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DIGITAL TRANSFORMATION

The future of connectivity and automation in wellsite operations and workflows

Automation and remote operations solutions address persistent industry challenges to drive efficiency, safety and sustainability in wellsite operations. These innovations redefine what is possible in well construction and set new benchmarks for performance and operational excellence.

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The oil and gas industry faces complex operational and regulatory challenges. Digital transformation answers these challenges.

As the industry evolves toward digital transformation, the challenges for the optimization of wellsite operations grow more complex. From well placement to data exchange, today's energy producers need integrated solutions that enhance decision-making, reduce operational inefficiencies, and improve safety.

The realization of these integrated solutions involves several challenges that must be addressed to achieve the benefits of digital transformation in wellsite operations. These challenges include the integration of legacy systems, effective management of real-time data, workforce transformation, and the inherent complexity of operations. The management of these hurdles requires a strategic approach that combines technological innovation, robust infrastructure, and a skilled workforce capable of navigating the digital landscape.

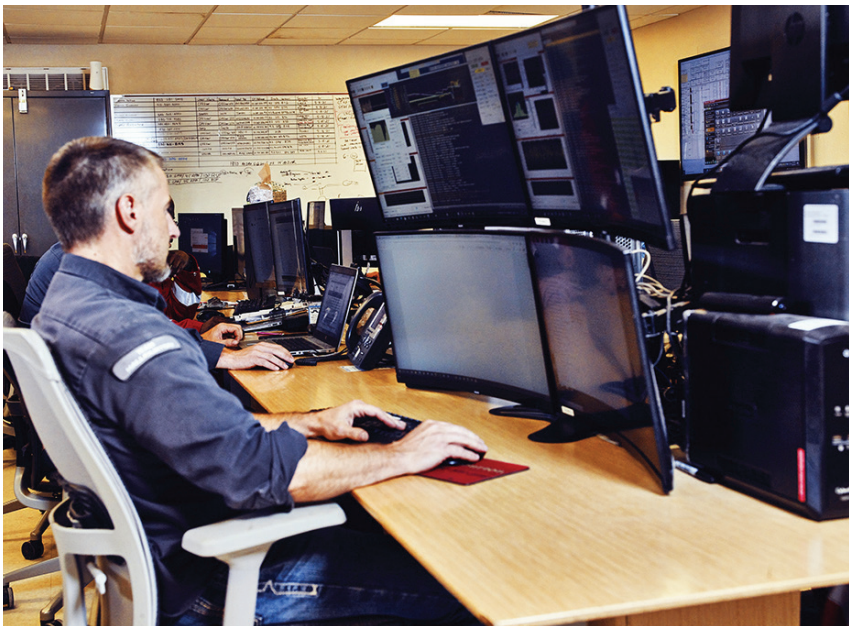

FIG. 1. Six categories contributes to a more connected, efficient and autonomous future for oil and gas operations.

A comprehensive, modular, and integrated suite of digital well construction solutions can address these challenges with real-time data insights and automation, and seamless collaboration across multiple disciplines. Halliburton has developed an ecosystem that can bridge the gap between traditional operations and cutting-edge digital workflows, to enable operators to achieve exceptional efficiency, consistency and transparency.

This digital solution is Halliburton's LOGIX™ automation and remote operations system.

This article explores how the LOGIX automation and remote operations create value with the combination of digital solutions and time-proven engineering across six categories: **Well placement, drilling performance, wellbore integrity, analytics and visualization, surface equipment, and data exchange.** Each category contributes to a more connected, efficient and autonomous future for oil and gas operations, FIG. 1.

WELL PLACEMENT

In complex drilling environments, precision and efficiency are critical. A recent case on the Norwegian Continental Shelf showcased how advanced technologies improved operational outcomes—with a 23.4% increase in the rate of penetration (ROP) and halved wellbore tortuosity.

Autonomous steering solutions, powered by digital twin technology and machine learning, facilitate accurate delivery with complex conditions. To minimize the need for human intervention, these systems manage variable downhole conditions through high-frequency data inputs and predictive algorithms.

LOGIX™ auto steer detects subtle changes in drilling depth and adjusts key parameters to maintain trajectory. The system tracks proximity to nearby wellbores and updates anti-collision limits in real time. This reduces the risk of safety incidents.

Success stories from the Middle East highlight these advancements, with an increase in ROP of 10% to 15%, and a 20% reduction in required runs. Projects achieved faster production timelines and improved well construction efficiencies, with historical well data and real-time adjustments. This approach illustrated the role of automation to address safety and challenges, **FIG. 2.**

FIG. 2. Use of LOGIX™ auto steer in the Middle East increased ROP and reduced required runs. Projects achieved faster production timelines and improved well construction efficiencies, with historical well data and real-time adjustments.

