

Overcoming Decision-Making challenges of managing a Digital Oil Field

- Describing a data flow through a generic asset system infrastructure
- Analysing key elements impacting the quality of a decision
- Improving the quality of decision making
- Strategic questions for consideration

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Who is GCA?

- International technical and strategic consultancy delivering advisory services to the O&G industry
- Founded in 1962 and acquired by Baker Hughes in 2008
- Approximately 400 staff
- Projects spans the entire spectrum of the energy industry
- Clients include a broad cross section of the industry: Governments, NOCs, IOCs, O&G Independents, Financial Institutions, etc.



KEY ELEMENTS OF A DIGITAL OIL FIELDS (DOF)

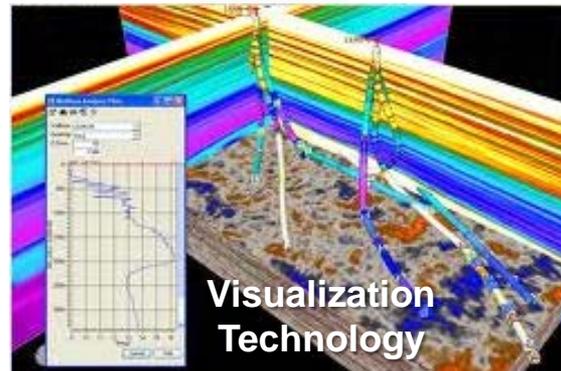
WHAT ARE THE KEY DRIVERS AND ENABLERS?

HOW DATA FLOWS ACROSS THE ASSET

AND

WHAT ARE THE DIFFERENT DECISION-MAKING LEVELS?

Key Elements of a Digital Oil Field (DOF)



