

Trends in Monitoring: How to Use Real-Time Data Effectively

David Pritchard, Successful Energy Practices International, Jesse Roye, Digital Oilfield Solutions, and J.C. Cunha, Ecopetrol America

Real-time data is not about well control, it is about well control avoidance. Recent catastrophic blowouts have underscored the value of real-time data and, more importantly, they have also underscored the value of having the right kind of experience to understand well data interpretation in real time.

What is the well telling us? How do we use real-time data to ensure a stable wellbore? Real-time monitoring integrated with rigorous total well control analysis is required to embrace and achieve continuous improvement and ensure the safest possible environment. Next generation monitoring requires a step change that includes hazards avoidance as a precursor to drilling optimization.

Real-time data can be used effectively to avoid, minimize, and better manage drilling and completion operations. They can also provide the foundational support to improve training in the industry as well as develop hands-on simulators for hazards avoidance.

The fundamental definition of process safety is that of ensuring containment. In the case of drilling and completion operations, that means well control. Process safety management (PSM), a regulation promulgated by the US Occupational Safety and Health Administration, is an analytical tool focused on preventing release of any substance defined as “highly hazardous.” This concept can be extended to oil and gas well operations within the context of ensuring that the well is constantly under control. The industry has pursued personal safety,¹ which resulted in significant improvement in preventing accidents commonly referred to as “slips, trips, and falls.” Though this is a notable accomplishment, it had no influence on well control

episodes, and blowouts remained a frequent occurrence.² As well complexity increases, well control events increase disproportionately.³ Even the term well control, which should be related to the performance of oil well operations in a controlled manner, became more associated with the operations necessary to fix a situation once control was already lost.

Often, the industry depends on blowout preventers as execution tools rather than the fail-safe tools they were designed as. If a driver constantly slams on the brakes of a car at high speed, eventually the brakes fail, or at the least, fail to operate in a timely manner or accurately.

Real-time data offers the ability to ensure process safety. **Fig. 1** shows the relationship between real-time data and its impact on operational outcomes.

Currently, real-time data is primarily used to improve efficiency and drive down costs. While this is a nice outcome, it is a secondary issue when compared with hazard avoidance and well containment that can be achieved by the correct use of that same data. In order to ensure reliability and safety, a paradigm shift is required in terms of real-time data monitoring and use. This shift to better use the data involves a realization of the following key elements:

- ▶ All well control events are predictable and avoidable, both in rotating and flat time (logging, casing cementing) operations.

- ▶ Independently of the company, one blowout can wipe out collective improvements in efficiency. This applies not only for a given well or company, but for the industry as a whole.

- ▶ Real-time data is now sophisticated to the extent that it has become a reliable predictor of well instability events

such as stuck pipe, wellbore breathing (commonly referred to as “ballooning”), mud column fluid losses, and well control events.

- ▶ The more complex the geological environment, the more uncertain the pore pressure and fracture gradient realities. Geomechanics information and prediction must be constantly updated in the face of the data being generated. Drilling trends can be excellent predictors of changing wellbore stability models while drilling. Effective monitoring helps ensure the successful navigation of the drilling margin.

- ▶ Monitoring must evolve to be proactive. Multiple specialists should be involved in the real-time recognition of prescient hazards.

- ▶ Real-time data not only can lead to process safety, but it can also improve decision quality in issues such as management of change and risk management.

- ▶ Our industry wellsite leaders are challenged in their ability to effectively monitor key drilling parameters. Their available time to monitor drilling conditions has been eroded by the necessary administrative requirements of well construction operations. They need help.

There are justifiable considerations for automation using real-time data. This is valuable and part of the natural evolution for this industry. Removing as many people from harm’s way is important. Successful realization of automation, to any extent, will first require effective subsurface recognition and avoidance of geohazards as well as the use of real-time data to successfully navigate the drilling margin.

