Digital Oilfield – 
A Template based Approach

Meyer Bengio
Vice President Petroleum Engineering
Schlumberger Information Solutions
What is it
Who will benefit from it
Why Digitize
How to Approach the Problem
What is a possible Solution
What is it?

Path to DOF

- Integrated Operations
- Collaboration
- Production Optimisation
- Surveillance & Monitoring
- Data Management
- Smart Iron

% of SPE Papers

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

Innovate. For the Long Run.
The IT view

Conceptual Architecture

Shared Services Infrastructure
- Presentation Services
  - Web Parts
- Business Process Services
  - Shared Business Processes
  - Business Process Rationalization
  - System & Human Centric Processes
- Business Activity Services
  - Atomic Business Services
  - Process Integration
  - Enrichment
  - Custom Business Logic
- Data Services
  - Logical Data
  - Data Aggregation
  - Data Synchronization
- Connectivity Services
  - System Access
  - Messaging
  - Adaptors
  - Data Access
  - Partner Integration

Portals and Mashups

Client/Legacy Applications
- Non Service Enabled Assets
- Service Enabled Assets
Who are the Users we are trying to serve?

- **Asset Management**: Take decisions based on economic value and strategic objectives.
- **Reservoir Engineering**: Maximize reserves and recovery at lowest possible risk.
- **Production Engineering**: Keep production flowing in the well and pipeline.
- **Production Operations**: Manage and monitor day-to-day operations.

Innovate. For the Long Run.
Asset Management
Take decisions based on economic value and strategic objectives

Reservoir Engineering
Maximize reserves and recovery at lowest possible risk

Production Engineering
Keep production flowing in the well and pipeline

Production Operations
Manage and monitor day-to-day operations

Digitize = Velocity + Quality ….. of decisions

Innovate. For the Long Run.
Example: The Operations and Production Cycle

Optimize the dehydration process performed
Reach a gas utilization of 99%, installing gas low pressure equipments.
Increase gas utilization efficiency.
Increase the reliability of compression equipment.
Optimize the lifting systems, while maintaining low lifting costs.
Optimize gas lift allocation on a field-wide scale
Maintain production costs near current levels
The “reservoir management” cycle

Accelerate production incorporation from new fields
Implement enhanced recovery systems to increase recovery factors.
Design optimum in-fill drilling strategies and reservoir depletion strategy.
An Approach
A Bottom Up Approach

ASSESS  DESIGN  BUILD  TRANSFER

Innovate. For the Long Run.
Field Assessment

- What Production Challenges
- What Environment
- What Recovery Mechanism
- What Lifting Mechanism
- What Sensors, Meters, Controls
- What Infrastructure
- What Models
- What Integration
System Level Requirements

- Acquisition and Data Exchange Standards: OPC-HDA, PRODML, WITSML
- Presentation Standards
- Workflow Automation
- Event and Time based Scheduling
- Openness & Extensibility
- Optimisation Libraries
Standard Workflows Examples

- Data conditioning: Automated cleansing and aggregation
- Rate estimation: Using neural networks, historical and real-time production data
- Well test validation: Compare well test rates to rate predictions from nodal analysis, neural networks and back allocation
- Liquid loading detection in gas wells
- Wax deposition prediction
- Sanding Prediction
Standard Template example: Waterflooding

Key concepts:
- Most common form of secondary recovery
- Wells are usually drilled in geometric grids or "patterns"

Pain points and Solutions:
- Large volumes of data. QC can be overwhelming > Workspace: collection of maps, comparative plots, outlier identification reports
- Determining allocation factors > Compare measured pressures with calculated (e.g. via MB), Streamline
- Calculations require PVT, but pressure data is sparse > Multiple estimation methods for creating continuous pressure streams

Innovate. For the Long Run.
Optimisation

- Workover Candidate selection: Using historical and real-time data
- Gas Lift Optimization: Single Well / Field wide optimization
- Mixed Lift Optimisation
- Economic optimisation
- Waterflood pattern optimization: Analytical / Streamline
- Steam Assisted Gravity Drainage (SAGD) real-time optimization
Example: An Artificial Lift System

- Unreliable sources of lift gas
- Ageing facilities
- Unreliable instrumentation
- Dual gas lift completion
- Surface facilities constraints
- Increasing water cut and sand production
- Unmanned operations
- New wells online that will require additional gas lift in the near future
Limitations

- Scada and Historian is just a monitoring system but not an optimizer.
- Additional powerful tools are needed to maximize the value of real-time data and optimize the field.
- Not equipped with alarms to warn users when abnormal parameters or trends are recorded.
- Intensive utilization of resources (full time dedicated surveillance engineer).
- Not capable to condition the high frequency raw data.
- Not capable to support automated surveillance workflows.
Digitisation

Welltest validation

Gas lift diagnosis

Full field gas lift optimization

Gas lift optimization at well & reservoir level

- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
- Redesign gas lift system in both strings
- Review current gas lift design in both strings
- Determine optimum split factors at reservoir level
- Determine optimum split factors at well level
- Determine target injection rate per string
Real Time Gas Lift Optimization

Gas Utilization Factor

Production Optimization

Reservoir Optimization

Date

GUF, GUF (L), Gas Lift Injection Rate, 14 per. Mov. Avg. (Gas Lift Injection Rate), 14 per. Mov. Avg. (GUF), 14 per. Mov. Avg. (GUF (L))

Innovate. For the Long Run.
DOF over the Life Cycle of the Field

- **Phase I**
  - Mature Field; Shallow, Unmanned platform; Gas Lifted
  - Increase Production Through Gas Lift Optimisation – Daily
  - Constraints: Well, Field level (pipeline, corrosion)

- **Phase II** Gas coming from Nearby Field
  - Optimise based on Gas availability and Gas contracts – Daily
  - Mixed Integer Optimisation

- **Phase III** Add ESP for certain Wells
  - Mixed optimisation Gas, ESP, Choke

- **Phase IV** WAG cycle design and optimise

- **Phase V** Minimise Water and Energy while maintaining Production levels

Innovate. For the Long Run.