DOF Drivers / Goals

– Accelerate time to first oil

– Increase production

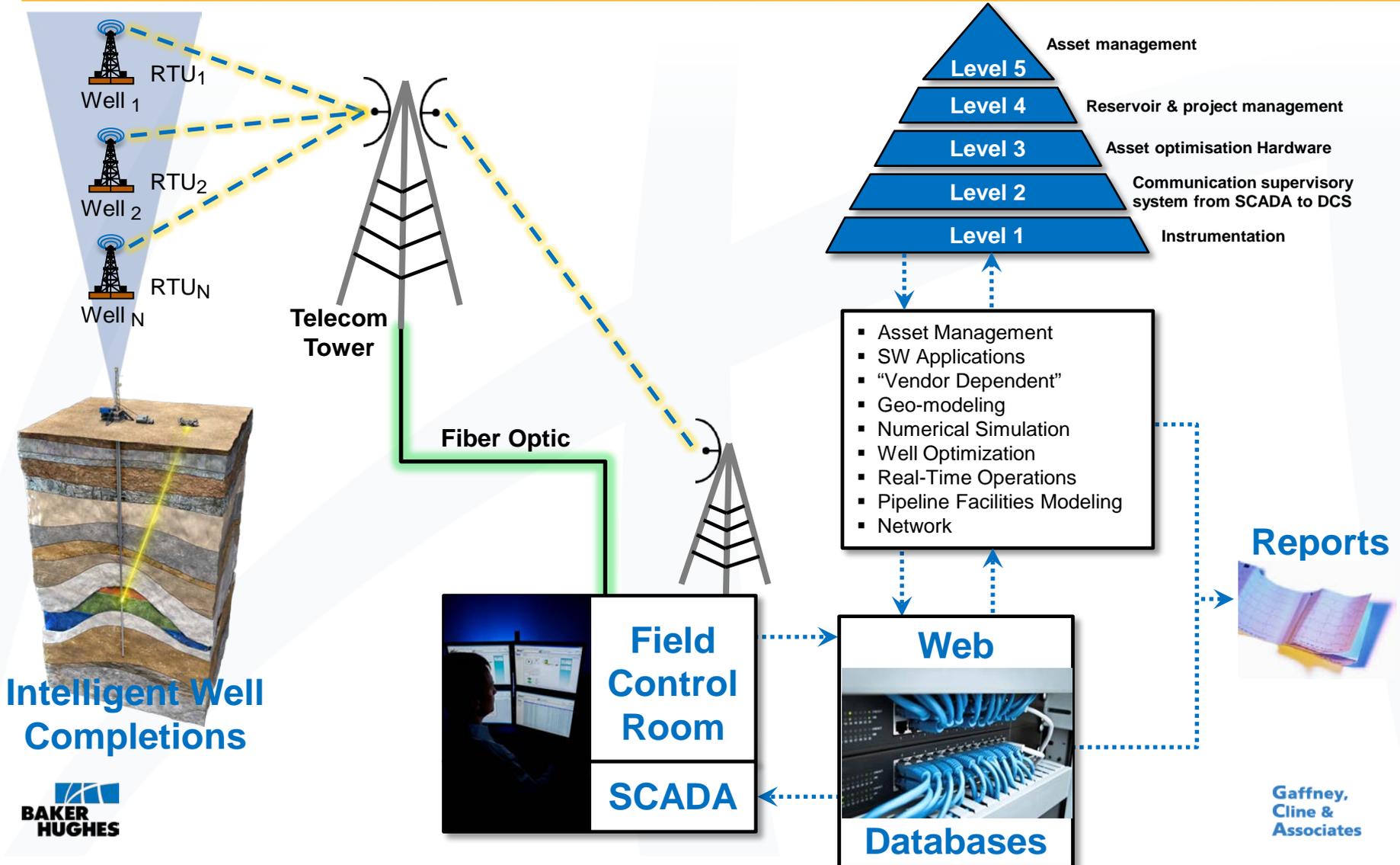
– Reduce cost and improve Safety

- immediate data access
- collaboration across disciplines
- global analogs and knowledge base
- immediate data access
- collaboration across disciplines
- global analogs and knowledge base
- remote operations and interventions
- central control rooms
- predictive maintenance

DOF Enablers

- High bandwidth communication
- Enhanced sensor technologies
- Large data storage capacity
- Expanded collaborative tools
- Emerging analytical and predictive tools
- Change Management to ensure sustainability

Generic DOF Data Flow and Decision Making Levels



DOF KEY CHALLENGES IDENTIFIED BY THE INDUSTRY PERCEIVED BENEFITS

Key Findings of SPE Digital Energy Survey* (2009)

Issues	Respondents
Perceived gaps in oilfield data integration that impedes their daily work	83%
Spends more than 25% of time identifying data to support their analysis	41%
Dedicates more than 25% of time preparing data for consumption by analytical programs	60%
Receives data automatically from their real-time systems into their engineering or geoscience analysis routines	9%
Consumes more than 50% of their time to identify, format, and prepare the data for the analytical tools	91%
Less than 25% of their professional time available for analysis, decision, and action	55%

*Source: JPT, September 2009 summary of SPE survey of more than 200 operating company respondents representing more than 30 companies

Key DOF Challenges

- Support of key staff across levels
- Alignment of business processes
- Training of staff
- Organizational culture

Benefits of Integration of DOF Tools

- Data and software integration
 - Accessibility of consistent, real time data to all stakeholders
 - Integration of applications for easy interoperability
- Workflow integration
 - Improved efficiency through combining and automating work processes
- Operations monitoring and control integration
 - Improved performance through real time operations centers servicing multiple distant locations
- Integration across disciplines and systems
 - Leverages diverse experts through real time collaboration
 - Enable asset teams to make better and faster decisions

DECISION MAKING AND THE DIGITAL OIL FIELD

Types of Business Decisions

- Strategic Decisions
 - Usually involve uncertainty / complexity and made over weeks or months
 - Life-shaping effects on corporate level
- Typical Decisions
 - Often collaborative with meetings that last for hours
 - Frequently tactical in nature but can have a large impact
- In-the-Moment Decisions
 - Often made within a short single sitting
 - Typically made relying on experience/pattern recognition

Strategic decision making has yet to be significantly influenced by DOF tools although these decisions usually involve the largest financial impact and the most time to decide.