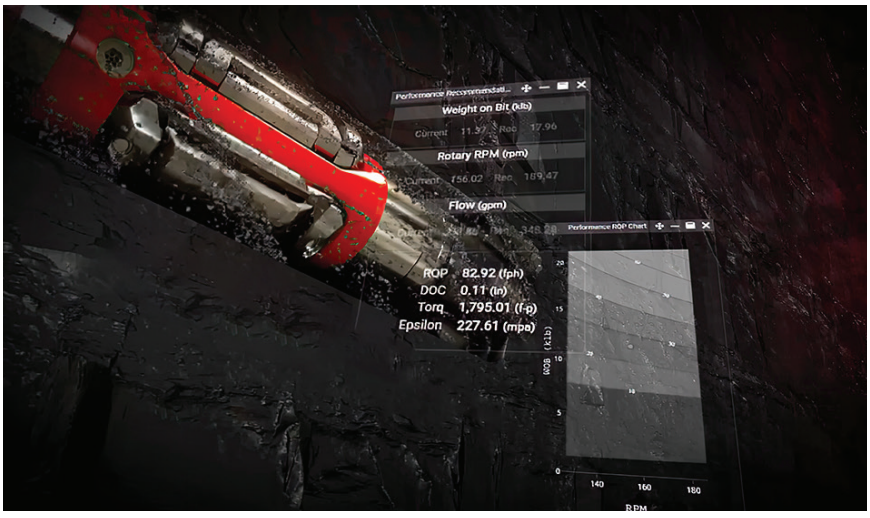

FIG. 3. During an operation in the Middle East, LOGIX drilling performance optimizer indicated that observed degradation in drilling efficiency was due to bit wear/damage. Once the BHA was on surface, the operator confirmed the bit was damaged, as predicted by the algorithm. This solution provided the operator with a reliable decision and reduced rig time.

DRILLING PERFORMANCE

Drilling performance plays an important role in the consistency of well drilling time, with the consideration of changes in the formation, the condition of the bit, and vibration measure.

Recently, a customer in the Middle East was drilling in an unconventional field with heterogeneous formations that included shale, carbonate, and anhydrite. These formations caused premature bit damage and required multiple trips. To address this, LOGIX™ drilling performance optimizer was used to calculate optimal drilling parameters to maximize the rate of penetration in the interbedded formations. This solution helped reduce operational risks and delivered wells in a reliable, repeated, and consistent manner.

During the operation, LOGIX drilling performance optimizer indicated that an observed degradation in drilling efficiency was due to bit wear/damage. The real-time data alerts notified the operator of abrupt bit integrity damage. A data-driven decision was made to trip out of the hole and reduce the impact on the well delivery time.

Once the bottomhole assembly (BHA) was on surface, the operator confirmed the bit was damaged, as predicted by the algorithm. This solution provided the operator with a confident and reliable data-driven decision and, as a result, reduced rig time.

Other examples have shown reduced well delivery time by 1.5 days, compared to offset wells, with drilling efficiency and rate of penetration (ROP) improved by 15%. These successes help operators achieve consistent and repeatable results with faster, data-driven decisions and precise control of downhole systems, **FIG. 3.**

WELLBORE INTEGRITY

Vital to efficient drilling is the maintenance of wellbore stability and the optimization of hydraulic performance. Advanced systems, such as LOGIX™ hydraulics optimization, integrate real-time rheology sensor measurements with proven hydraulic models that run in real time to address critical factors, such as pressure management, hole cleaning, and tripping optimization.

This digital twin technology creates a dynamic model of the wellbore to simulate pressures, fluid properties, and cut loads. This technology allows engineers to anticipate challenges related to equivalent circulating density (ECD) and facilitate effective hole-cleaning processes. Algorithms for cuttings transport provide precise insights and act as a "historian" to document fluid and cuttings data at any point in the well.

Hydraulic optimization tools work in tandem with drilling performance systems to calculate the optimal ROP and balance pump rates and rotational speeds. In a similar matter, tripping optimization tools determine the safest and fastest acceleration and velocity for moving pipe.

These solutions reduce non-productive time (NPT) and enhance overall efficiency.

Hydraulic services have reduced average drilling days by as much as 30%—a transformative impact on wellsite operations. These advancements contribute to safer, more reliable drilling processes.

ANALYTICS AND VISUALIZATION

In drilling operations, actionable insights are key to success. Advanced analytics and visualization tools enable engineers to monitor risks and optimize performance in real time. These tools use algorithms to analyze live data to present complex information in accessible formats and support quick decision-making.

One notable feature of the automation and remote operations platform is the LOGIX™ alert management system. This system eliminates the need for constant manual monitoring. Contextualized alerts prioritize critical events to allow remote engineers to focus on essential tasks. The tool's integrated dashboards offer multi-well visibility and use event detection algorithms to replace traditional trend analysis with actionable insights.

The 3D visualization of the wellbore gives drillers real-time situational awareness. The LOGIX well visualization module displays downhole conditions, fluid dynamics, and subsurface lithology on the same screen. Through consolidated screen views, this feature streamlines operations to enhance efficiency.

Real-time performance comparisons against planned metrics also play a pivotal role. Automated rig state engines convert activities into micro key performance indicators (KPIs) to help teams identify inefficiencies and take corrective actions. These capabilities empower operators to mitigate risks and maintain optimal performance throughout the drilling process.

