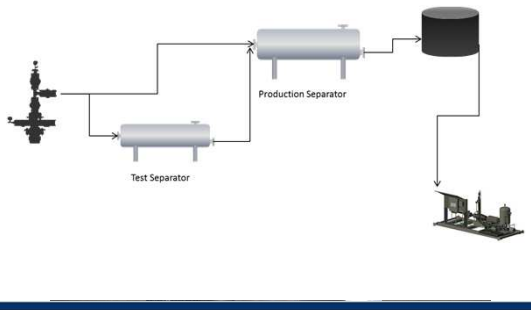
Field Optimization : Multiphase Meters



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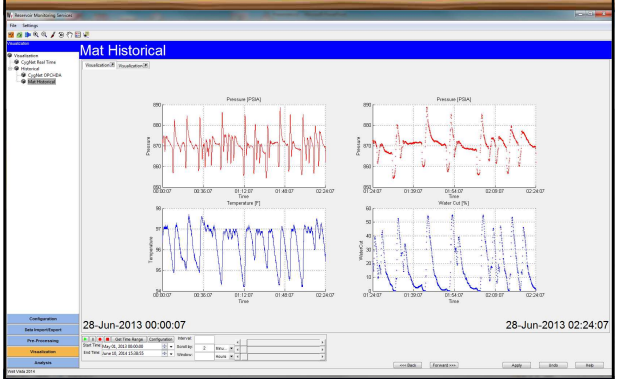
Shale Well Real-Time Measurement



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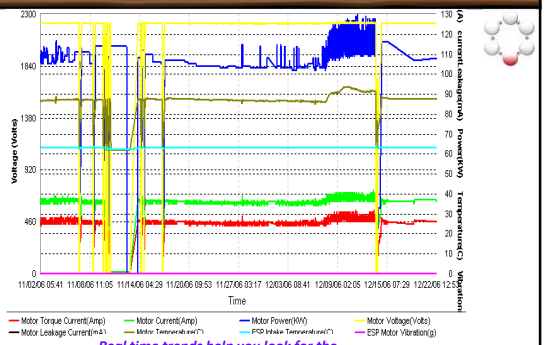
Surveillance & Analysis: Real Time & Historic Trends



Real time trends help you look for the root cause of underperformance.

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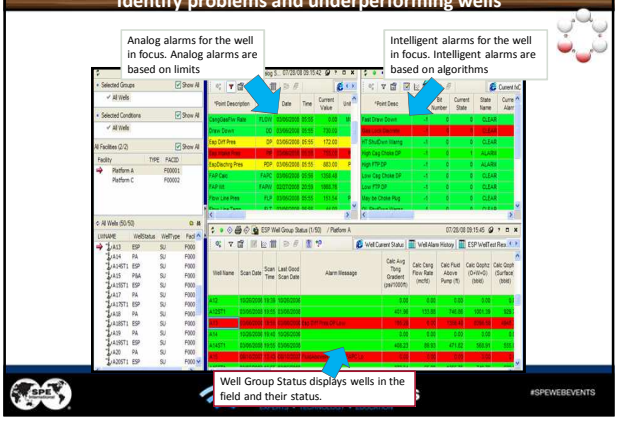
Surveillance, Analysis & Optimization

Identify problems and underperforming wells



Integrated Field Management - *Operations*

- Alarms
- Activity monitoring
- Task scheduling
- Lift analysis
- Field visualization
- Process evaluation
- Asset scheduling

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Integrated Field Management - *Engineering*

- Well and network engineering
- Well data acquisition
- Reservoir monitoring
- Reservoir simulation
- Nodal analysis
- Lift simulation
- Well test analysis
- Flow assurance
- Network optimization
- Productivity forecasting

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Integrated Field Management

OPERATIONS

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Collaborative Work Environment

- The technology augmented with the establishment of a collaborative work environment (CWE) in a Collaboration Center (CC)
- Improved processes to guide the team's work habits
- Visualization, communication and collaboration technologies for management of digital information and improved decision making.

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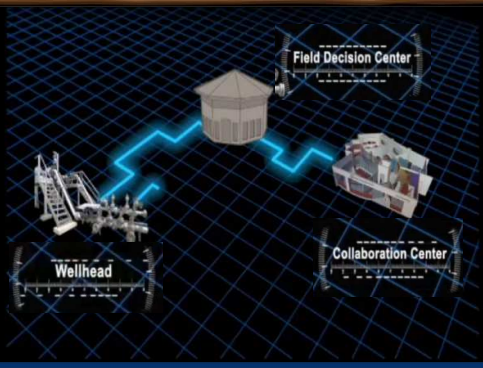
KOC's Digital Oil Field



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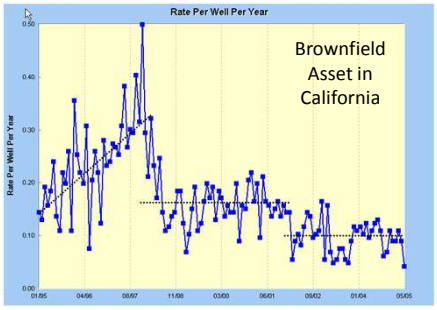
Brown Field Real Time Optimization



$6 million per year annual savings – Real Benefit

**SPE 99949: Real-Time Field Surveillance and Well Services Management in a Large Mature Onshore Field*

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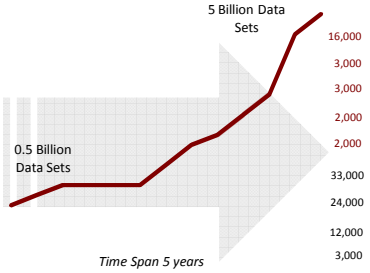
Operator Landscapes are Shifting – More Technology, Rising Complexity

Producer Example: Operating 26,000 Wells

Plunger Wells	12,000	16,000
PCP Wells	750	3,000
ESP Wells	1,000	3,000
Rod Lift Wells	800	2,000
Other/Natural Flowing	11,450	2,000
Gas/Oil Meters	18,000	33,000
RTU/PLC Automation	16,000	24,000
Oil/Water Tanks	11,000	12,000
Compressors	3,000	3,000
Water Meters	5,000	6,000



Absolute growth in technology used to "create" production:

- 5 years ago: 0.5B data sets
- Today: over 5B data sets, every 24 hours

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Digital Oil Field benefits

- "... Industry results to date suggest big prizes await the winners of this race: up to 25 percent in operating cost savings, up to 8 percent higher production rates, 2 to 4 percent lower project costs, and as much as 6 percent improved resource recovery within the first full year of deployment, according to IHS-CERA, which tracks projects at a dozen companies, including Chevron."[1]
- "Some of Valhall wells have increased production by more than one and a half million barrels of oil equivalent per year because of Field of the Future® technology"[2]
- "For example, in its "smart fields" projects, Shell has experienced a 10% sustained improvement in production, 5-10% increase in recovery, as much as a 20% reduction in operating costs, and as high as a 75% reduction in workflow cycle times in its core processes."[3]

Sources

1. IHS-CERA as quoted in Chevron's Next magazine: (http://www.chevron.com/next/digitizingoilfields/)
2. BP's Field of the Future: (http://www.bp.com/en/global/corporate/about-bp/bp-and-technology/more-recovery/real-time-data-and-decisions/field-of-the-future.html)
3. Unearthing the potential of digital oilfield technology – Deloitte report (http://www.deloitte.com/assets/Dcom-UnitedKingdom/Local%20Assets/Documents/UK_EIU_drillingDeep_jan06(1).pdf


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