Source: Carl Spetzler, Director of the Strategic Decision and Risk Management program, Stanford University

Decision Making Traps

Trap	Result
Groupthink Trap	Consideration of limited alternatives
Failure to Frame Trap	Misstating the problem
Complexity Trap	Data overload and ambiguous analysis
Status Quo Trap	Maintaining “less than optimal” current situations
Prudence Trap	Being overly cautious in estimating uncertain events
Recallability Trap	Giving undue weight to recent, dramatic events

Source: John S. Hammon, Ralph L. Keeney and Howard Raiffa, The Hidden Traps In Decision Making, Harvard Business Review 2006

DOF enhances Decision Making Quality

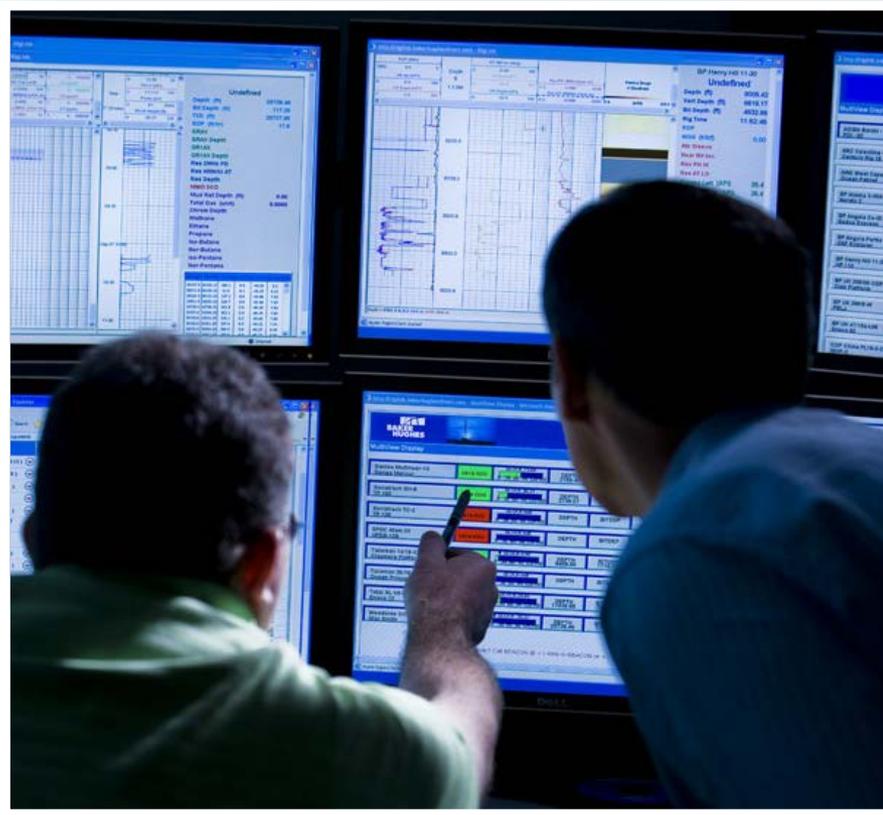
Trap	DOF Countermeasure
Groupthink Trap	<ul style="list-style-type: none"> • Enhanced collaboration tools • Increased centralization
Failure to Frame Trap	<ul style="list-style-type: none"> • Improved scenario modeling tools • Expanded knowledge management tools
Complexity Trap	<ul style="list-style-type: none"> • Faster and more accurate data access and manipulation • Improved analysis tools • Emergence of predictive analytics
Status Quo Trap	<ul style="list-style-type: none"> • Improved speed and accuracy of data • Expanded knowledge management • Emergence of predictive analytics • Expanded collaboration tools
Prudence Trap	<ul style="list-style-type: none"> • Broader access to analogous historical data • Improved scenario modeling tools • Emergence of predictive analytics
Recallability Trap	<ul style="list-style-type: none"> • Broader access to analogous historical data • Improved analytical tools • Improved scenario modeling tools

