

Integrating Business and Technical Workflows to Achieve Asset-Level Production Optimization

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Abstract: The pressure on the oil and gas industry to meet the growing demand for energy when faced with fewer technical professionals, more complex reservoirs, and increased global competition is making it more critical than ever before for operators to make quick, accurate, and informed field development decisions that efficiently leverage the expertise of seasoned technical professionals. With experienced, technical professionals in short supply, the industry is looking for information technologies that can extend the reach of technical experts and better ground high-level business decisions in the scientific evaluation of the asset. Flexible workflow automation systems can now take technical production applications at the engineering level and put them in a computing environment where they can be integrated with business process management (BPM) systems to create automated asset-level workflows. In initial implementations, the results have included more efficient production operations, less personnel time required to complete repeatable production tasks, better incorporation of uncertainties into business level decisions, and most importantly, increased reservoir production.

Halliburton has partnered with SIMULIA to deliver advanced technologies that have traditionally been used for complex manufacturing and design applications to the O&G industry. Halliburton has adapted the iSight® and FIPER® software into the normal day-to-day operations routine of an O&G production engineer and allowed him/her to become much more efficient.

Halliburton commercially markets the SIMULIA iSight and FIPER technologies into the O&G industry re-branded as AssetConnect™ and part of Landmark's DecisionSpace® for Production™ technology suite.

1. Introduction

The oil and gas industry faces manpower, equipment, and service shortages as it tries to cope with a world energy demand that is projected to grow from 230 million barrel of oil equivalents per day (boe/d) today to 335 million boe/d in 2030. As such, it will rely heavily on technological advances to meet future energy demands, which means ever more complex operating environments and, consequently, the need for applying more rigorous solutions. Additionally, the most experienced engineering staff will retire in the next 5–10 years. Therefore, significant workforce productivity gains will have to be realized through digital oilfield automation initiatives to manage future levels of E&P activity.

1.1 Industry Issues

- Data volumes and data size

- o Advanced acquisition techniques
 - o Advancements in HW allow large volume analysis
 - o Advancements in seismic data acquisition
- Industry “crew change”
 - o Past knowledge hemorrhaging
 - o New generation entering workforce
- No more easy oil
 - o Rising costs
 - o Complex workflows
 - o Global collaboration
- Increasing customer focus on operational efficiency

Many production workflows require engineers to coordinate data flows between disparate numbers of applications. Studies have shown that about 70% of an engineer’s time is spent gathering, formatting, and translating data for use in these different applications. For standard production activities (i.e., workflows), this time can be drastically reduced by creating an automated system to execute the prescribed workflow. The automated workflow not only reduces the engineers’ valuable time performing these repetitive tasks, but also ensures consistency in methods, reduces the likelihood of input errors, and creates a repository for "best practices" that can be maintained long term as personnel (and their knowledge) is moved into, and out of, the production asset.

For many years, automated workflows have been a part of the design and production cycles in other industries, including aerospace, automotive, and industrial manufacturing. These industries have been tying together applications and data sources along with using stochastic analysis methods and optimization to improve their overall productivity.

Within the O&G production space, some common workflows may include:

Well-Test Validation

Long-Term Work Plan

*Subsurface / Surface Production
Forecasting*

Production History Match

Well Shut-in Testing & Analysis

Mid-Term Work Plan

Daily Production Optimization

Well-Restart Monitoring

Production Allocation

Glycol Monitoring

Pressure History Match

Data Statistics and Visualization

Production-Dcline Analysis

Process Material Balance

*Candidate Recognition & Production
Prediction*

SAGD Integrated Forecast

KPI Monitoring

Reliability Monitoring

Stochastic Production Forecasting

*Subsea and Surface Pipeline Network
Performance Analysis
Flow Assurance
LPG Monitoring
Pump/Motor Performance
Production Economics
Well-Test Prioritization
Compression-System Monitoring
Chargeable Fired Hours Tracking
Pipeline Monitoring
Virtual Metering
Well Production Surveillance and
Optimization
Model Update
Facility Monitoring
BHP Correction
Real-Time Asset Optimization*

