

# Technology Development and It's Impact on Current and Future Oil and Gas Supplies

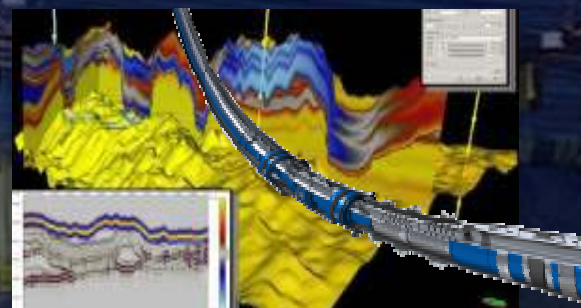
Rod Nelson

# Market Drivers

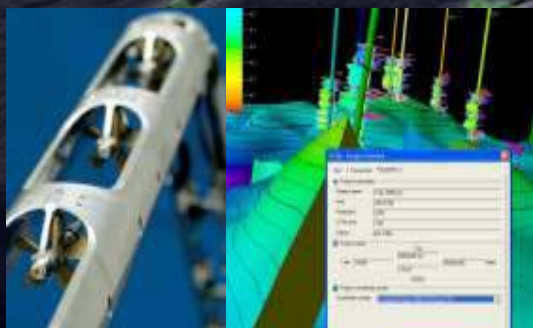
Exploration to add reserves



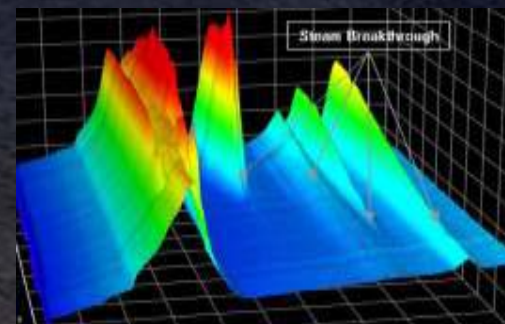
Maximizing reservoir recovery



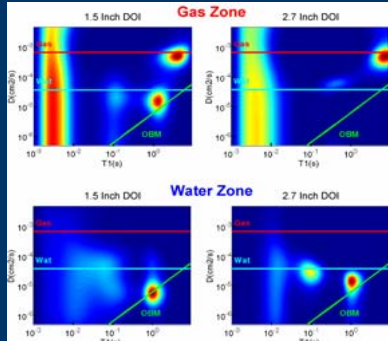
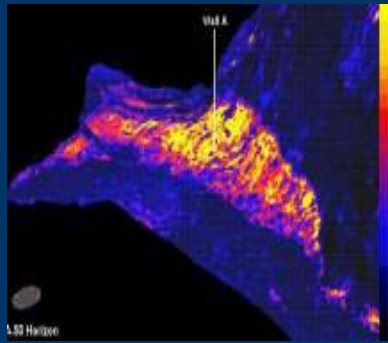
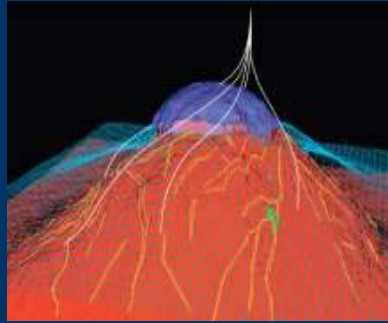
Boosting production from existing fields



Unlocking unconventional hydrocarbons



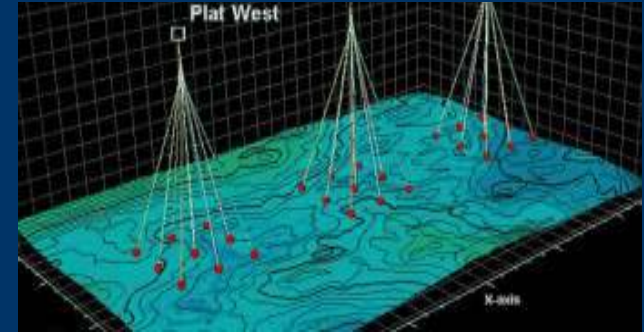
# Exploration to Add Reserves—Reducing Risk