Critical Success Factors in Improved Decision Making*

- Data Quality; the right amount at right time
- Improved Analysis
- Change in culture
- Education and training of key staff

*Source: Based on a survey of 57 companies Thomas H. Davenport, "Are You Ready To Reengineer Your Decision Making", MIT Sloan Management Review, July 2010

From Data to Decisions



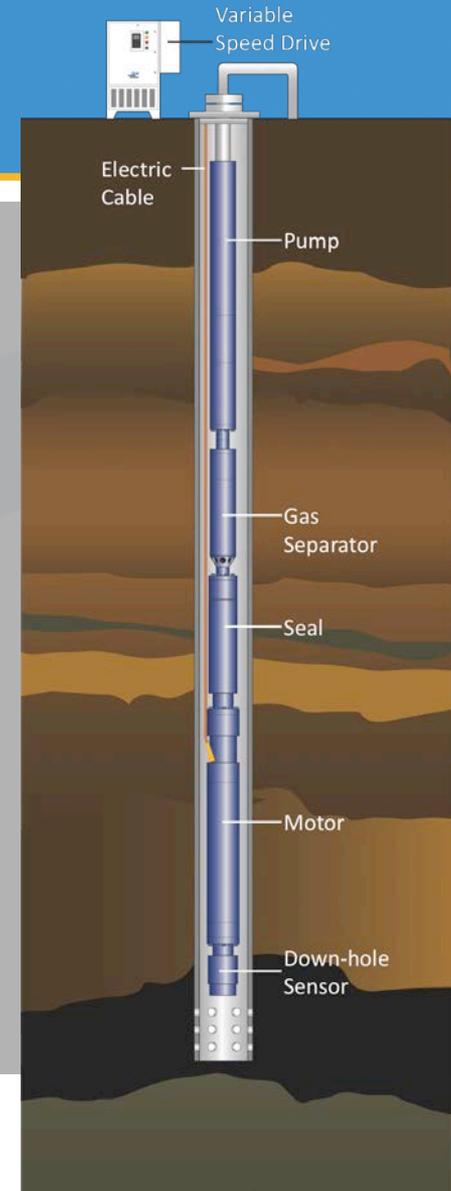
It's not just about
Gathering Data.
It's about **Improving the
Quality of the Decisions**
you can make from
interpretation of that data.

