The Value of Failure Tracking and Analysis Using WellView

A White Paper

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Introduction

Production downtime is costly in the capital intensive operations of drilling, completing and operating wells. The wellbore is the principal producing asset for an oil and gas company and represents 25% to 50% of the lifting cost. For more than two decades, E&P companies have understood the business value of systematically documenting equipment failures in the field and analyzing their root causes. Patterson and Bucuram investigated avenues for minimizing failures in rod pumping, a principal mechanism for artificial lift, and published some key requirements in 1993. Operators have reported that failures alone account for 30% of the Lease Operating Expense (LOE). Knowing the specific frequencies and root causes enables the identification of trends and patterns in failures over time, which can reduce both costs and production downtime. Analyzing failures can also mean improvements in completion and stimulation design for one well, or for an entire field. Consequently, even marginal reductions in the frequency of failures will have dramatic financial benefit. One operator projected that, “Lifting costs can be literally cut in half or more by applying certain actions to reduce failures. A savings of $4 to $6/bbl is very achievable.”

Effective and easy-to-use software tools for analyzing the incidences and root causes of downtime have only been available in recent years. This paper describes the application of WellView, a commercial software application by Peloton, for tracking and analyzing failures in the field by equipment type, location and cause. WellView is a complete well information management system for planning, drilling, completion, testing, and workovers. WellView offers a consistent, consolidated source of knowledge, enabling comparisons between wells and areas, and identifying common problems. Included in this paper is a case study describing the results of a failure tracking and analysis program, based on WellView, implemented in the Permian Basin by a major E&P company.

Spreadsheets have been commonly used in the industry to record failure incidences; however, important details are often lost due to the lack of granularity and the time required in maintaining and integrating data from multiple spreadsheets. Version control and accuracy of spreadsheet-based reports is also problematic. A single, consolidated database application enables information to be captured on wellbore equipment failures and downtime, and is essential to effectively track the causes. Equally valuable is recording recognition and repair time. The following case study illustrates how some operators have used WellView for failure tracking and analysis to develop standards on equipment and the expected time required for repairs.
Case Study - Demonstrating the Value of Failure Tracking & Analysis

Prior to 2004, a major E&P company operating in the Permian Basin had employed several different tools and methods for recording failures in the field, including spreadsheets and even an in-house mainframe application. This operator found that spreadsheets presented several limitations, including duplicate data entry and inconsistencies in naming failure causes. While addressing some of the inherent challenges with spreadsheet-based reporting, the in-house mainframe application was also limiting in that it did not contain a complete well history and schematic of the wellbore. Multiple methods and tools were used to track progress of repairs to individual wells, including a dry erase board. Investigation of root causes of failures, and subsequent progress on repairs, were hampered by this lack of process consistency and inadequate software tools. While this company had been using WellView for recording and managing information about each well, it was not capitalizing on WellView’s ability to track and analyze failures. Wellbore schematics were maintained in WellView as part of the history of each well. A failure analysis initiative was launched in 2004 that expanded the use of WellView to capture failure causes and to track the repair process on each well. Prior to the implementation of WellView, the operator experienced a 70% failure rate in West Texas. Failure rates have since dropped to 25% as a direct result of capturing and analyzing the root causes of well failures.

Understanding the causes of failures has lengthened the mean time between failures (MTBF). As a result of this initiative, WellView became the consolidated database for failures and the single reference source on progress of repairs.

Figure 1 depicts the negative failure trend from January ‘06 to August ‘09, while Figure 2 shows the decreasing frequency of failures during that same period. Note that although the well count increased, the failure count continued to decrease. As shown in the graphics on page 3, the average number of failures fell from about 30 per month in January 2006 to 15 per month by August 2009.