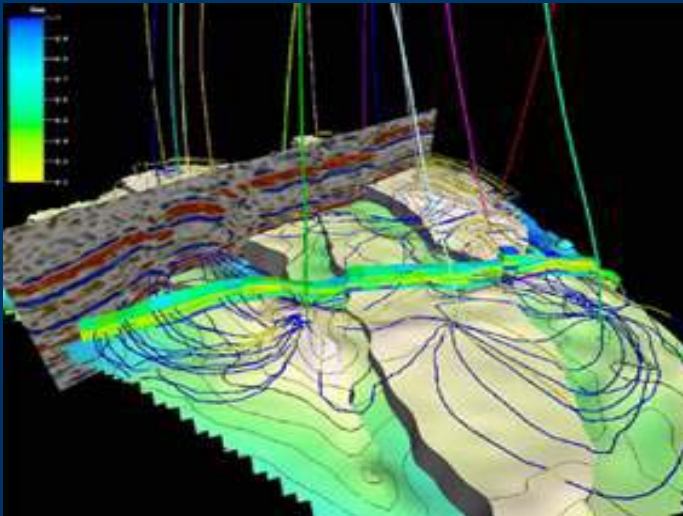
- Explore frontier areas and new basins
- Ultra-deep targets for oil and gas
- Better image below salt and basalt
- Hydrocarbons in small and complex accumulations
- Understand complex reservoir fluids
- Reduce uncertainty by integrating surface and borehole measurements

# Boosting Production from Existing Fields— Improving Performance

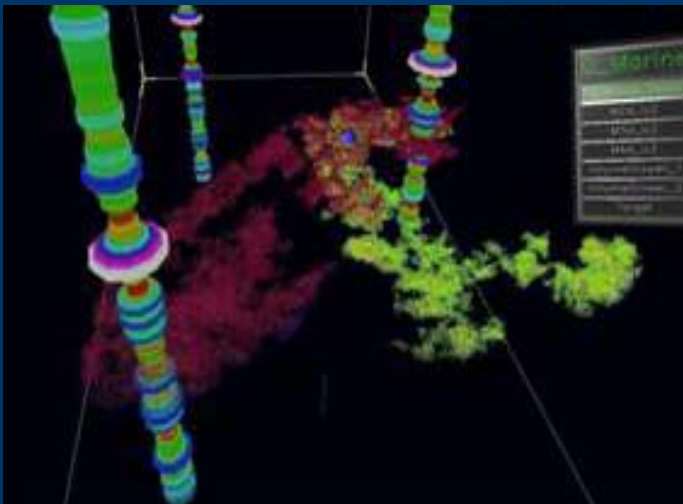
- Advanced field development planning workflows
- Optimal well placement for maximum reservoir contact
- Faster drilling and well construction technology
  - Increased penetration of rotary steerables
  - Novel drilling techniques for mature land environments
  - High-pressure, high-temperature solutions
  - Deepwater – reliability and flow assurance
  - Multi-layer stimulation completions
  - Sand management for deepwater fields



# Maximizing Reservoir Recovery—Improving Performance



- Reservoir simulation for optimisation
- Optimize well placement
- Identify by-passed pay
- Lateral/infill/sidetrack drilling
- Selective stimulation
- Water production management
- Optimize artificial lift



# Unlocking Unconventional Hydrocarbons— Reducing Risk

## Heavy Oil

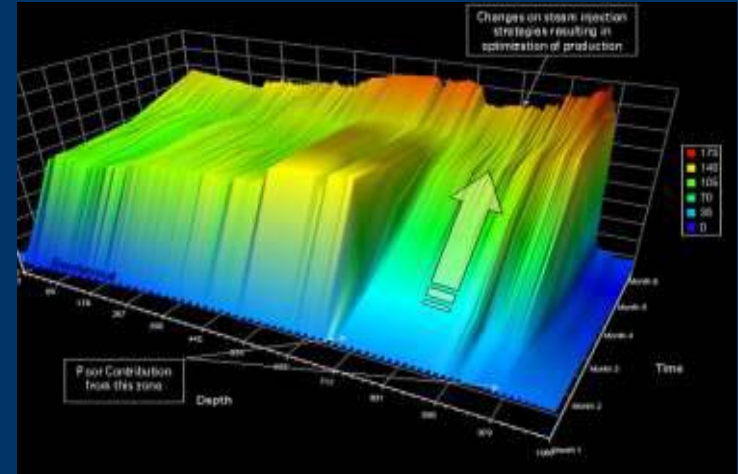
- Mobility modifiers
- Reduce associated energy costs

## Unconventional Gas

- Improved characterization and geomechanics knowledge
- Advanced stimulation capability

