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Implementation Results for Chevron's *i-field** in San Joaquin Valley, California

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Abstract

This paper summarizes results to date of implementing *i-field* projects in selected assets in Chevron's San Joaquin Valley Business Unit (SJVBU) in California. The *i-field* projects include collaborative environments to transform operational processes at a basin-wide or asset level remote collaboration and visualization has been implemented to help execute reservoir management and major capital project targets reliably and efficiently in the field. Successful asset prototypes are standardized and replicated across the business unit. The results to date demonstrate business value and take-up of the technology and processes by oilfield operations.

Introduction

The major producing assets of Chevron's SJVBU are shown in red in Figure 1. SJVBU production in 2007 averaged over 220,000 barrels per day from approximately 15,000 producing wells. Approximately 83% of the production was heavy, 10% light, and 7% gas. The heavy oil is generally recovered through thermal operations, while the light oil is produced by waterflood.

Unneland and Hauser (Reference 1) described the beginning of Chevron's digital oilfield program called "*i-field*". Ouimette and Oran (Reference 2) summarized the use of decision support software, integrated with improved instrumentation, workflow automation, and data architecture to enable more reliable and efficient field operation and execution of reservoir management targets at San Ardo within SJVBU.

i-field has become critical to SJVBU's quest for operational transformation, in pursuit of a vision to:

- *Operate from a centralized asset decision environment where the application of smart oilfield technologies result in industry leading margin performance*
- *Integrate reservoir management with operations*
- *Automate routine decisions by artificial intelligence*
- *Create a highly virtual organization where innovation and collaboration efficiently move ideas to applied technology*

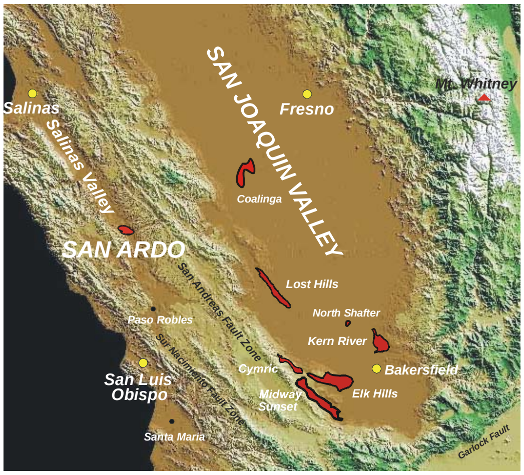

Figure 1

Approach

i-field in SJVBU began as an asset based project at San Ardo aimed at transforming 21 work processes for steamflood reservoir management and field operations. SJVBU then launched a number of projects which served many of the work processes and which could be deployed throughout the business unit. Those deployed currently include:

- *Decision Support Center (DSC)*
- *Master Schedule Visualizer (MSV)*
- *Steam System Optimizer (SSO)*
- *Reservoir Management Workflow Manager (RMWM)*
- *Well Event Surveillance Tool (WEST)*
- *Pattern Exception Tool (PET)*

The common *i-field* theme in all these applications is work process transformation integrated with new technologies, which produce efficiencies in reservoir management and field operations.

Selected Results to Date

Decision Support Center (DSC)

A Decision Support Center (DSC) in SJVBU's Bakersfield headquarters provides a collaborative, visual environment to facilitate steam generation process standardization and improvement across the entire business unit. SJVBU operates over 150 steam generators across assets, and steam generation is a significant component of operating expense.

The DSC allows simultaneous display of important performance metrics for all the steam generators throughout the BU. The DSC builds on an existing infrastructure of standard steam generation controls, Supervisory Control and Data Acquisition (SCADA), and remote access to historical and SCADA data. Enabling technologies include a reliable intra-asset communication network and a real-time data management system in which Programmable Logic Controller (PLC) tags from all generators feed data historians with overlying applications such as trending, visualization and alarming. Portal technology enables web based viewing of relative performance data simultaneously for all units. The DSC provides a visible monthly scorecard for relative leading and lagging indicators to drive individual assets to improve.

The DSC includes a dedicated specialist who monitors the generators for optimization and who provides support to field operations. The DSC steam specialist works full time in a collaboration space with large screens and multiple work stations for periodic collaboration across assets for joint problem solving. A significant benefit is that the specialist and the various operators at SJVBU's scattered assets are able to see the same information, thus reducing cycle time for corrective measures.

The benefits to date include:

- 12 % improvement in generator capacity utilization
- Capital avoidance for emission upgrades with fewer generators needed
- 1% improvement in generator efficiencies
- Reliability improvements with predictive response to generator problems

The DSC concept is being replicated for centralized, remote management of other basin-wide processes.

Master Schedule Visualizer (MSV)

The MSV is a technology enabled collaboration environment supporting the Surface Maintenance Planning process at Kern River oilfield, SJVBU's largest and most complex asset. The Kern River oilfield is approximately 22 square miles, with over 8,000 producing wells, and with over 80 surface maintenance crews consisting of hundreds of workers at any given time.

As shown in Figure 2 the various field activities are scheduled, mapped, and visualized on a large rear projected screen. Six planners manage the weekly planning of surface maintenance work. One planner and four crew leads manage surface maintenance crews minute by minute.

The benefits of the MSV include an increase in crew efficiency and better integration with other field activities. It has strong support from the maintenance planning team at all levels.

The field maintenance MSV is being replicated at other SJVBU assets.