*Reserves Tracking
Loss Management
Flux Monitoring
Well Monitoring
Real-time Closed-loop Well Optimization
Production Stimulation Design Optimization
Zonal-Split Calculation
Methanol Injection Optimization
Non-Operator Reporting
Pipeline Network Deliverability
Production-Performance Analysis
Model based Production Optimization
Equipment Surveillance by Exception
Reservoir Performance Analysis
Short-Term Work Plan
Maintenance (KPIs and root cause)
Reservoir Surveillance*

2. Upstream Oil and Gas Business Needs

The O&G production domain software ecosystem has for many years been highly fragmented. Individual operating assets had been given the autonomy to select their own preferred software and data solutions based on the specific needs unique to their own operating conditions. As a result, the O&G companies' IT infrastructure became quite burdened with the large number of individual engineering applications and data systems it was asked to support. For years, this inefficiency was tolerated because of the relatively high operating margins that could be achieved. However, times have indeed changed. The higher costs of producing from more challenging reservoirs and the diminishing numbers of O&G professionals graduating from university to replace the estimated 40% of the workforce that will retire within the next 15 years have placed a sense of urgency within the industry.

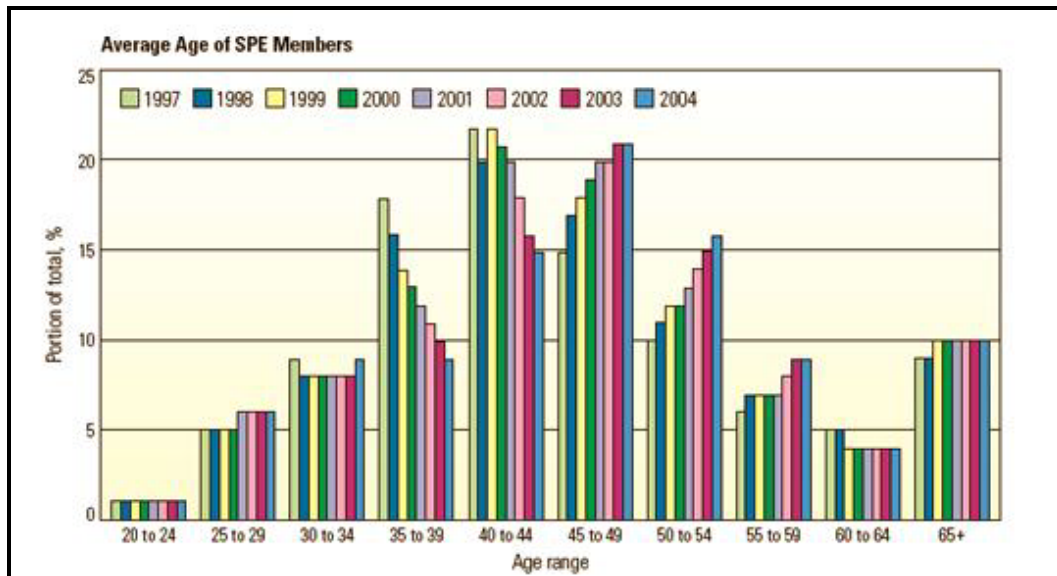


Figure 1: Age distribution of Society of Petroleum Engineers (SPE) members from 1997 to 2004. The SPE is an international network of Petroleum Engineers with more than 60,000 members.

The problem has been aggravated owing to the loss of in-house training programs in many large oil companies and the loss of research centers in many major oil companies. This loss was a response to the lower oil prices, which caused overall contraction in the industry after the oil crises.

Over the past 5 years, O&G companies have recognized the need to make their production operations more efficient by using digital technologies. These initiatives go by different names, such as “iField™” (Chevron), “SmartField™” (Shell), “Digital Oil Field” (BP), and the “Digital Asset®” workflow (Halliburton). While results have yet to be quantified precisely, the results are expected to be in line with the Cambridge Energy Research Associates (CERA) expectations for operators implementing digital oilfield initiatives. With a production increase of approximately 4%, the reservoir recovery factor improved by as much as 3%, and costs reduced by 9%.