## Environmental Concerns

- CO<sub>2</sub> storage
- Simulation and long-term monitoring
- Reduce associated by-products

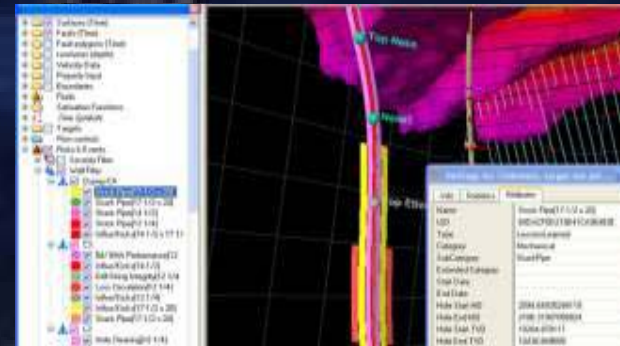


# Technology Platforms

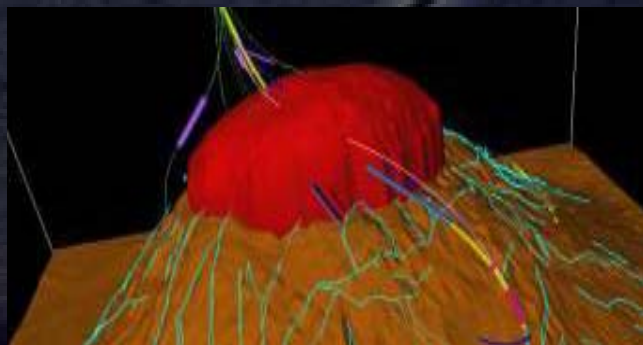
Q-Technology



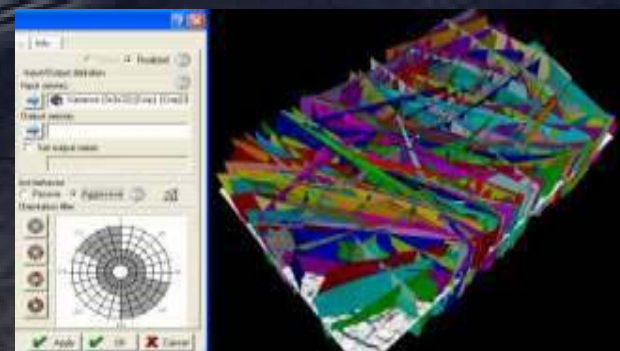
Digital Enablement



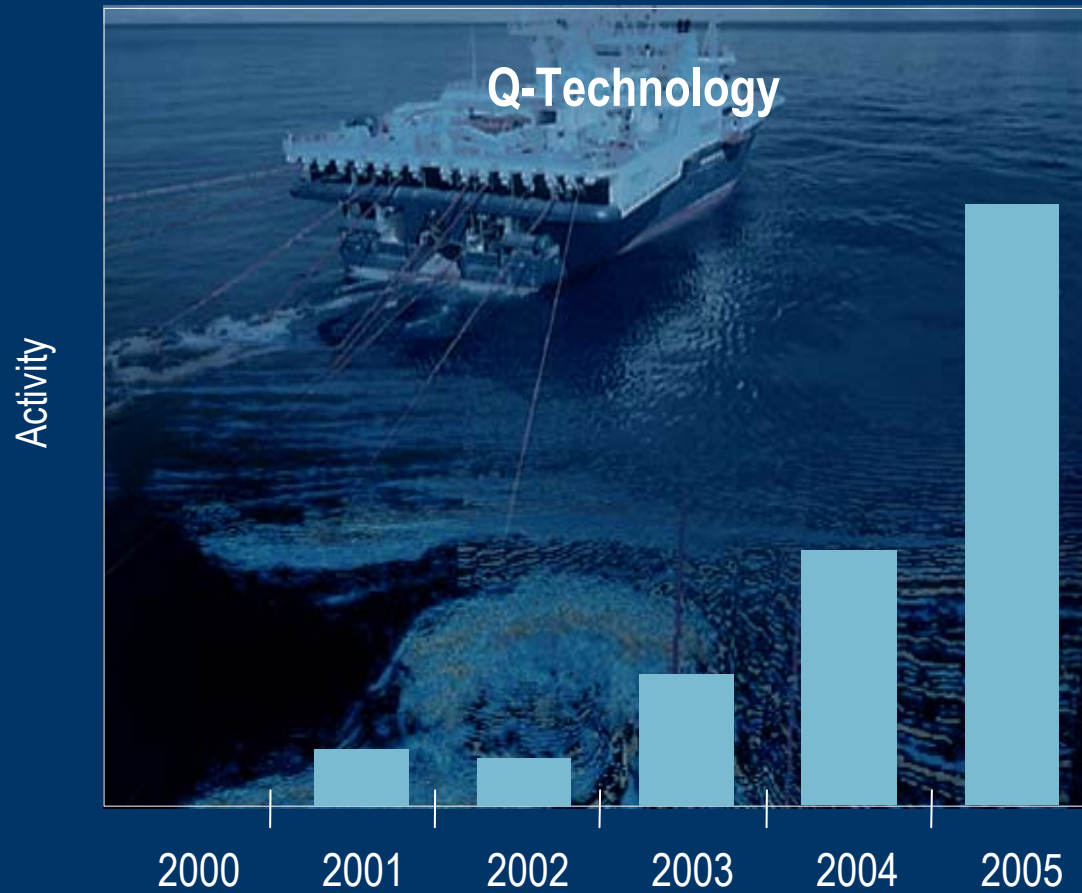
Deep Reading Measurements



Petrel

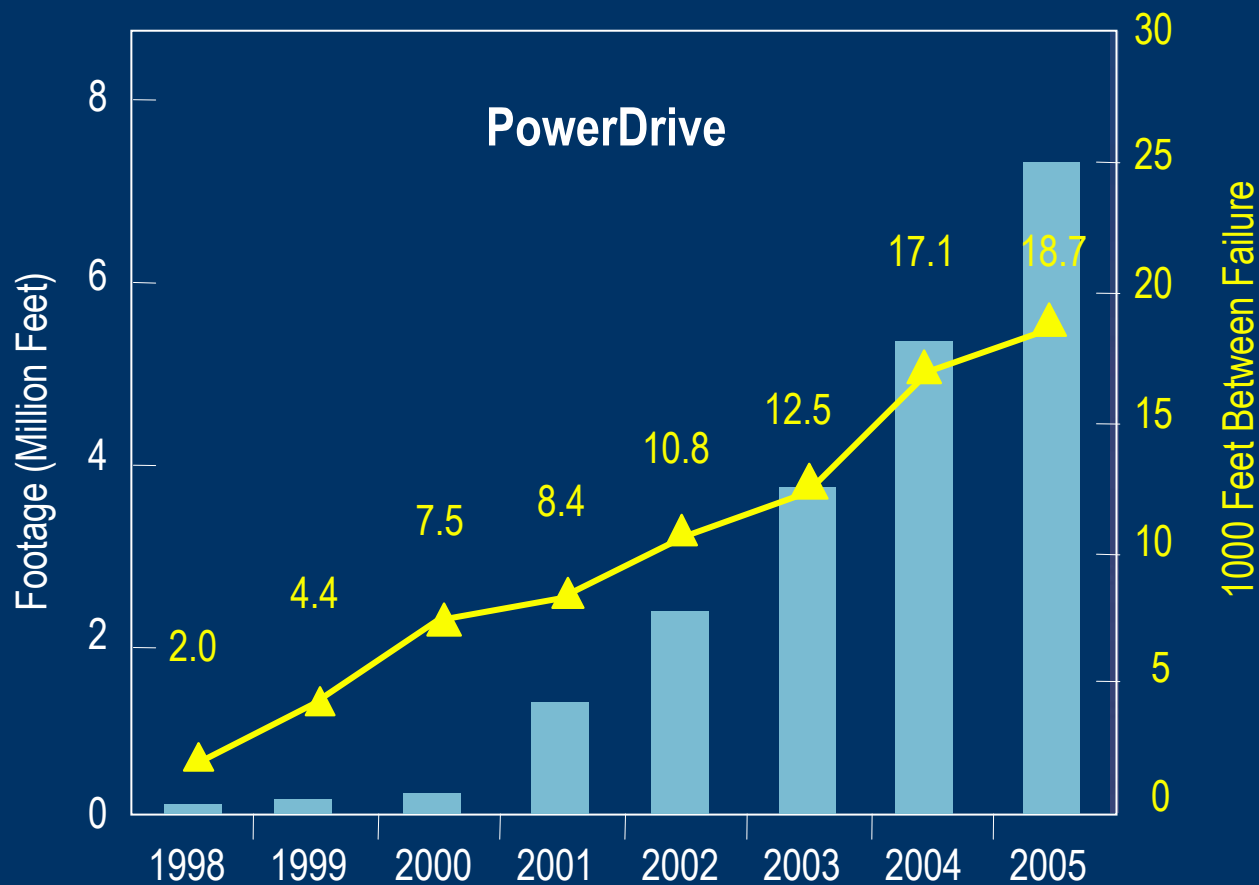