The Safety Training Observation Program (STOP) became a proactive tool in our industry regarding personal safe-

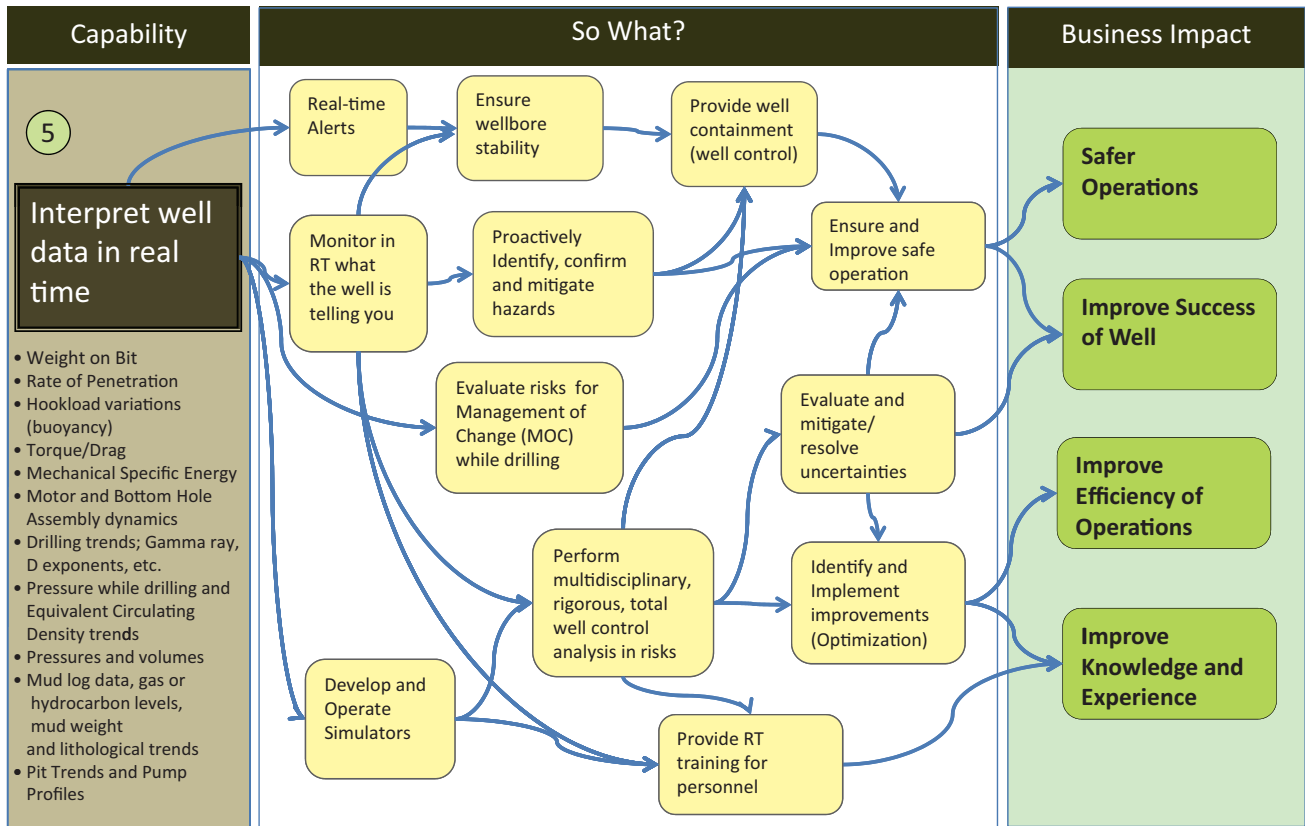


Fig. 1—Real-time data and operational impact. (Courtesy of Successful Drilling Practices and Digital Oilfield Solutions.)

ty.⁴ This same principle must be applied to operations in general. Real-time monitoring should evolve to this level, not necessarily in terms of declaring STOP, but in creating the ability to notify that conditions are, or may become abnormal. As mentioned before, all well-control events are predictable.

There are no worldwide industry standards regarding acquisition or monitoring of real-time data. The fact is that our industry could substantially benefit from standardization present in other industries. This would improve its overall safety record.

An example is the airline industry, where there is no room for a pilot to decide on matters related to how, when, and where to land an aircraft. Industry standards regarding monitoring of real-time data would help ensure that regulations are effective. The more proactive the industry is in this area by establishing a set of standards for data and monitoring, the less the regulatory involvement.

The industry is reluctant to develop collaborative standards, primarily for fear of losing a competitive edge; however, everything is secondary to process safety. Ensuring process safety is fundamental to the industry's viability.