SURFACE EQUIPMENT: ENABLEMENT OF SEAMLESS OPERATIONS WITH REMOTE LOGGING

Surface equipment forms the backbone of drilling, cementing, and wireline operations. New technologies enhance these systems with automation and remote capabilities to drive significant gains in efficiency and safety. A standout innovation is LOGIX™ remote logging. This capability uses digital twin technology to overcome the challenges of offshore and low-connectivity environments.

LOGIX remote logging creates a virtual replica of the wireline logging system, so operators can control downhole tools and remotely access real-time data. This reduces the need for on-site personnel (decreased costs) and minimizes health and safety risks (fewer personnel). The ability to control tools with latency-free precision proved invaluable with critical tasks, such as formation testing and wireline interventions.

Remote logging delivered remarkable outcomes for one customer, who operated a formation tester 500 mi from the wellsite and avoided expensive delays. Another customer used real-time data transfer to accelerate exploration decisions. This reduced the data processing time from hours to minutes.

Automated cementing solutions further illustrate the potential of remote operations. Offshore projects—often conducted with high costs and risks—benefit from full remote control of offshore cementing units. The use of LOGIX™ automated cementing improved efficiency by a third and has delivered consistent results across more than 400 jobs since its launch.

DATA EXCHANGE

Crucial to rig operations is the rig's connection to the office for data exchange and commands. To support transparency and operational agility, LOGIX data exchange links the rig to the integrated remote center. This capability connects well design to well construction execution; aggregates and transmits synchronized data; and integrates it with the cloud in real time. This service creates transparency between rig workers and in-house experts and provides consistent data access across the entire rig fleet. Durable data transmission through the system facilitates delivery to the cloud, even under poor connectivity conditions.

Using open subsurface data universe (OSDU) and cloud-native technologies, the system integrates data from multiple sources throughout the well design phases to provide operational parameters and recommend operating ranges to rig-based systems. The API-based interface embodies open architecture principles and makes operational information available to rig-based systems. This ensures everyone involved in the well construction process can access the same up-to-date information.

The result: flawless execution and consistent service quality.

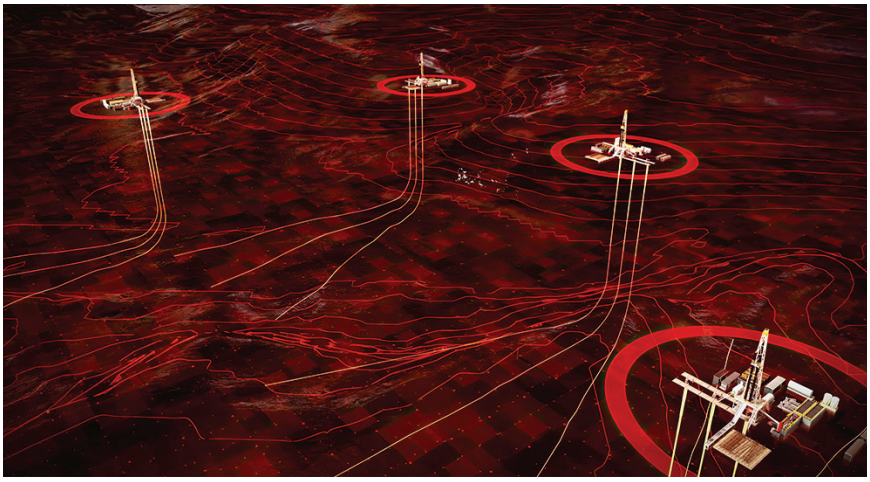

FIG. 4. Through the integration of real-time data, machine learning, and cloud-based platforms, operators can achieve more consistent results and reduce environmental impact.

CONCLUSION

Advancements in automation and digital technology have transformed wellsite operations. From autonomous drilling and hydraulic optimization to remote logging and data exchange, Halliburton's LOGIX automation and remote operations solutions address persistent industry challenges to drive efficiency, safety and sustainability. Through the integration of real-time data, machine learning, and cloud-based platforms, operators can achieve more consistent results and reduce environmental impact. As the industry evolves, these innovations redefine what is possible in well construction and set new benchmarks for performance and operational excellence, **FIG. 4. WO**

DR. MILOS MILOSEVIC is a senior director at Halliburton, responsible for managing the digitalization of well construction activities. In this role, he creates technology development and go-to-market strategies for automation, remote operations, and process digitalization. Since joining Halliburton in 2013, Dr. Milosevic has served in several roles, including senior director for Strategy and Marketing, technology director for Halliburton Landmark, and Production and Pipeline Solutions. Prior to these roles, he held multiple strategic and product development positions at Halliburton, SLB, Texas Instruments, and Motorola. Dr. Milosevic holds a Ph. D. in electrical engineering from The University of Texas at Austin, an MBA from Rice University, and M.S. and B.S. degrees from the Illinois Institute of Technology.