Decisions About Your Well

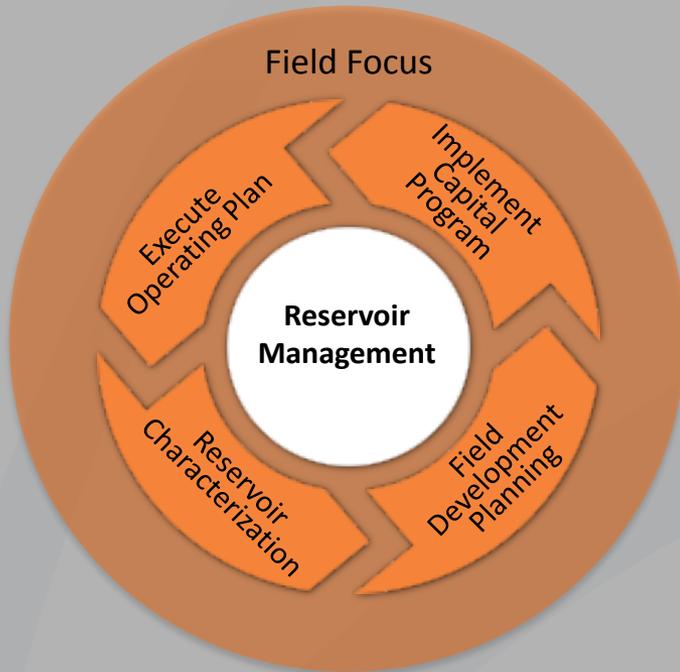


Intelligent diagnostics

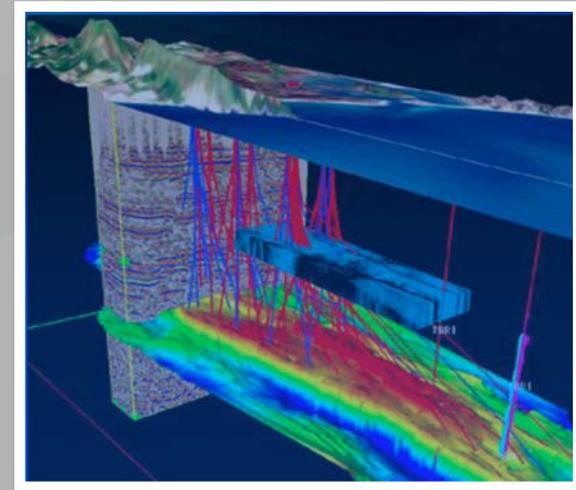
- Gas and water breakthrough
- Tubing leak
- Tubing plugged
- Pump plugged
- Pump worn
- Closed valve
- Choke open
- Gas lock
- Shaft broken