Wellbore Stability and Process Safety

Ensuring a stable wellbore is the precursor of process safety. To its credit, the industry has made enormous improvements and technology advancements in areas such as rig floor management, equipment, and automation. Real-time data reflects every drilling parameter related to these technologies. The following are examples of some key parameters:

- ▶ Weight on bit
- ▶ Rate of penetration
- ▶ Hookload variations (buoyancy)
- ▶ Torque/drag
- ▶ Mechanical specific energy
- ▶ Motor and bottomhole assembly dynamics

▶ Drilling trends; gamma ray, D-exponents, etc.

▶ Pressure while drilling and equivalent circulating density trends

▶ Pressures and volumes

▶ Mud log data, gas or hydrocarbon levels, mud weight, and lithological trends

The typical real-time system has a multitude of tracks; all to some degree reflect drilling trends and/or flat time conditions. Our technology and efficiency gains have been so good that some questions must be asked and answered: Are we outdrilling our ability to properly recognize and address changing wellbore stability conditions? Are we allowing the time to interpret the data? This is not to suggest that we should slow down, or lose efficiency, but that we use the data to facilitate reliable and safe operations. "Stop, look, and listen" comes to mind.

The problem with the plethora of data available in terms of monitoring

TABLE 1—DAYS OF WELLBORE INSTABILITY AS A PERCENTAGE OF TOTAL TIME (EXCLUSIVE OF WEATHER)

Events Related to Wellbore Instability	General Populations: 263 Wellbores < 600 ft of Water	65 Sub-Salt Wells: WD > 3,000 ft	99 Non-Sub-Salt Wells: WD > 3,000 ft
Stuck Pipe (%)	2.20	2.90	0.70
Wellbore Stability (%)	0.70	2.90	0.90
Loss Circulation (%)	2.30	2.40	2.00
Kick (%)	1.20	1.90	0.80
Total (%)	6.40	10.10	4.40
Total Wellbore Instability (Days)	2.240	9.797	2.376
Total NPT Days	4	29	9
Instability % of NPT Days	56.00	33.78	26.40
Average Days to Drill Kick Days	35	97	54
	0.420	1.843	0.432

is that only limited viewing screens are available, and oftentimes there are several influencing variables in terms of understanding and interpreting wellbore stability issues. Furthermore, the more complex the drilling operation, the more multidisciplinary input is required.

All of this data is critical and no single piece of data will yield a good decision. The totality of the data must be considered, and if the drilling conditions are changing such as increasing rate of penetration (ROP), this could be a result of several factors, and justifiably could lead to a “flow check.” What if the operation is “time” drilling with controlled ROP and the well is becoming underbalanced? What if the faster ROP is lithology-related and yet the mud weight is incorrectly increased? What if the well is being displaced with simultaneous operations confusing pit volumes? How do we use real-time data and monitoring to ensure process safety concerning test procedures? The point is that total data interpretation is critical.

Drilling Management Is Risk Management

Risk management is beginning to be recognized as fundamental to drilling management.⁵ No matter how robust the planning processes and procedures, wellbore stability models are, at best, predictions that are constantly changing because of the uncertainties inherent in the drilling process. Too often, it

is presumed that these changes do not affect the risk of achieving the overall well objectives safely and reliably. Real-time data can and should be instrumental in recognizing and addressing change, commonly referred to as management of change, and the resultant risks. Risks can never be eliminated, but they can be managed and mitigated. For example, real-time data has the ability to update stability models with actual drilling conditions and change projected casing points. Not only does it improve the efficiency of the operation, but it also provides an advanced planning platform and decision fault analysis for issues such as contingency planning.

Recognition and addressing of risks is an evergreen, real-time process. Real-time centers should be proactive in management of change and risk analysis. Lessons are only as good as the validating information that supports them. Trend changes should be important for developing any new or revised well procedures or programs going forward. For example, applying correct mud weights, rheology, and general drilling dynamics in forward operations would make it less arbitrary and safer. Contrarily, misapplication of the same lessons can lead to inducing hazardous conditions:

Excess Mud Weight → Excess Equivalent Circulating Density → Ballooning → Losses → Mud Barrier Compromised
 → Potential Kick Follows → Well Control Operation

In this sense, drilling management must have a component of management of existing risk. And the tool for this process is the correct use of real-time data, which includes, besides constant monitoring, accurate interpretation and timely preventive actions.