A failure analysis initiative was launched in 2004 that expanded the use of WellView to capture failure causes and to track the repair process on each well.
Figure 1: Failures – all active wells, 2006 to present

Figure 2: Failure frequency, all active wells, 2006 to present
Using WellView, this producer could easily access the complete history of failures on demand. Because failures and repairs were maintained in the consolidated WellView database, comparisons between areas helped to identify best practices, which effected improvements in well equipment, services and materials. Repeated failure types were identified and steps were taken to address root causes. Failures were tracked not only on components but down to subcomponents, and jobs were analyzed to expose relevant failures. Similar problems were addressed for large groups of wells in a systematic way. Viewing failures in higher levels of aggregation revealed common failure causes and frequency types across the field. Figure 3 illustrates a breakdown of failure frequencies by type, while Figure 4 identifies the root causes of failures.

**Figure 3: Equipment failures for all active wells**
Along with the specific causes of failures on equipment and materials, key steps and timing in the repair process were also recorded with each failure. Documenting the initial observed cause and the final determination of failure in WellView has also afforded the producer insight that has resulted in increased efficiency of repairs. Root causes were captured with the initial observed cause, which revealed the effectiveness of the repair process. Capturing information about the time required to affect repairs has reduced the average time for repairs and the associated cost.

Some of the key pieces of information tracked in the repair process on each well included:

- The time required from failure until it is reported to engineering
- The time from reporting the failure until a repair procedure is issued
- The time from repair request to repair completion
- The cost (AFE) for each repair
- Mean time between failures

Along with the specific causes of failures on equipment and materials, key steps and timing in the repair process were also recorded with each failure.
Having this level of insight into the repair process equipped this operator with the ability to predict how long, on average, a well would be down and identify variances in the repair process against norms, including the cost of repairs. The body of data existing on failures and associated repairs provided a valuable and effective means of analyzing the tradeoffs between resources. An example would be projecting how much the average days-to-repair would increase if the rig count is reduced, or understanding the tradeoff in operating costs between rigs and production downtime.

**Enabling Work Processes & Knowledge Sharing**

The ability to examine the failures and repairs for all the different components of downhole systems enables proactive steps to be taken to remedy components and sub-components with repeated failures. Perhaps as important, it also becomes practical to forecast when wells are likely to fail. Since WellView contains the complete wellbore schematic, well history and instances of failures, the WellView database is a growing source of knowledge for almost every job function, from the field to the back office. Knowledge gained from well failures and repairs can be shared among multiple disciplines to build best practices, while redundant data entry is dramatically reduced or eliminated altogether. These capabilities fundamentally affect how work is performed as different functions collaborate around a consolidated history of each well.

Automation systems, such as Supervisory Control and Data Acquisition (SCADA), can also be served with the same information available in WellView. Where a SCADA system has rod pump control, for instance, it is critical that the equipment information in the SCADA system be fully consistent with what is downhole. Without a consolidated database of wellbore equipment, a well’s specifications must be re-entered in the SCADA system manually or by spreadsheet every time a well string is pulled. Because all pertinent equipment information resides in WellView, updates to the SCADA systems can be done daily from WellView automatically. In the case study previously discussed, each night the SCADA system automatically obtains updates from WellView by well on rod, pump, pumping unit, pumping unit stroke length, weight and crank position.

Using WellView to maintain the history, wellbore schematics, and instances of failures provides a single repository of information that is shared across the business. Information can be found quickly in a consistent format. In addition to reducing the root causes of failures, having a single repository of information on each well facilitates buying and selling properties since both parties will have greater confidence in a consolidated electronic history of the well, as opposed to the data being on paper or various spreadsheets.

An example would be projecting the increase in the average days-to-repair if the rig count is reduced, or understanding the tradeoff in operating costs between rigs and production downtime.
Implementing a Failure Tracking/Analysis System & Processes

WellView is an integral tool in many well-work and related work processes. The results described thus far show how an effective failure tracking and analysis capability will enable nearly every job function in an E&P business. When planning the implementation of a failure analysis and tracking system, the best practice is to begin with the desired end-state. The following key tasks are recommended in shaping an effective implementation plan:

1. Plan for the data to be maintained in a single repository to eliminate multiple conflicting versions.
2. Identify key business drivers and associated rules that may impact how business is conducted.
3. Compile the list of standard reports and key fields needed on each.
4. Develop high-level implementation and data validation plans to ensure data quality.
5. Design the system to make the data easily accessible, available where and when it is needed.
6. Provide effective and efficient data processes for stakeholders.
7. Establish data standards to ensure a consistent naming convention.
8. Identify roles for data entry with a view towards economizing on the types of data required.