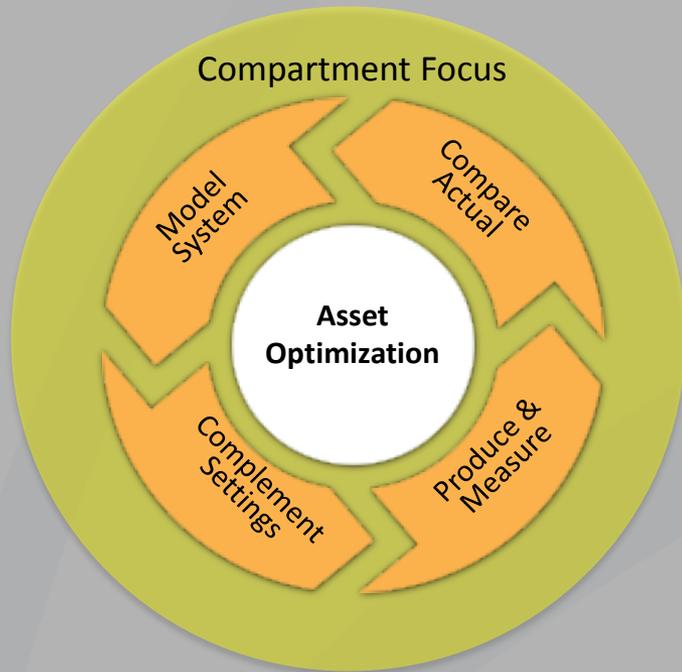
Decisions About Your Reservoir



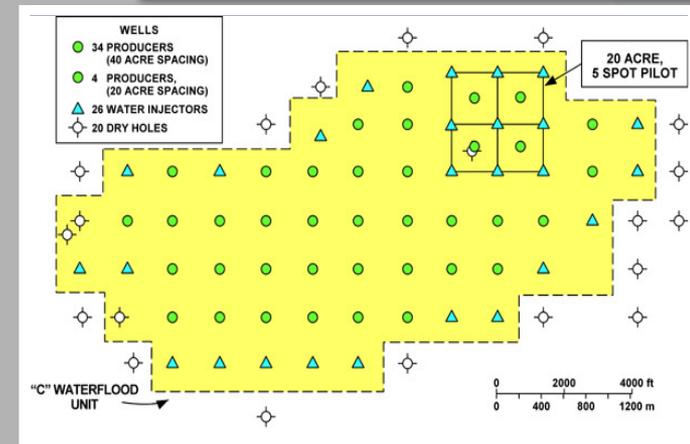
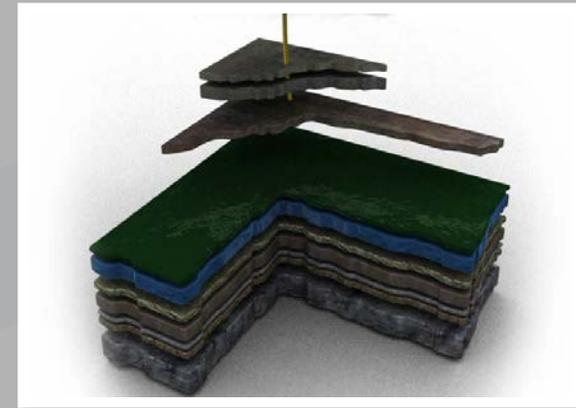
- Managing I/W
- Managing CO₂ cycles
- Managing GOC
- Managing aquifer Displacement



Decisions About Your Assets



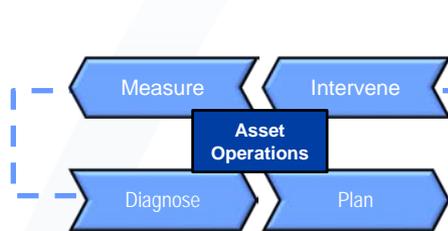
- Managing pattern vertical and lateral conformance
- Managing I/W ratios



Map showing the location of 20-acre 5-spot pilot flood. The peripheral flood pattern of injectors and producers.

Decision Making Along an Asset Life Cycle

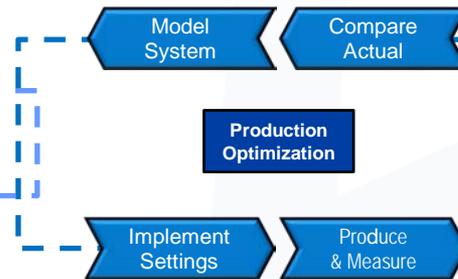
Operations Focus



Operations Cycle: Fast Loop

- Optimize operating efficiency
- Daily monitoring and surveillance
- Supervisory Control and Data Acquisition (SCADA)
- Adjust field equipment (chokes, gas lift injection, production routing, pump / compressor speeds, etc.)
- Remote actuation

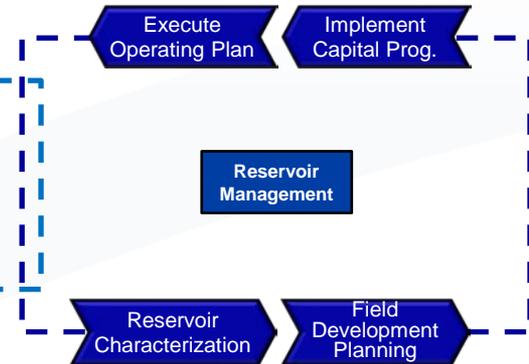
Engineering Focus



Engineering Cycle: Mid Loop

- Production optimization
- Surveillance and analysis of production data typically analytical models (Nodal Analysis)
- Identify problem wells and opportunities for maximizing production
- Well intervention
- Artificial lift
- Upgrade of field equipment
- Remediation of flow assurance problems

Asset/Field Focus



Field Development Cycle: Slow Loop

- Optimize recovery efficiency
- Numerical reservoir modelling
- Multi-discipline teams
- Field development strategies
- Infill and step-out drilling
- Primary, secondary, enhanced oil recovery
- Facilities design and sizing

Elements of a Good Decision

- The right frame - making sure the right problem is being addressed at the right time
- Clarity about the goal
- Developing creative alternatives
- Gathering the right information, including information about the uncertainties
- Analysis and reasoning
- A commitment to follow through