One may correlate a well-managed and controlled operation with procedures that will slow down the drilling and completion processes. This is not necessarily true. Firstly, we need to notice that in the Gulf of Mexico (GOM), for wells drilled in deep and ultradeepwater, wellbore instability as a percentage of nonproductive time ranges from 26% to 56% as depicted in Table 1.⁶

Secondly, even with so much lost time, we are still having situations of loss of circulation, fluid gains, wellbore instability, and many others that can potentially result in loss or total loss of well control. So the outcome of careful management will be more efficient and less costly, with safer and faster operations.

However, to obtain the desired outcome, a paradigm shift must be made by the industry. With the risks and decision making involved, well drilling operations must be the responsibility of a multidisciplinary team.

Information Technology and Real-Time Data

In order to successfully apply and monitor real-time data, information technology (IT) systems must be in place for users to access the data from around the globe. Furthermore, there should be consistent monitoring criteria, beginning with the wellsite and then the office and other offsite designations. Alerts must be consistent and the IT system and software should recognize changing drilling trends, no matter which tracks are onscreen at the time, and bring forward abnormalities not in the line-of-sight of a particular screen. Establishing bandwidths for alerts is critical to ensure that alarms are synchronized, and all viewers are simultaneously and correctly alerted in a timely manner. Unilateral disablement of an alarm is unacceptable, as is the establishment of alerts bandwidths

