Field Surveillance and Well-Services Management in a Large Mature Onshore Field

A real-time field-surveillance and well-services management system was deployed in an onshore mature field in California. The challenges of data management included automatic handling of very large quantities of real-time data, management of inventory, and integration of field-level data with corporate-level data. Technologies required for this project included software systems and integration of these with remote intelligent-field sensors and data-transmission systems. This project established that integrated intelligent remote devices, communications networks, and workflow-management software could be deployed successfully on large mature fields.

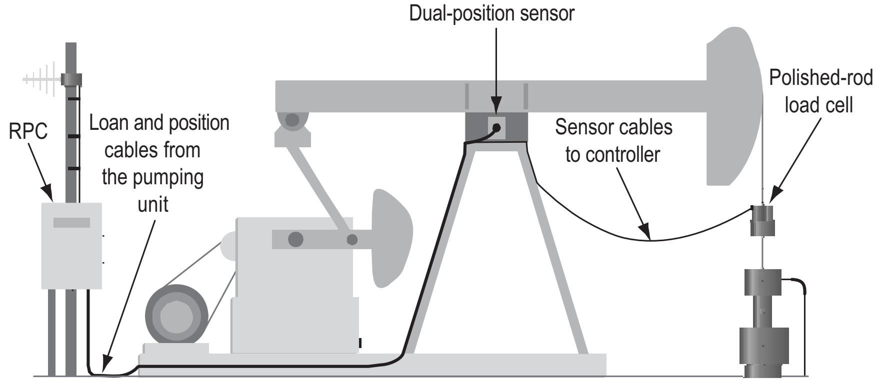

Fig. 1—Typical POC Configuration; RPC=remote power controller.

Prior State of the Business

Chevron's San Joaquin Valley Business Unit (SJVBU) is in the southern San Joaquin Valley in central California. The SJVBU operations encompass assets in seven oil fields, which before the merger of Chevron and Texaco were operated by those two companies. The earliest of these oil fields was developed in the early 1900s. Most of the development occurred in the 1960s and 1970s with the implementation of steamflood technology. Aggregate production from the SJVBU assets is approximately 200,000 BOPD. Approximately 15,000 active wells produce in the SJVBU, yielding an average production of approximately 13 BOPD/well.

The SJVBU fields produce from relatively shallow reservoirs, including the Miocene/Pliocene Kern River, Tulare, Temblor, and Potter formations, which typically have porosities ranging from 20 to 30% and permeability in the range of 1 to 5 md. Oil gravity ranges from 13 to 20°API, and viscosity is approximately 50 cp. Reservoir depth of approximately 1,000 ft enables extremely rapid drilling. Oil-production revenue is more than 95% of total sales, and virtually all wells use sucker-rod pumps (SRPs).

The key operational focus of these fields concerns the challenge of maintaining this very large number of wells at optimum production. An online system for well surveillance and well-services management was installed in the SJVBU, and the experience of implementing this system was used in the Cymric field. Cymric is typical of the SJVBU fields and contains approximately 800 SRP wells producing 16,000 BOPD. Cymric has another 500 huff 'n' puff cyclic-steam wells that flow after the steam cycle, adding another 24,000 BOPD, for a total field production of 40,000 BOPD.

This article, written by Technology Editor Dennis Denney, contains highlights of paper SPE 99949, "Real-Time Field Surveillance and Well-Services Management in a Large Mature Onshore Field: Case Study," by ***L. Ormerod,*** *SPE, Weatherford;* ***H. Sardoff,*** *SPE,* ***J. Wilkinson,*** *SPE, and* ***B. Erlendson,*** *Chevron; and* ***B. Cox*** *and* ***G. Stephenson,*** *SPE, Weatherford, prepared for the 2006 SPE Intelligent Energy Conference and Exhibition, Amsterdam, 11–13 April.*

Automation History

In the 1980s, a program to increase production in the Lost Hills field was based on finding the best method to fracture the wells. Field production rose from less than 3,000 BOPD to more than 20,000 BOPD. Managing this new production became a priority, and pump-off controllers (POCs) were installed throughout the field similar to that shown in **Fig. 1.**

Between 1995 and 1997, well failures at Cymric, measured by the rate of failures per well per year, had increased from approximately 0.15 (i.e., 15% of the wells fail over a period of 1 year) to approximately 0.3. These failures resulted in significant cost in terms of repair and an additional cost from deferred production. Technology played a significant role in this effort: POCs were deployed on the basis of experience gained in the Lost Hills field, well-management software for surveillance and SRP optimization was introduced, and downtime from production allocation was analyzed to prioritize repair jobs.

Also, significant changes were made to the field-management process including development of the well manager's role, a well-review process,

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and the trending of run-time metrics. Staff development and participation was increased including frequent communication of the aggressive targets to operators, sharing of best practices with contractors' staff, and training. Key suppliers were reviewed and in some instances changed.

Change Drivers

When estimating the costs of failures, two main categories were considered, the direct cost of making the repair itself and the cost of the deferred production. Deferred production equals the well production rate multiplied by the total time between failure and production restoration (times between failure occurrence and detection, between detection and commencement of repair work, and duration of repair work). The relative cost contribution between direct costs of repair was U.S. $6,000, and the cost of deferred production was $3,000, for a typical well failure in SJVBU. Because the production rates are relatively low, the total cost of the failure cannot be greatly reduced by improving the time taken between failure and repair (i.e., deferral); instead, operators must focus on reducing the overall failure rate.