Source: Carl Spetzler, Director of the Strategic Decision and Risk Management program, Stanford University, Strategic Decisions Group Executive Briefing Paper, December 2006

From Digital Oilfield to Decisional Oilfield

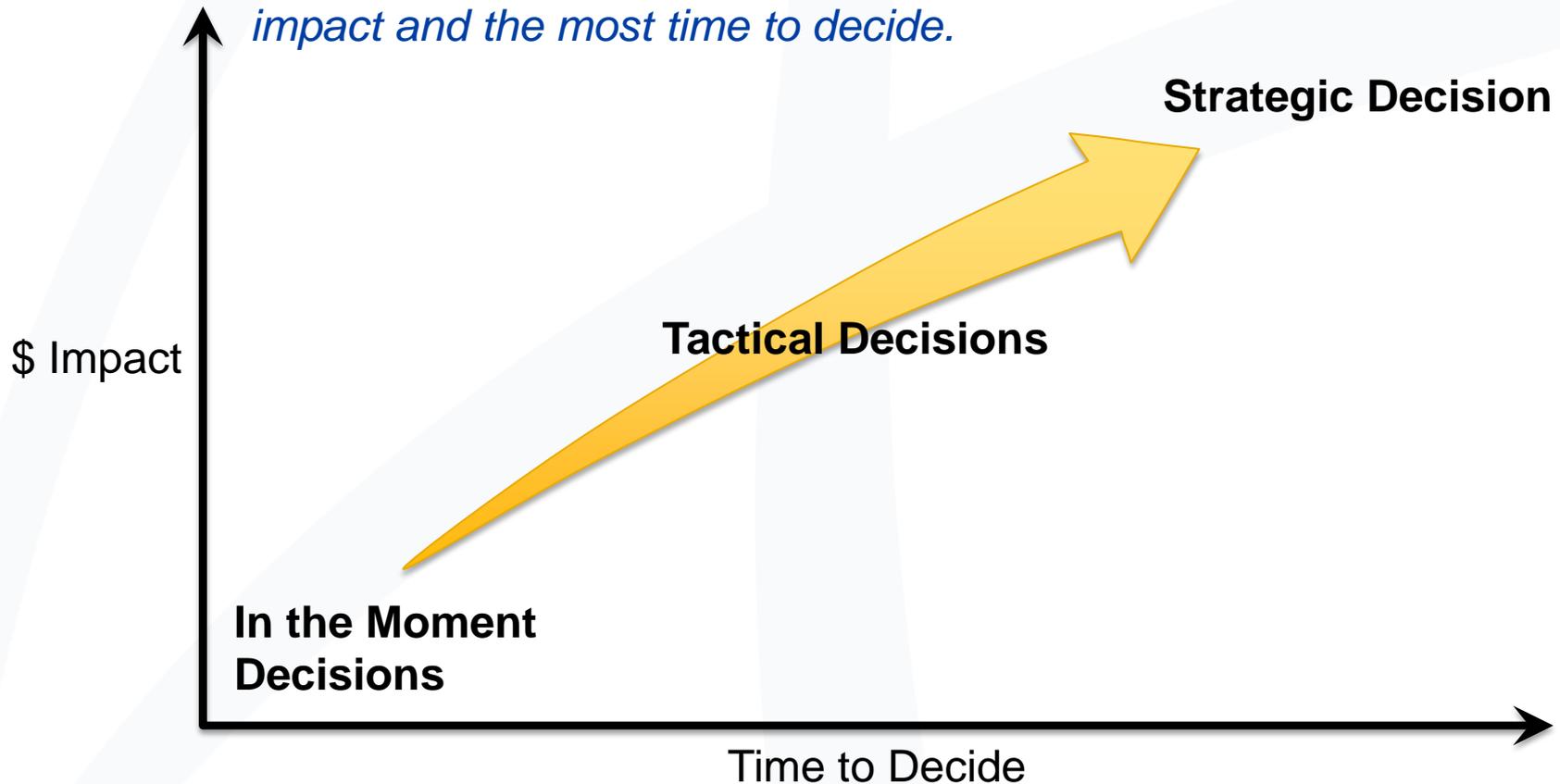
The
right data
at the
right time
through the
Relevant Processes
and Technologies
to the
right People