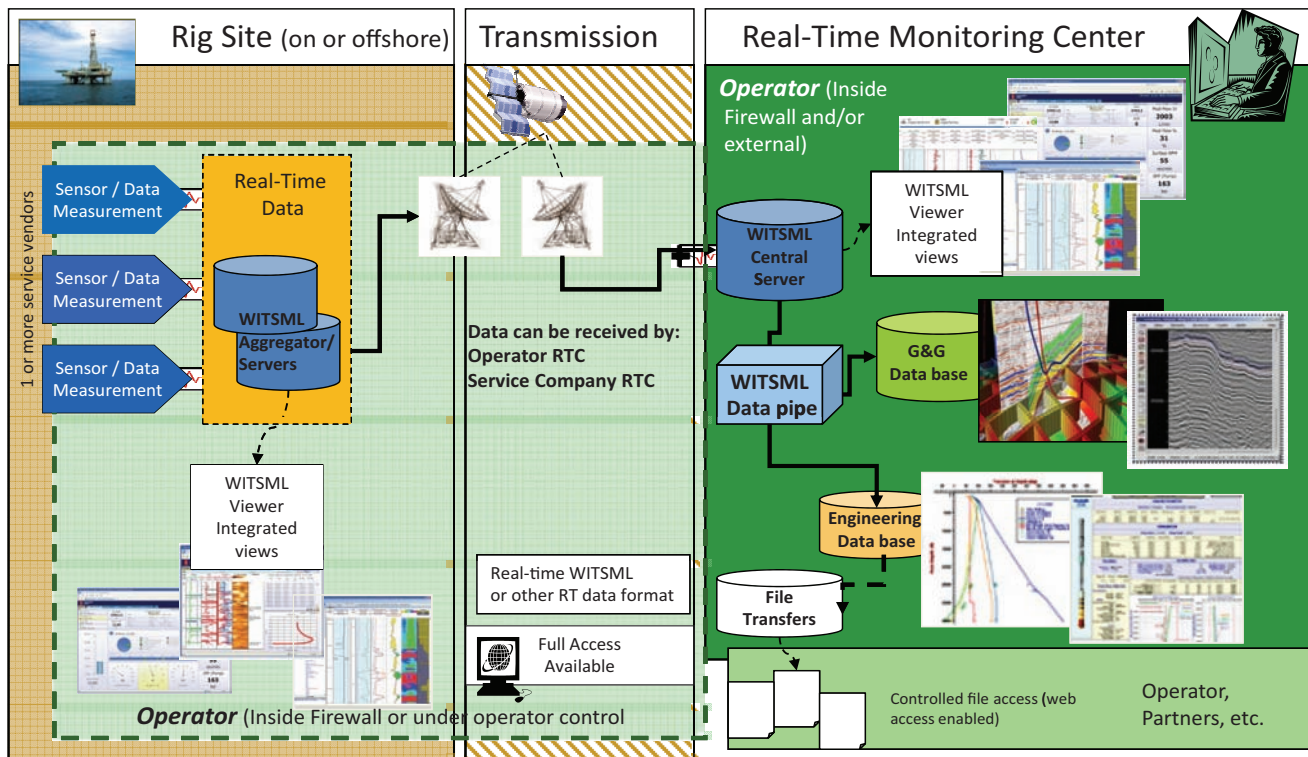


Fig. 2—Real-time data flow for monitoring real-time operations. (Courtesy of Successful Drilling Practices and Digital Oilfield Solutions.)

that are so broad as to render the existence of alarms meaningless. Default and exceptions to defaults must be established by consensus involving the operator and critical contractors. Common situational awareness should be the determiner in establishing effective bandwidths of monitoring. This also requires a multidisciplinary alignment as a geoscientist might interpret real-time data differently from a driller, whose metrics are based on different criteria. Drilling performance and reliability are a multidisciplinary responsibility. Bandwidths for alerts will also be dependent on the category of the well being drilled and the maturation of the subsurface and drilling knowledge of the area.

The Evolution of the Control Room: Real-Time Operating Centers

In its current state, the dynamics of “control room” input may be viewed as a positive factor or as interference. Lack of common direction may lead to certain individuals seeking input to improve

operational efficiency, while others may ignore the input. Also, in some cases, geoscientists may not be willing to share subsurface data because of “tight-hole” or privileged information conditions. This behavior, especially regarding data from tools such as logging while drilling and mud log, can be detrimental to the management of the operation, since the data is crucial to process safety. In today’s increasingly complex wells, this model must change. Again, process safety is paramount and trumps a perceived competitive edge. Although confidentiality is important, it is up to each company to ensure that confidentiality is maintained only while not compromising process safety.

Many companies still subscribe to the belief and practice of either not using or minimizing the use of real-time data systems to coordinate drilling and completion operations—both offshore and onshore. Such practices directly compromise process safety management and leave these companies increasingly vulnerable. Currently, products from major

E&P service providers give reliable, multiyear proven capability for both onshore and offshore real-time data collection and transmission. The addition of a real-time operations center to deliver interpretation and analysis of the real-time data stream and relay proactive recommendations provide the following:

- ▶ Leverage of experienced resources across multiple operations
- ▶ Access to deep subject matter experts regardless of location
- ▶ Capability to perform trend and model analysis not available at the rig
- ▶ Proactive ability to identify issues before they become problems
- ▶ Effective integrated operations
- ▶ Enhanced process safety
- ▶ More cost-effective operations

The design for such an integrated system is understood and documented. It should come as no surprise that many companies across the world have successfully adopted this model. Many operating companies, including supermajors, national oil companies, and independents, have been using this model for

years and continue to refine and expand their capabilities. The basis for these real-time systems can be represented by the model in Fig. 2.

The linkage of real-time data and real-time centers to monitor and support drilling and completion operations provides tangible economic, engineering, operational, and risk mitigation benefits. These benefits will continue to increase in importance as the pool of experienced drilling and completion, and E&P workers decreases and as operations continue to expand into more complex and costly operating environments onshore and offshore.

Competency and training are critical in the industry. While there are many excellent training companies and centers, including for well control, there is little training or practice for hazard avoidance. Again, referencing the airline industry, pilots train periodically in aircraft simulators specifically developed for practicing to avoid hazards. There are many good well control simulators, but are there any well control avoidance simulators? Given that well control is predictable by properly interpreting drilling trends and

monitoring flat time operations, well control avoidance simulators can be natural extensions of control rooms and excellent training venues not only for drilling, but also for multidisciplinary personnel.

Conclusions

The industry as a whole must cast off vestiges of outmoded thinking that drilling is all about cost per foot and embrace the fact that process safety is paramount.

Senior management must warrant that there are processes in place and adhered to that consider process safety management as the precursor to reliability. For example, in deepwater operations in the GOM, wellbore instability represents from 26% to 56% of total nonproductive time, and real-time data provides an opportunity to predict and avoid these instability events. Removing hazards and reducing their daunting number will significantly lower organizational and industry drilling costs.