Once operational, the failure tracking and analysis process should set specific targets on the MTBF for major well systems, such as pumps, rods and tubing. Charting failures and root causes monthly will quickly identify areas needing attention. For example, onshore facilities would, more than likely, experience the most pump failures due to wear, followed by rod and then tubing failures, which should be the least frequent (number) of failures.

Using WellView for failure tracking and analysis, the cost of failures by cause can be captured and analyzed (See Figure 5). Since WellView also contains a complete history of the equipment with the wellbore schematic, failure analysis is amplified when operating problems are analyzed, i.e., any time production or injection drops (See Figures 6 and 7).

In setting up data, WellView offers complete flexibility in organizing failure-related information, including:

- Details about the failure, such as date, type, cause, cost, and action taken
- Elapsed time from failure to action to resolution
- A link to the failed item, such as a casing component
- A link to the repair job

Once data is entered, analysis can be done through the use of single and multi-well reports or add-ins, such as spreadsheets or other statistical reporting tools. Output reports should focus on problem wells meeting certain criteria, such as repetitive failures in the last twelve months.
The frequency analysis identifying the problem wells can be charted in multiple ways, including:

- By failure cause or type
- By well completion time
- By areas and dates

Figure 6 is a report of types of equipment that have failed with the corresponding reason.

Figure 5: Charting the cost of failures by cause through WellView
### Equipment Failure Summary

**Well Name:** Sample 37 - Failures

<table>
<thead>
<tr>
<th>Event Date</th>
<th>Failed Unit</th>
<th>Fail Type</th>
<th>Cause</th>
<th>Duration (Hrs)</th>
<th>Days Down</th>
<th>Casing Pump Duration (Hrs)</th>
<th>5-Casing Dia (Ft)</th>
<th>9-Casing Pump Dia (Ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997-06-17</td>
<td>Rod Box Failure</td>
<td>Failed</td>
<td>Fatigue</td>
<td>Completed</td>
<td>63.96</td>
<td>Rod Insert Pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997-06-06</td>
<td>Rod Pin Failure</td>
<td>Failed</td>
<td>Fatigue</td>
<td>Completed</td>
<td>63.96</td>
<td>Rod Insert Pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998-02-18</td>
<td>Tubing Body Failure</td>
<td>Failed</td>
<td>Human Error</td>
<td>Completed</td>
<td>73.5</td>
<td>Tubing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999-03-12</td>
<td>Rod Box Failure</td>
<td>Failed</td>
<td>Fatigue</td>
<td>Completed</td>
<td>63.56</td>
<td>Rod Insert Pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999-07-21</td>
<td>Tubing Body Failure</td>
<td>Wear</td>
<td>Abrasion/Wear</td>
<td>Completed</td>
<td>73.5</td>
<td>Tubing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999-11-05</td>
<td>Rod Box Failure</td>
<td>Failed</td>
<td>Fatigue</td>
<td>Completed</td>
<td>63.56</td>
<td>Rod Insert Pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999-03-05</td>
<td>Tubing Body Failure</td>
<td>Other</td>
<td>Other</td>
<td>Completed</td>
<td>73.5</td>
<td>Tubing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999-03-10</td>
<td>Rod Pin Failure</td>
<td>Failed</td>
<td>Fatigue</td>
<td>Completed</td>
<td>63.56</td>
<td>Rod Insert Pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999-10-00</td>
<td>Rod Pin Failure</td>
<td>Other</td>
<td>Other</td>
<td>Completed</td>
<td>63.5</td>
<td>Rod Insert Pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000-03-12</td>
<td>Polished Rod Failure</td>
<td>Failed</td>
<td>Fatigue</td>
<td>Completed</td>
<td>36.10</td>
<td>Polished Rod</td>
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<tr>
<td>2000-12-06</td>
<td>Tubing Body Failure</td>
<td>Wear</td>
<td>Abrasion/Wear</td>
<td>Completed</td>
<td>73.9</td>
<td>Tubing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000-09-08</td>
<td>Tubing Body Failure</td>
<td>Wear</td>
<td>Abrasion/Wear</td>
<td>Completed</td>
<td>73.9</td>
<td>Tubing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001-10-12</td>
<td>Rod Pin Failure</td>
<td>Failed</td>
<td>Fatigue</td>
<td>Completed</td>
<td>63.56</td>
<td>Rod Insert Pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003-06-25</td>
<td>Rod Pump Failure</td>
<td>Wear</td>
<td>Abrasion/Wear</td>
<td>Completed</td>
<td>63.56</td>
<td>Rod Insert Pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003-08-17</td>
<td>Rod Pump Failure</td>
<td>Wear</td>
<td>Abrasion/Wear</td>
<td>Completed</td>
<td>63.56</td>
<td>Rod Insert Pump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003-10-20</td>
<td>Rod Pin Failure</td>
<td>Failed</td>
<td>Abrasion/Wear</td>
<td>Completed</td>
<td>60.1</td>
<td>Bucker Rod</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003-12-12</td>
<td>Casing Failure</td>
<td>Failed</td>
<td>Corrosion/Erosion</td>
<td>Completed</td>
<td>53.67</td>
<td>Casing Joints, 128.7mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004-06-18</td>
<td>ESP Motor Failure</td>
<td>Other</td>
<td>Heat</td>
<td>Completed</td>
<td>98.4</td>
<td>ESP - Motor w/2 Lead Cable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006-05-11</td>
<td>ESP Pump Failure</td>
<td>Wear</td>
<td>Wear</td>
<td>Completed</td>
<td>98.4</td>
<td>ESP - Pump</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Value of Failure Tracking and Analysis Using WellView

