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Introduction

Drilling operations, especially those involving unconventional, deepwater and ultra-deepwater plays, often involve a plethora of challenges. The rise in exploratory frontiers, the increase in rig day rates and costs, and the introduction of new regulatory policies heighten the demand for innovative technologies. To manage costs and mitigate risks, oil and gas operators need technologies that can enhance drilling efficiency and optimize drilling operations across all phases.

The established drilling engineering improvement process involves four key stages that help avoid problems, improve efficiency and capture lessons learned and best practices. The right skill sets and technologies must be used to create business value within these stages:

- **Planning.** During this stage, establish overall well construction objectives, optimization key performance indicators (KPIs) and pre-well planning.
- **Execution.** In the drilling phase, implement the optimization plan.
- **Analysis.** During this stage, review in context and conduct a post-well analysis of actual performance against the plan.
- **Knowledge management (KM).** In this phase, capture and aggregate insights.

While the four key stages of the drilling engineering improvement process are important, new approaches to create efficiency within each component are necessary. This is especially relevant during well execution, when safety hazards, operational costs and financial risks are at their greatest. In recent years, estimates showed that nonproductive time (NPT) ran from 15 percent to 40 percent of overall well construction time.\(^1\) This represents a potential $14 billion to $37 billion in increased operating expenditures.

To address these adverse costs, drilling contractors are seeking decision-support tools that provide more than passive surveillance. What they need is real-time analytics to actively inform the decision-making process at the well site. Shifting to these new capabilities requires evolving from a reliance on deterministic analytical reports to prescriptive, real-time decision support.

Drilling Efficiency Requires Robust Data

Many factors influence drilling efficiency. One of the most important is having access to robust data that can help operators dramatically improve efficiency, reduce costs and ultimately enhance the overall value of the well construction project. Being able to aggregate relevant data of varying frequency within a common repository and format is essential for drilling engineers and asset team members, no matter where they are. This enables them to make the right decisions at the right time.

Traditional approaches to managing data often involve tackling disparate data sources. As a result, you may spend a significant amount of time searching for, aggregating and doing quality control of your data. The result can be delays in real-time advice to your asset teams.

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\(^1\) Society of Petroleum Engineers (SPE128722). *Increased Drilling Efficiency Through Collaboration and Analysis of Real-Time Historical Drilling Data.* [www.spe.org](http://www.spe.org)
In comparison, best-in-class drilling operations centers build analytical data marts so operators can derive key parameters to improve overall drilling performance. Operators note significant gains in drilling efficiency when their analytics consider disparate data from a variety of sources and formats.

Data management solutions from SAS support this approach by using real-time monitoring to profile, validate, aggregate and standardize data based on customizable business rules. SAS solutions for the oil and gas industry provide advanced data quality applications that can impute missing data, cleanse erroneous data, and correct spelling mistakes in both structured and unstructured reports. As a result, all of your relevant data is available in a single master data management environment you can trust.

This robust solution helps improve decision making across your entire organization. For example, during the planning stages of a well, engineers can review and analyze offset well information that's organized in a common data environment to identify risks and hazards associated with the planned well. When risks are identified, such as wellbore instability, the geological team can rapidly access and analyze historical data and trends that help prescribe alternative drilling scenarios for the final drilling plan.

Figure 2: With a common repository to aggregate drilling data from various sources, you can use SAS® Data Management solutions to improve data governance.
Improving Drilling Efficiency

While drilling, surface and downhole data provide vital information about the condition of the wellbore, the formation pressures, BHA performance and geology. This range of measurements amplifies the complexity and sequence of events that can adversely affect the safety and efficiency of your operation. By implementing advanced analytics that surface and quantify relationships between these disparate sources, you can predict operational inefficiencies and even prescribe actions that optimize drilling rig performance in real time.

By using a master data management environment with drilling information from offset wells, an asset team can gain a full understanding of the hazards involved from spud to total depth. This wealth of information can surface KPIs that alert you to the best and worst performing components of your drilling program. These KPIs might show, for example, that low rates of penetration, high temperatures, stuck pipe, and bit and tool failures related to vibrations are just some of the issues that contribute to nonproductive time.

Consider the goal of reducing cost-per-foot-drilled. In this scenario, a statistical data mining solution could identify the key data elements needed to develop a neural model of performance characteristics. This model can be connected to the asset in real time to give your drillers crucial diagnostic advice about how to reduce costs.

To facilitate user interaction and decision making during the drilling operation, you can implement a proven workflow such as SEMMA. This analytical workflow generates exploratory analysis and helps reveal insights about your data. The workflow involves five phases commonly referred to as the SEMMA process: sample, explore, modify, model and assess. The first three – sample, explore and modify – aggregate data in context to support advanced analytics. The model phase identifies valid early indicators for creating a predictive model. The final phase, assess, supports automated monitoring of prediction accuracy.

Conventionally, we react to a lost-time event as it occurs – and then we apply deterministic reporting to understand how and why it happened. The SAS approach uses historical data to identify leading indicators of situations that – according to forecasts – could develop into nonproductive time. In cases where this type of predictive workflow has been deployed, the result has been hours or even days of advance notification, resulting in significant reductions in nonproductive time.

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2 The SEMMA analytical workflow is described in the paper: Maximize Placement of Wells and Production in Unconventional Reservoirs: Part 1; SPE# 149784. Keith R. Holdaway, SPE, SAS.
Lessons Learned: Applying Predictive Analytics

Despite the fact that significant amounts of drilling operational data is generated daily, much of this data is largely underused. Technical decision makers are seeking alternative tools that enable greater interaction with their data, within and across domains. These tools need to be scalable and able to incorporate advanced analytics, yet be easy to use.

As operators focus more on knowledge management during drilling operations planning and execution stages, the challenge becomes to effectively access the various sources of relevant well information. Apart from knowledge and experience stored in the human mind and in paper-based well files, today's well information is also stored electronically in vendor-supplied databases, spreadsheets, documents, emails, social media and, now, the cloud. It's often a monumental task to identify, centralize, standardize and categorize this information. By using capabilities such as text analytics, asset teams can more easily uncover patterns and anomalies across unstructured well data.

SAS provides a master data management solution that enables the engineer to rapidly search both the structured and unstructured data, as well as text analytics that converts unstructured data into a structured format that improves engineering diligence during the well planning process.

Not All Analytic Solutions Are the Same

Measurable, improved drilling efficiency starts with better-quality data, the application of predictive models and increased understanding through post-well analysis using robust business intelligence tools. Many solutions deliver capabilities in one or more of these areas. But the difference in these solutions lies in whether they can provide advanced analytics and visualization.

Across every step of the upstream well life cycle, important business decisions are made. It is imperative for petrotechnical workers, whether they are geoscientists or engineers, to have access to the right data and to have confidence and trust in that data. Through a scalable framework, SAS offers a complete, rich set of solutions to improve overall drilling efficiency. SAS Data Management solutions give operators a proven approach to establishing data governance as a foundational prerequisite. These solutions support proven methodologies where advanced analytics using predictive models have reduced lost time. Establishing a culture of analytic excellence can also add value as an integral component of real-time monitoring centers and workflows.

SAS Visual Analytics goes well beyond basic visualization. With this solution, drilling engineers, advisers and asset team members can employ intuitive analytic capabilities that improve their understanding of wells and operations, without the need to be statisticians.

For More Information

To learn more about drilling optimization from SAS.

For more information about oilfield analytics from SAS.