# Technology Penetration

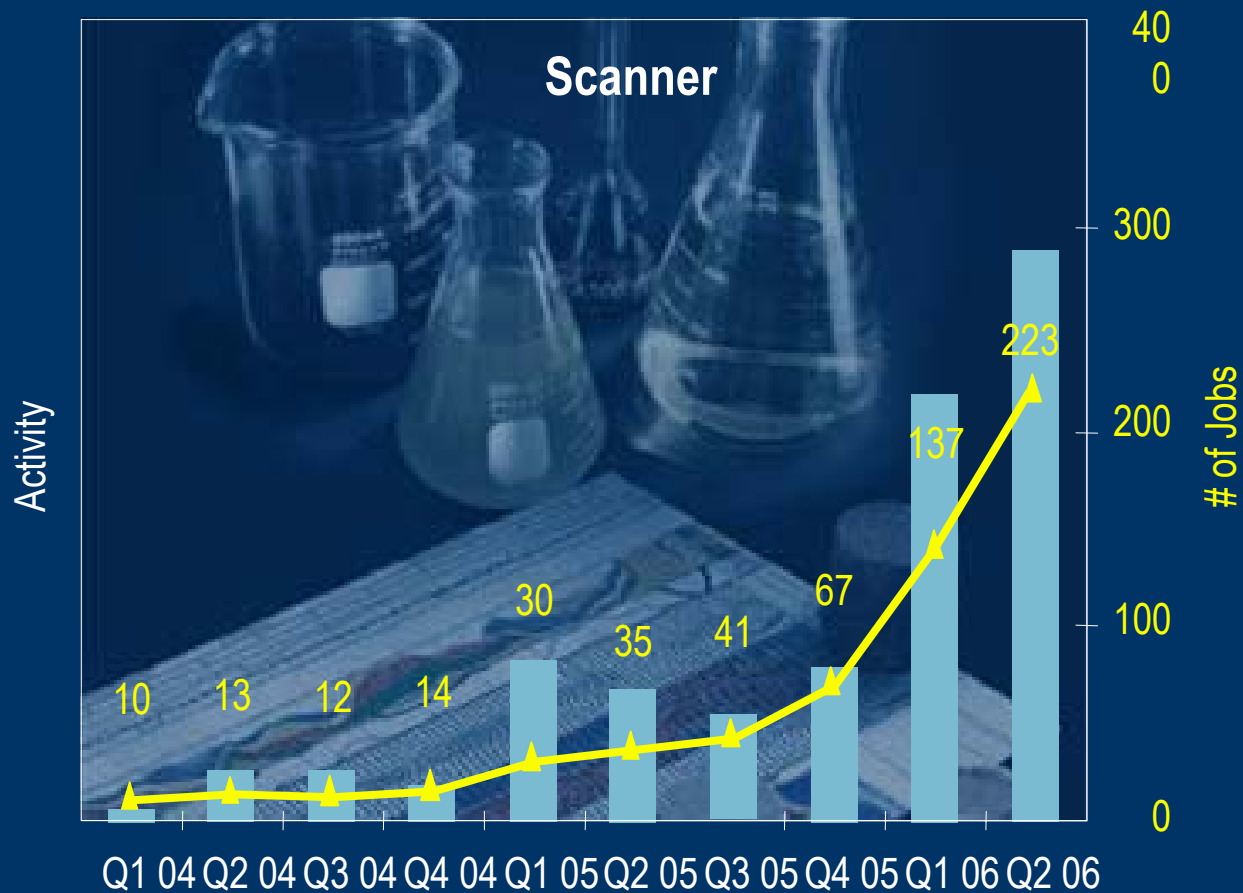




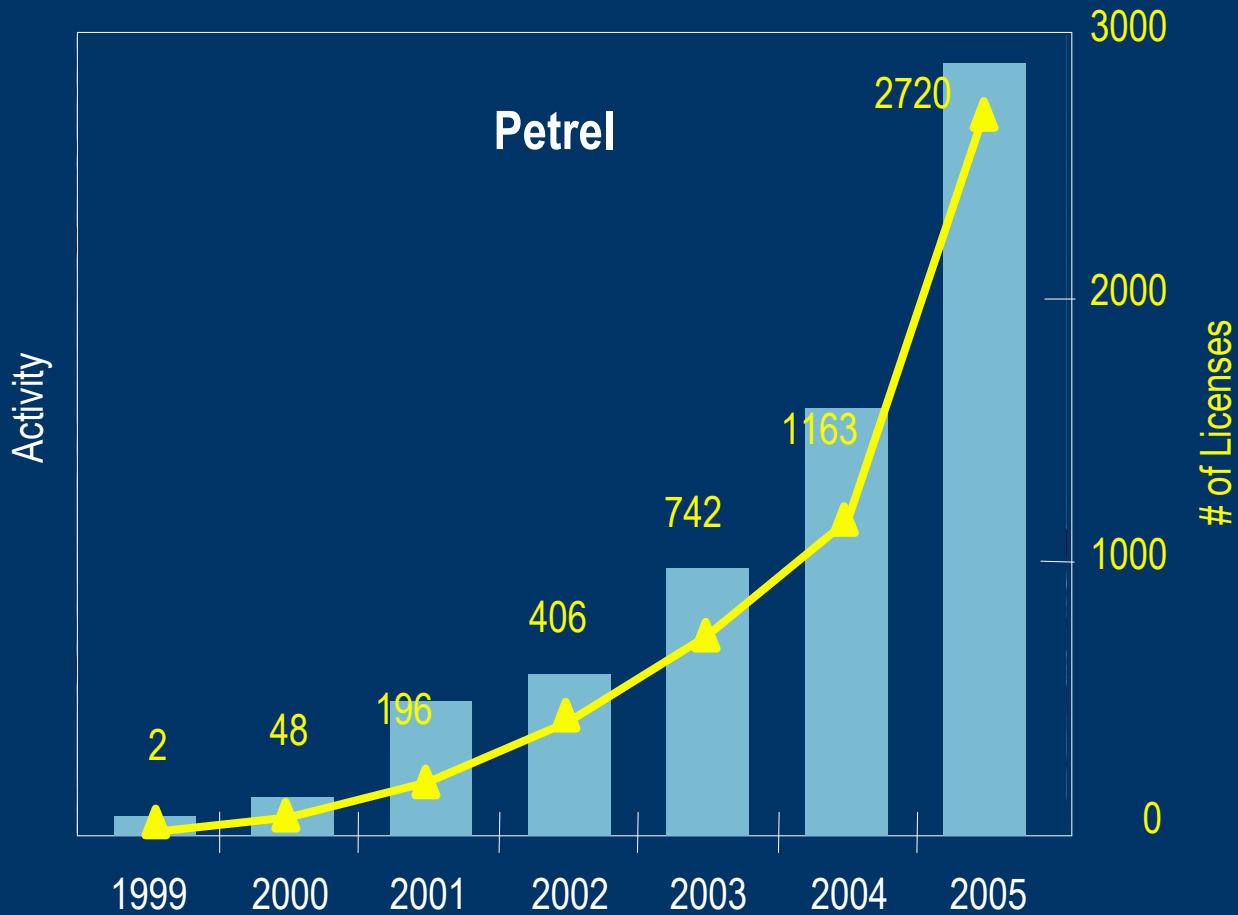
# Technology Penetration



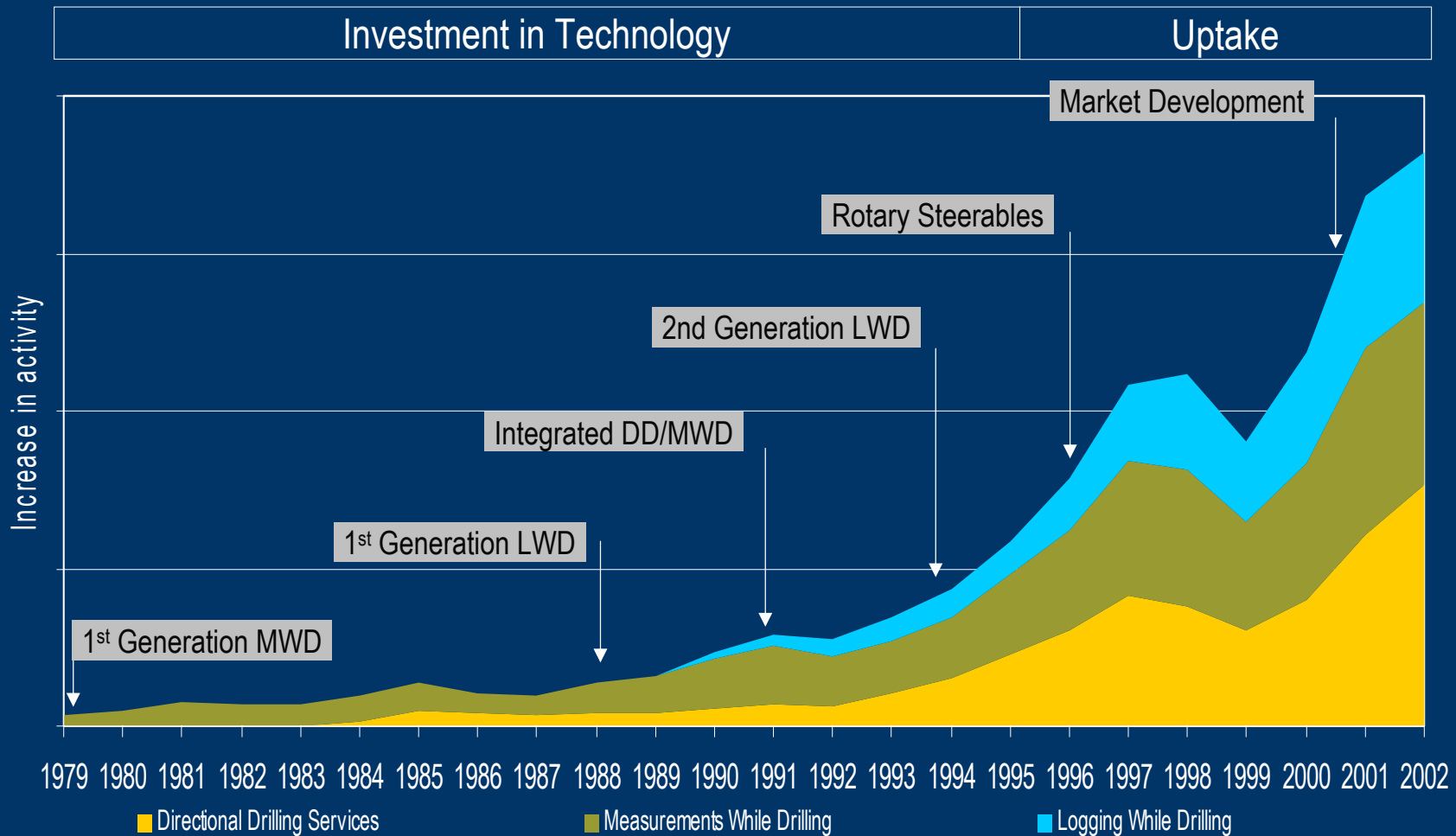
# Technology Penetration



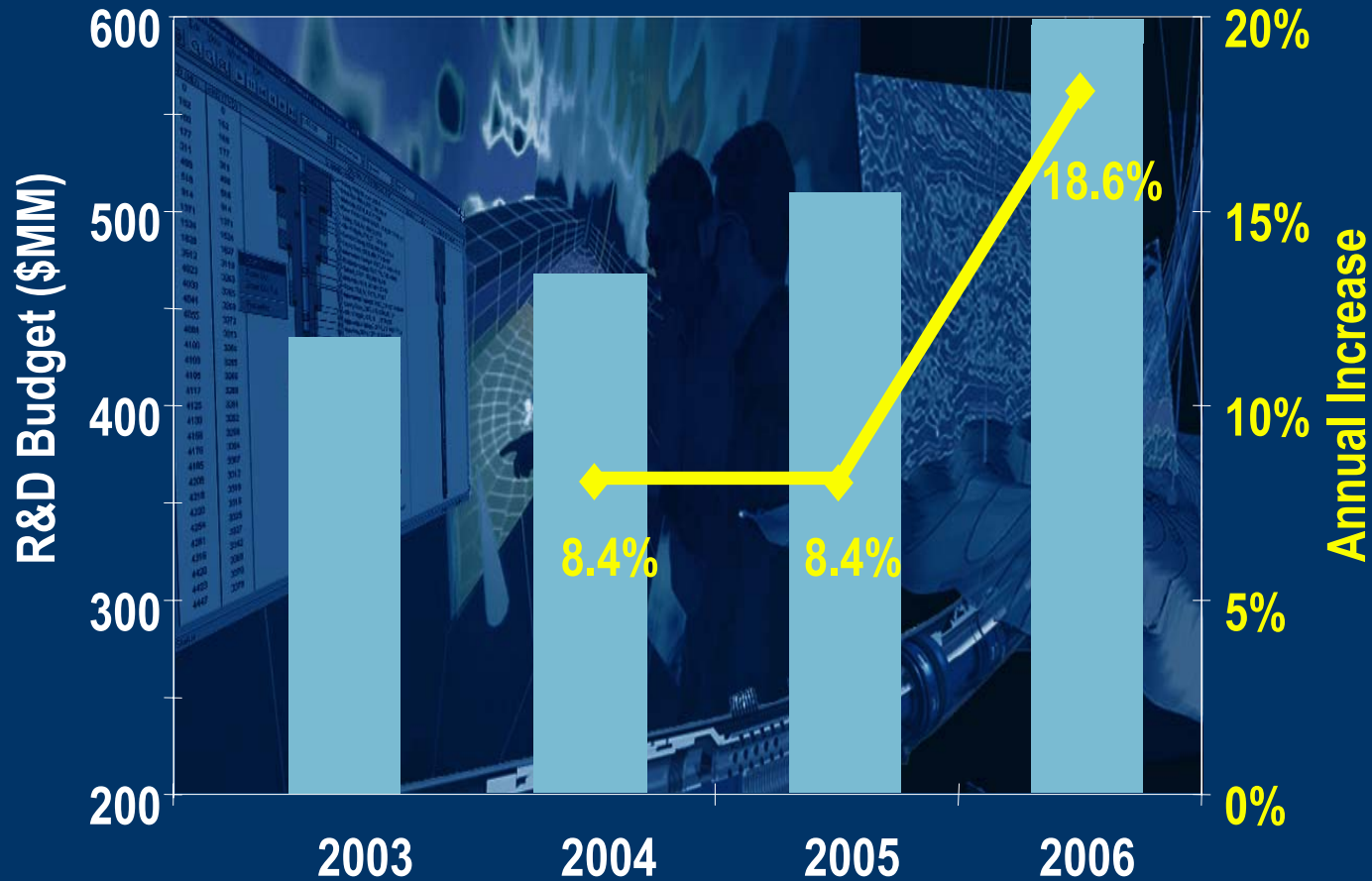
# Technology Penetration



# Historical Uptake for Directional Drilling



# Technology Development is a Long Term Commitment



# Technology Development Today is Global



Research  
336

Boston, Ridgefield 153