Figure 2

Steam System Optimizer (SSO)

The Steam System Optimizer (SSO) at San Ardo is a set of technology enabled work flows designed to manage the tactical decisions associated with heat management of a steamflood. SSO's goal is to follow the field development plan, represented by a set of signposts and trends that must be met for the plan to succeed. SSO monitors the reservoir via critical measurements and tests the results against the signposts and trends. It develops a picture of the current thermal state of the reservoir and suggests adjustments to operational parameters such as steam rates using proprietary technology.

The SSO consists of four proprietary modules, or "managers": thermal maturity, policy, tools, and monitoring. SSO work process and associated software architecture have been broken into three different timeframes, which can be thought in terms of "loops".

The **Fast loop** set of activities are the daily tactical decisions. These include:
-- Setting the daily steam rates by well, by generator, and the water requirements.
-- Monitoring the field data to determine if field development is on or off plan.
-- Accumulating and summarizing data for other slower loop modules.
-- Displaying activities and reacting to thresholds.

Medium loop (quarterly) acitivities:
-- Analysis is performed and evaluated in this layer using updated temperature observation well data.
-- The thermal maturity is updated for patterns.
-- New rules are created for the policy manager which makes decisions in the tactical layer.

Slow loop (annual) activitities:
-- Last year's activities are evaluated.
-- New goals and strategy for the SSO are created consistent with the field development plan.

The San Ardo team is streamlining their work processes and has created a new field position for a coordinator to use the application. The San Ardo SSO is being evaluated for replication at other Chevron steamflooding assets.

Reservoir Management Workflow Manager (RMWM)

The San Ardo RMWM aims to integrate data sources and applications, including SSO, at a well, pattern, or field level to speed up team decision making regarding field development. A Geographical Information System (GIS) portal guides the user. A collaboration room has been completed at San Ardo for collaborating between the San Ardo field office and the asset development staff 150 miles away.

A workflow is viewed as a reliably repeatable pattern of activity enabled by a systematic organization of resources, defined roles and information flows, into a work process that can be documented and learned. Workflows help users capture knowledge by standardizing critical business practices. Once a best-practice workflow has been defined, it may be repeated time after time by any asset team or individual. A workflow manager breaks down a workflow into logically ordered steps in such a manner that when an engineer or operator repeats those steps, they can arrive at a consistent end product (i.e. a decision, action item, forecast, documentation, etc.) It ensures reliability and efficiency.

The Reservoir Management Workflow Manager focuses on the integration of data for making decisions in a reservoir management workflow with 4 steps:

1. Determine scope/get oriented
2. Review production/injection trends
3. Review surveillance data
4. Recommend corrective actions

Figure 3

Viewing alarms from SSO on a map (figure 3) allows the user to put the information in context to understand if there is a possible relationship based on facility proximity. Launching other applications from the map also adds value to the user experience. For example, viewing SCADA data, Temperature Observation Viewer, and digital documents from the Electronic Well Files system from the map allows the users to pull in as much information that is needed to make the right decision in the workflow.

The RMWM is being evaluated for adaptation and replication at other Chevron onshore assets in North America.

Well Event Surveillance Tool (WEST) and Pattern Exception Tool (PET)

The WEST and PET tools at Lost Hills are used to help manage a waterflood by enabling cross functional exception identification, analysis, decision making, and follow up action management.

The applications currently:

- Conduct intelligent surveillance on over 1000 producing and 1000 injection wells.
- Examine well test and Pump Off Controller (POC) data from all wells and suggests probable problems
- Identify underperforming patterns by exception
- Provide condition monitoring of pattern parameters
- Prioritize pattern performance

- Identify underperforming/performing injector and producer wells
- Classify Alerts (OK, Pending Alert, Alert and Not OK)
- Classify injector and producer well events
- Integrate data from multiple data sources

A collaboration and visualization room includes:

- Audio, video and data collaboration (Internal & External, Wireless)
- Visualization (19 foot by 6 foot Screen using 3 high resolution blended projectors)
- Integration (Simultaneous workspace for Linux/Windows, Control Panel, Laptop connections)
- Smart Board

The benefits of the WEST and PET tools in the collaboration room are as follows:

- 30-40% increase in pattern and well reviews per month
- Standardization of pattern and well review processes, capture of asset knowledge
- Engineers evaluating the common data using standard methodology
- Automatic diagnostics of routine events and identification of underperforming wells and patterns.
- Cross functional disciplines (engineering and operations) accessing, visualizing and evaluating the same data
- Increased number of participants at meetings has increased collaboration between disciplines
- End User consensus that there is a positive impact on increasing production and decreasing downtime with the use of the tools.

The PET and WEST tools are being integrated and updated using Service Oriented Architecture (SOA). There is potential to integrate these with RMWM functionality.

Data Architecture and Support

The data necessary to support these *i-field* activities are significant. The SJVBU launched the "Minerva" Project to create an SOA with web enabled data access to support MSV, SSO, and other *i-field* activities. Historically, data collected from the SJVBU assets were accessed by custom queries by multiple applications from multiple locations in various forms, making consistent data analysis and system support difficult. With Minerva, data drives more confident decisions, and as a result these *i-field* deployments benefit from a firm foundation in place. The Minerva Project also developed a management reporting portal that provides current and consistent reporting of key business unit leading and lagging indicators, replacing a previously cumbersome process of rolling of up information via disparate shadow systems from individual assets on a weekly basis.

Conclusions

SJVBU has implemented many *i-field* projects. The results to date demonstrate business value and take-up of the *i-field* technology and work processes by oilfield operations.

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