Two parallel changes happened, which further increased the demand for a step change. First, after the merger, there was an increasing corporate desire to standardize field-management processes. The SJVBU, for example, contains fields that previously were operated by both Chevron and Texaco. Most fields were developed with each company's well-management processes, and many relied on individual spreadsheets, databases, and custom-generated applications. The volume of such applications in use throughout the SJVBU made it impossible to leverage the information effectively or to standardize the business processes. Therefore, it was decided to consolidate all of these ad hoc applications into a single software platform, as shown in **Fig. 2.**

A vision was developed to find "missing opportunities" required to reduce Cymric's failure rate further. A solution was envisaged that would tie together the automation technology, provide real-time well surveillance, have the ability to research well histories, and develop well-service plans. This well-services-management capability was projected to lead to a reduction in time required to execute well services as well as a means of driving down the costs of well services through recording and planning the activities. Also, this system should allow trending of historical data to help evaluate failure causes. This would be a true life-of-well information system (LOWIS).

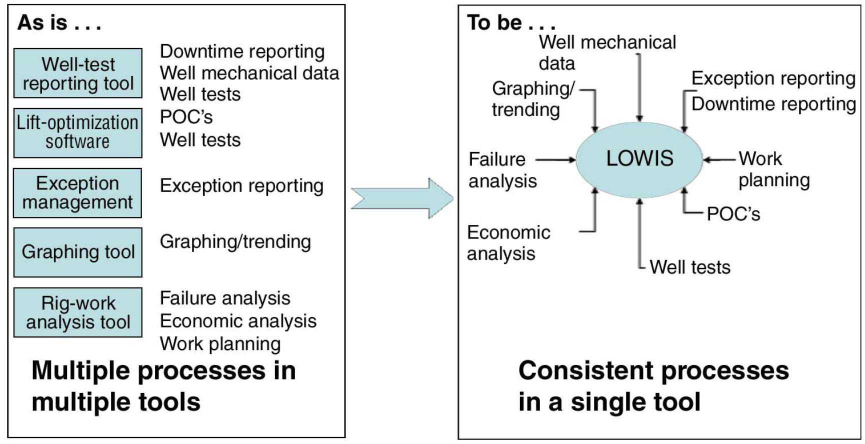

Fig. 2—Process and software-tool consolidation.

Requirements. The key challenge was to build knowledge and understanding necessary to capture the business processes in such a way that they could be standardized across multiple fields (and eventually multiple business units). To understand better how these standards might be established, the team developed a high-level mapping of the various roles and responsibilities within the organization against this workflow.

Then it was necessary to work at a detailed level. There was no shortcut past this detailed work. The task was taken in two major phases. The definition phase lasted for approximately 1 year, during which time standard operating procedures and process-flow diagrams for each key business process were documented in detail.

The second phase developed detailed, comprehensive roles and responsibilities matrices. These matrices described each user's role within appropriate portions of the software.

Results

The key business driver to which the project was aligned was operating-cost reduction. Evidence of success was the reduction in well-failure rate following deployment of the software system. The Cymric-field failure rate began a downward shift early in 2002. This shift also corresponded to several other initiatives including a new pump supplier, changes to hardware, and further POC work. The software system contributed to these gains along with other changes, and it is expected that the software system will continue to deliver further changes as its use is fully consolidated across the SJVBU and is further expanded in the future. The improvement in failure rate over the time of deployment of the software was from 0.15 to 0.1 in the Cymric field. This improvement corresponds to a direct cost saving for repairing failures of approximately $0.5 million/yr in this field. Scaling this performance improvement up to the whole SJVBU represents an annual savings of $6 million.

This system enables consistent ranking of jobs by economic priority across all wells requiring repair. As a result, wells will be repaired in line with their business effect. Before deployment of this system, there was no way to know if, at the field (and less at the business-unit) level, the correct wells were being fixed in the proper order.

New processes have been enabled, many that were not envisaged at the beginning of the project but emerged as additional value through use of the system. One example is that, previously, well managers would be responsible for a group of wells and would write the jobs required to repair these wells in a manual process. There were no resources available to review these jobs before their execution. Now, the jobs are prepared electronically, and it is possible for a coworker or supervisor to review the plans before execution, improving quality and reducing costs.

A new process relates allocating pumping units to wells where they will be used properly. Before use of the online system, operators had no idea about gearbox loading. Now, monitoring loading can reduce failures (the initial purpose), and checking pumping units throughout the field enables moving them to wells for more-efficient use. A data-mining approach is possible because all well data across all the assets are now visible to all users. The field-operating teams are confident that many more such improvements will be made in the future.

In general, use of this electronic system drives better performance through areas such as data validation and quality (i.e., because data are visible and used, bad data are found and fixed), the ability to look at quality and performance across all fields through electronic score carding, the ability to compare actual job costs with estimated costs, and the ability to compare jobs and costs performed by one rig or crew with those performed by another. In a large business unit, incremental savings of a small percentage can have a very large effect, and the tool is now in place to enable the field-operating teams to uncover and execute such savings.

Extension to Other Business Units. A high degree of standardization was desired that would facilitate comparison and sharing of operational data across the North American operations. However, with the variations in field requirements, it was realized that the SJVBU work could not be a direct "copy and paste" application, but that it could be a good starting point. Leveraging off the development in the SJVBU, modifications were made to the work processes and to the software. Standard processes were developed at a level that would allow for these variations in production methods and work types. Features were added and enhanced in the software to meet the needs of these other areas in North America. The concept was that if a process was 80% fit for purpose across assets, then it would be adopted as a standard and the assets could adapt the remaining 20% "gap" to current manual processes. This "80/20" approach was taken, and the majority of the North American operations are included in new processes and programs. Staff from the SJVBU has been seconded into the rollout program, leveraging their experience and skills. **JPT**