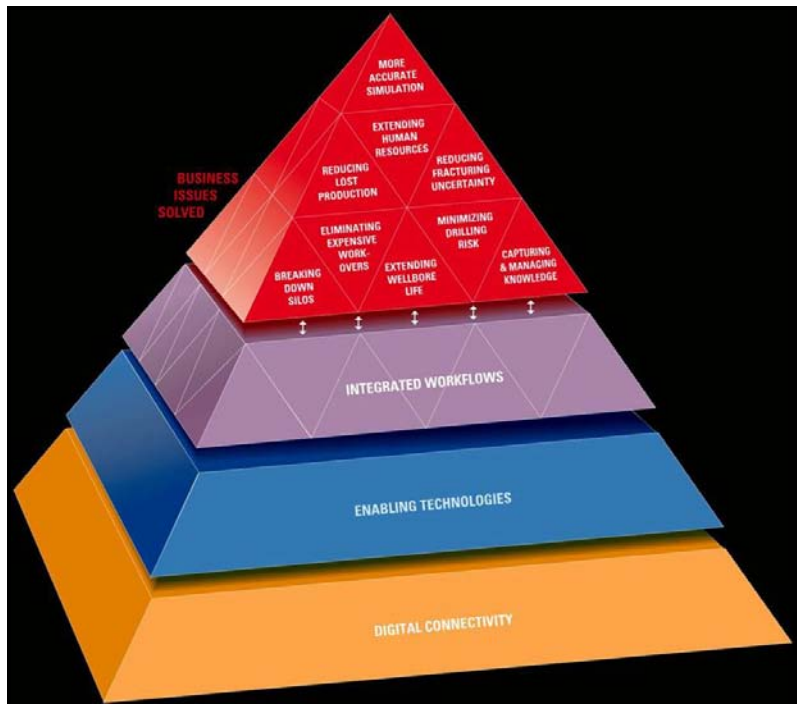


Figure 2: Halliburton Digital Asset®—A Real-Time Collaborative Environment to Model, Measure, and Optimize the Asset.

These digital initiatives all have common elements of orchestration, automation, and integration, as shown in this upstream business activity diagram recently presented by Microsoft.

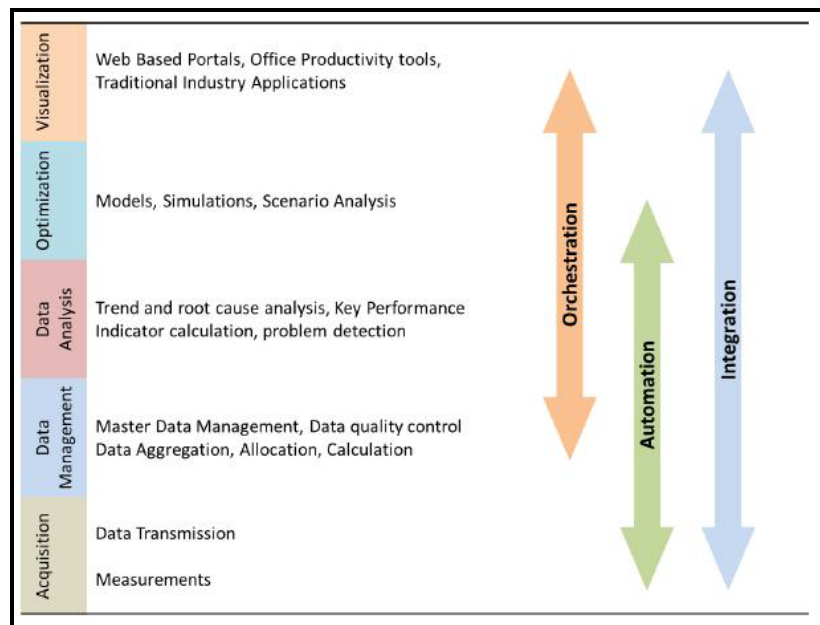


Figure 3: Upstream O&G Business Activities.