Integrating Failure Analysis with Production Economics

Clearly, addressing the sources of failures reduces cost while sustaining production. Consequently, even marginal reductions in the frequency of failures will have a dramatic financial benefit. Extending the use of failure tracking and analysis, the incidence of failures can be correlated to the economic impact on production. In addition to the entire well history, failures, and their frequency, activity-based costs are also captured in WellView. An easily accountable cost in WellView is lost or deferred production during the period the well has been down. As shown in the report of Figure 7, WellView can report production by month, along with the number of days the well has been down due to repairs.

Figure 7: Integrating production and well downtime through WellView
ProdView™ Obtaining a Field-wide View of Production

Individual well failures can impact production on the entire field. Understanding the inter-related effects of individual well failures on production across the field can be substantially aided by visualizing the physical flow network in the field/area. Peloton has developed a new software tool called ProdView that aggregates and graphically presents information on the network of flows in the field/area. Integrating with WellView and based on the Peloton AppFrame technology, ProdView has been designed to improve the way that the oil and gas industry tracks, calculates, visualizes, and reports production. Enabling production allocation and field data capture, the principal functions of ProdView include the following:

- Maintain an interactive, data-driven visual flow network diagram
- Allocate volumes by product, component, and disposition
- Track equipment operations, maintenance, and downtime
- Visualize data audits
- Facilitate partner reporting
- Perform regulatory reporting

As illustrated in Figure 8, the field flow network diagram is drawn automatically by ProdView from the data entered and illustrates where problems are occurring, such as volume imbalances. The system is interactive and selecting a node displays intermediate volume flow rates.

Figure 8: Field flow network diagram in ProdView
Conclusion

When applied to failure tracking and analysis, WellView offers a consolidated data repository of the history, wellbore schematic and details of failures on each well. Used in this way, WellView provides a paperless well file system for analyzing the details associated with failures. Tracking well failures has two key economic outcomes:

1. Costs are saved in services, replacement equipment and supplies.
2. Downtime is avoided and production sustained.

Leading producers are implementing WellView as a systematic means of tracking and analyzing the occurrences, root causes and the cost of failures. Capturing and analyzing failures in WellView enables trends and patterns to be identified that affect well failures. Abnormalities, such as rod and tubing failures at certain depths and direction, can be identified and the necessary changes to equipment and processes made to increase the Mean Time between Failures (MTBF).