WHAT STRATEGIC QUESTIONS MAY STILL REQUIRE FURTHER ATTENTION

Profile of Business Decisions

Strategic decision making has yet to be significantly influenced by DOF tools although these decisions involve the largest financial impact and the most time to decide.



Key DOF Strategy Questions

- Does our system efficiently target the best information to make the “right” decisions (time, \$) ?
- Does our system have the tools:
 - To analyze complex business issues?
 - To predict key business events and opportunities?
 - To identify opportunities that can be leveraged across assets, fields or even regions?
- Does our strategy incorporates organizational structure, training and change management?
 - If not, how will the organization manage the transition to the next generation of DOF processes and technologies?
 - How will our People embrace and sustain the DOF way ?

QUESTIONS ???

The Next Steps

- Extending DOF tools and collaborative way of working beyond production, drilling and operations into other functions and stakeholders
- Integration of emerging analytical software and predictive tools
 - Answer “why”, not “what”, questions
 - Expanded problem solving
- Incorporation of cultural and change management issues in DOF strategy

The Next Wave: Predictive Analytics

- Predictive analytics leverage DOF data to provide a form of business intelligence which utilizes quantitative and/or statistical models to solve business problems
- Oil and gas applications
 - Optimized maintenance programs to eliminate unplanned downtime
 - Increased understanding of existing field operations (answering not just what, but also why and how questions)
 - Identification of possible oil and gas reserves based on seismic, geophysical and well data as it is collected, analyze and shared across disciplines on timely manner.
- Benefits perceived to be faster and more fact-based decision making
- If models are not properly constrained they could mislead decision makers

DOF Technology Evolution

Decade	Focus
1980s	<ul style="list-style-type: none">• Remote monitoring technology• Communication technology
1990s	<ul style="list-style-type: none">• Control systems• Data management and infrastructure• Integration across functions
2000-2010	<ul style="list-style-type: none">• Centralization of operations• Collaboration• Business process reengineering
Current	<ul style="list-style-type: none">• Integration across stakeholders, assets and corporate processes• Lean Six Sigma to eliminate “waste”• Predictive analytics• Enhanced Collaborative Working Environments to improve Decision-Making• Change Management

Baker Hughes DOF Solutions (1 of 2)

Increase production rates and recovery

- Baker Hughes Reservoir Development Services finds and maximizes reserves; increases production rates and recovery factors; selects, defines, and executes field development plans; and analyzes A&D options

Ensure precise wellbore placement

- Reservoir Navigation Services customized, multidisciplinary approach reduces NPT and maximizes production by keeping your wellbore in the pay zone

Reduce total cost of ownership

- Intelligent Production Systems offers the information needed to make confident decisions that accelerate production, increase ultimate recovery, and reduce total cost of ownership

Baker Hughes DOF Solutions (2 of 2)

Anticipate problems and optimize decisions

- The BEACON™ real-time remote collaboration platform ensures your experts and ours make the right decisions at the right time, regardless of physical location
- Wellbore monitoring uses permanently installed electronics and fiber optics to enable critical production decisions
- WellLink Vision™ real-time monitoring service and our electrical submersible pumping (ESP) systems optimize production
- SENTRYNET™ chemical automation technologies ensure chemicals are applied optimally
- Downhole flow control technology remotely reconfigures completions in response to downhole measurements

Agenda

- GCA Introduction
- Key Elements to describe a DOF
- Drivers and Enablers of the DOF
- Decision Making and the impact of the DOF
- Key Challenges and