Mature Field Optimisation

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VP Field Development
Reservoir Development Services
Baker Hughes Incorporated
Reservoir Development Services

400+ technical professionals with a broad range of in-depth capability

- Exploration
  - Basin Studies
  - Play feasibility mapping
  - Trap/charging analysis
  - Decision/risk analysis
  - Portfolio management

- Geophysics
  - Seismic acquisition management
  - Seismic processing and inversion
  - AVO, thin bed
  - VSP interpretation
  - Seismic interpretation (faults, tops)
  - Attribute Analysis

- Geology/Reservoir Characterization
  - Structural Geology
  - Stratigraphic studies
  - Data analysis and geostatistics
  - Geocellular modeling

- Reservoir Performance Analysis
  - Reservoir simulation
  - Field Development Planning
  - Decline curve, MDE
  - Well testing
  - Evaluation and design of stimulations

- Production Technology/Production Chemistry
  - Integrated Asset Modeling
  - Production Optimization
  - Artificial Lift
  - Flow Assurance Management
  - Scale evaluation
  - Corrosion assessment
  - Phase separation
  - Hydrates
  - Water Injection

- Geomechanics
  - 2D Geomechanical modeling
  - Wellbore stability
  - Pore Pressure
  - Sand production prediction
  - Fracture stimulation
  - Fault sealing and activation
  - Subsidence
  - Creepally Stressed Fractures

- Well Engineering and Operations
  - Mechanical completion design
  - Well Surveillance
  - Well testing and stimulation
  - Drilling engineering
  - Completion design through stimulation

- Evaluation, Certification, Strategic Advice
  - Transportation, supply and storage
  - GLT, LNS projects etc.
  - Refining, processing and downstream studies
  - Supporting transactional and financing activities
  - Analysis and advice to clients on development alternatives
  - Business entry or exit plans
  - New business plans, bidding, M&A, etc

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Real-World Experience from All Angles

- Multiple Perspectives
  - Government & Oil Company
  - Operator & Non-Operator
  - Buyer & Seller
  - Lender & Borrower
  - Private Sector & Public Sector
  - Upstream, Midstream & Downstream
  - Greenfield/Brownfield
Optimizing Production Over Time

- ‘Based on our experts’ analyses oil and gas will run out in [pick a number] years’
  - Trace that back as long ago as pre WWII
  - Every decade or so we hear the same thing, just a few more years until supplies get dangerously low
  - Challenged, the oil industry has learned to adapt and grow

- Changing limits to find new hydrocarbons
  - Drill deeper (vertical, water depth); drill longer (horizontal)
  - Operate under ever increasing pressure, temperature
  - Real time data gathering and processing while drilling
  - Evaluation tools that ‘see’ deeper, further away from the wellbore
  - The ‘Independent’ approach vs. the ‘Super Major’ approach
The Natural Order of Things

- Super Majors
- Midsize
- Large Independents
- Independents

Gas Rate (MMcf/d)
Cum. Gas (Bcf)
Water Rate (Mbbl/d)
Well Count

Entrepreneurship? Different Risk Profile? Technology? or The ‘Pygmalion’ Effect

40 year period
Optimizing Production Utilizing Technology

“Old School” Technologies still very much applicable
- Review the data, ALL data
- Challenge assumptions – bring in a new set of eyes
- Know your physical set-up
- Understand laws, regulations and contracts

“New” Technologies can be game changers
- 3D Visualization
- Geology to Reservoir to Market linked models/simulations
- Horizontal drilling
- Fracture stimulation
- Real time pore pressure
Integrated Study and Technology solutions enhance owner value by:

- Improving reservoir understanding
- Improving reservoir management
- Accelerating production
- Accessing bypassed oil
- Optimizing facilities
- Deferring abandonment
- Applying proper EOR solutions
- Managing market dynamics
Improving Decision Cycle Time

- **Long Term Reservoir Depletion**: Project and Corporate data for portfolio management and decision making to deliver improved asset performance.
- **Reservoir Management**: Daily data for operational planning, further optimisation and re-forecasting.
- **Well Management**: “In the day” operational data for daily production optimisation.
- **Operations**: High frequency data for operational monitoring and control.

**Decision Making**
- **Strategic**
- **Tactical**
- **Operational**

**Recovery Performance**

**Operating Performance**
Old School West Texas Example: Increasing Production and Adding Reserves

Over a 3 month period:

Digitized logs & production history for over 4000 wells. Built multi-mile cross sections for 7 reservoirs

Developed an in-depth understanding of completions, surface facilities, processing and markets

Built new geological and reservoir models

Identified a series of production optimization and drilling options

This included accessing new/bypassed hydrocarbons, infill drilling, horizontal re-drills, multi-stage fracs (before this was the norm) and facility reconfigurations

*These results were delivered on a collection of fields which were thought to have been played out and under “care and maintenance” operations*
New School Shale Example: Technology Addressing the Challenges

Landing the well
- Shale Gas Evaluation Suite
- Target
- • Vertical variation
  • Lithology
  • Geomechanics
  • Steering

Placing the well
- Reservoir Navigation Services
- • Stearing
  • Vertical/Lateral variation
  • Geomechanics
  • Fracture identification

Completing the well
- Plug and Perf Completion Systems
- • Optimal staging
  • Vertical/Lateral variation
  • Reservoir Quality
  • Geomechanics

Completing the well
- Single Run Multizone Completion Systems
- • Optimal staging
  • Vertical/Lateral variation
  • Reservoir Quality
  • Geomechanics
New School Shale Example: Understanding the production Source

- Microseismic events do not relate to production response
- Do all microseismic events relate to fluid presence?
- Production seems dependent on natural fractures

Rates measured 5 months later
Infill Drilling: Doubling Daily Production and Additional Reserves

Provided a permanent subsurface team for client for 13-year period during significant asset divestiture

Developed an in-depth understanding of the subsurface architecture and field dynamic performance

Identified and developed a series of production optimization and investment opportunities on behalf of the client

This resulted in the client:
• Doubling daily production
• Accessing an additional 4 million bbls of reserves

These results were for a field being prepared for abandonment!
The Business of Energy – The right tool at the right time

Optimized the field development planning and phasing of capital expenditure for international gas fields in order to meet local gas demands over the next 30 years.

Built an integrated subsurface-to-facilities model linking the three reservoirs in question.

The fully compositional model had to optimize the production profile against several reservoir management and field operating conditions:

- NGL, Gas, Injection/stripping
- Wide ranging CGR’s
- Separate concession contracts
- Drawdown constraints to avoid Condensate drop out and Sand Production & Erosion
- Corrosion restrictions
- Development schedule

The client is now using the tool to optimize capital investment decisions to manage the production profile.
Energy Business Solutions

- Exploration to Abandonment
- Reservoir to Burner Tip
- Primary/EOR
- Conventional/Unconventional
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