One breach of process safety eliminates all efficiencies gained from technologies both on a company and industry basis. Therefore, the industry must undertake a step change in how it per-

ceives real-time data, and how the data is interpreted and used.

The development of standards for real-time data and monitoring centers will be a big, positive step change for the oil and gas industry. Change is difficult but necessary, and achieving it will greatly improve the holistic safety consciousness, reliability, and reputation of our industry.

References

1. Brett, J. Ford. 2010. Forum on Offshore Drilling, Panel Session, Pensacola, Florida. 11 August 2010.
2. SINTEF Offshore Blowout Database. 2009. Scandpower Blowout and Well Release Frequencies.
3. Pritchard, David M. and Lacy, Kevin D. 2011. Deepwater Well Complexity—The New Domain, Prepared for the President's Commission for the Deepwater Horizon Study Group (1 March 2011).
4. STOP is a registered trademark of DuPont.
5. Cunha, J.C. 2010. Drilling Management, *JPT*, September 2010, Vol. 62, No. 9, 72.
6. The James K. Dodson Company. <https://www.dodsondatasystems.com/Default.aspx> **JPT**

David Pritchard has more than 43 years of oil and gas production, exploration, operations, and drilling experience. He has consulted for more than 20 major and national oil companies, independents, chemical companies, and major service providers across the globe. A registered professional engineer, his expertise includes drilling hazards management and training, well planning, execution, and analysis with a focus on risk, particularly related to narrow margin drilling and high-pressure/high-temperature operations. Pritchard has authored or coauthored 16 industry publications, and was selected as co-chair of the Technical Committee of the Deepwater Horizon Study Group examining the Macondo blowout. He received a BS in petroleum engineering from the University of Tulsa.

Jesse Roye is a principal at Digital Oilfield Solutions, a consulting firm specializing in real-time drilling and completions operations centers, and has more than 35 years' experience in the E&P industry. Previously, he has worked for supermajors and oil service providers. His career spans engineering and management responsibilities in the US onshore, deepwater Gulf of Mexico, Canada, Middle East, and Asia Pacific. He has authored various technical articles and papers and coauthored a number of books and engineering software programs on production and drilling engineering. He earned a mechanical engineering degree from the University of Houston and an MS degree in computing, systems, and management from Houston Baptist University.

J.C. Cunha, SPE, is drilling manager for Ecopetrol America in Houston. Previously, he was the well operations manager for Petrobras America. A former associate professor of petroleum engineering at the University of Alberta, Cunha has served on several SPE committees and was an 2010–11 SPE Distinguished Lecturer. Cunha's career spans engineering and management positions on several projects in South America, the Gulf of Mexico, Africa, and the Caribbean. He has authored various technical articles including 30 SPE papers and has coauthored two recently published SPE books, *Advanced Drilling and Well Technology*, and *Fundamentals of Drilling Engineering*. He earned a civil engineering degree from Juiz de Fora Federal University, Brazil, and MS and PhD degrees in petroleum engineering from Ouro Preto University, Brazil, and the University of Tulsa, respectively.

Pump downtime out of your operations.

Dragon delivers.



Frac & Well
Service Pumps

Sand Delivery &
Mobile Blending

Centrifugal, Vacuum
& Mud Pumps

Pump Accessories

Parts & Service

Dragon pumps work and work and work. So your operation can too. Our state-of-the-art U.S. manufacturing facility turns out a wide range of pumps, from frac and centrifugal pumps, to vacuum and mud pumps. It all begins with our highly experienced team of pump experts. They employ advanced engineering and keep close control over manufacturing to ensure Dragon pumps are designed and built to be high-quality, long-term performers. Every product off our line is fully tested. Then, when a pump is put to work in your operation, we continue to stand behind it – and you. You get extra support, including equipment recommendations, warranty assistance, 24/7 access to parts, and service teams who can help you onsite or in our four service centers. Whatever you need to fight downtime and pump up your business, we're with you. Make it happen.

1-800-231-8198

www.dragonproductsltd.com



DRAGON

Make it happen.

U.S. owned and operated. Founded in 1963.

© Copyright 2012 Modern Group Inc. All rights reserved.