Cambridge 104

**Moscow 30**

Dhahran 26

Stavanger 20

Technology  
4,147

Sugar Land 1281

Clamart 531

Oslo 308

Fuchinobe 184

Rosharon 448

**Stonehouse 266**

Abingdon 126

**Beijing 129**

Houston 280

Stavanger 93

Princeton 119

**Novosibirsk 91**

**Edmonton 74**

Gatwick 75

Calgary 72

Manufacturing  
2,847

Bartlesville 370

Belfast 240

**Tyumen/Ufa 220**

Singapore 668

Houston 305

Aberdeen 130

Lawrence 158

Abbeville 97

Edmonton 102

Barrow 91

Southampton 76

# Additional Comments on R&D

We must continue to do more with less people – the “big crew change” is real and it is happening

R&D dollars flow like capital — to the most attractive area

- US lower 48 specific issues attract limited investment

Industry drives technology development based on resource opportunities

- e.g. Deepwater, Coal Bed Methane

Technology continues to mitigate the environmental impact of production

Deepwater and arctic limitations are economic not technical

# Alternatives to Conventional Oil and Gas

Oil shale will enter a new phase in the next decade

- In-situ upgrading

Gas hydrates face significant hurdles

Coal-to-Liquid and Gas-to-Liquid technology is known

- Capital costs and environmental concerns are challenges especially at large scales

Increasing heavy oil production, mainly in Canada:

- Requires increased natural gas and water resources

Increasing unconventional oil and gas development in the western US requires additional water resources



# So What Can We Expect?

Improved exploration success ratios

Increased reservoir recovery factors

Higher labor and material costs

Continued shift east

More unconventional plays

Reduced environmental footprint requirements

Digital oilfields and increased connectivity

Continued Innovation