3. Approaches to Achieving the Digital Asset® Workflow

While most agree on the individual elements required for achieving the Digital Asset® workflow, the people, process, and technology approach is often very different. Originally, some companies have tried to connect software systems and data together using custom programming or via Excel spreadsheets and macros. While this may seem to be a valid solution at the outset, many have experienced serious problems with maintaining these systems in the long term. Another methodology for creating complex automated workflows is to replace existing systems and software with an “All-in-One” solution that provides the required functionality within a single environment from a single technology provider. This method sounds like an attractive alternative to building custom solutions. However, it must be realized that companies have significant investment in the existing systems and software that is currently used to make critical business decisions. Replacing the existing reliable systems and software is very risky and often comes with unforeseen compromises in performance and capability.

Halliburton has taken a third approach by allowing O&G companies to retain their existing software technologies and data sources while at the same time providing a common platform for software integration and automation. This combination of flexibility and maintainability will increase the efficiency of production operations while significantly lowering the cost of overall systems maintenance. Furthermore, Halliburton recognized that such technologies already existed in other manufacturing-related and process industries. Currently, Halliburton is leveraging technologies from the following companies:

- Rockwell Automation (formerly Incuity) – Federated Data Model
- Rockwell Automation (formerly Pavilion) – Data Modeling / Real-time control and optimization.
- SIMULIA (formerly Engineous) – Production Workflow Automation

By smartly leveraging these existing technologies, Halliburton has been able to leapfrog competitors and become the leader in the industry for delivering Integrated Production Operations (IPO) Systems.

4. SIMULIA iSight and FIPER Technologies

The SIMULIA iSight and FIPER technologies play a very key role for Halliburton. Over the past 3 years, Halliburton has extended the iSight platform to support upstream modeling software for reservoirs, wells, networks, and facilities. In addition, Halliburton has pushed the limits of iSight and FIPER applications into areas that traditionally were not common. For example, while Halliburton's use of iSight software for design focused on workflows, such as Well Stimulation Design or Reservoir Uncertainty Analysis, workflows were reasonably aligned with the traditional CAD/CAE workflows, other workflows, including Well Test Analysis and Pressure Transient Analysis, required elements, such as continuous condition monitoring, interactive human approval processes, and portal workflow visualization. Such elements are typically found in Enterprise level Business Process Management (BPM) software. Traditional BPM software, however, is incapable of integrating the required level of technical software.

The iSight and FIPER suite of SIMULIA software gives Halliburton the right level of application integration, workflow system management, and architectural flexibility to implement a series of 30+ inter-dependant business critical workflows for a single customer at a single producing asset. Many of these 30+ workflows are running 24/7 and constantly being used by operations personnel to make real-time operating decisions. An example of one of these real-time workflows is well-test validation.

5. Halliburton Well-Test Validation Workflow

Production from oil & gas reservoirs is a dynamically changing process. Not only are the exact characteristics of the producing reservoir not completely known, it is often very difficult to acquire accurate flow and compositional data (over time) for a well's production. This may be due to the remote location of the well or maybe a lack of measurement instrumentation on a particular well. Of course, a well's production over time is a very important piece of information when you are trying to "optimize" fluid production from the system. The reality is that wells are typically only tested on a monthly or quarterly basis. During this testing process, the individual well is isolated from other wells within its network so its flow characteristics can be measured independently.

Well testing often involves the “shut in” of certain wells, so that others may be tested. As a result, well testing frequency is often minimized so as to not disrupt overall production.

The results from a well test are used for revenue allocation across the ownership entities, production history matching of reservoir models, and calibration of well models. The calibration of the well models is an important part of overall understanding of a well operating health. When a well test does not match the results of a predictive hydraulic software model (PROSPER for example), the engineer must decide if the reservoir characteristics need to be adjusted (ie. Lowered bottom hole pressure) or if the well model itself needs adjustment (ie. Skin factor). This well test validation process is a prime candidate for automation.

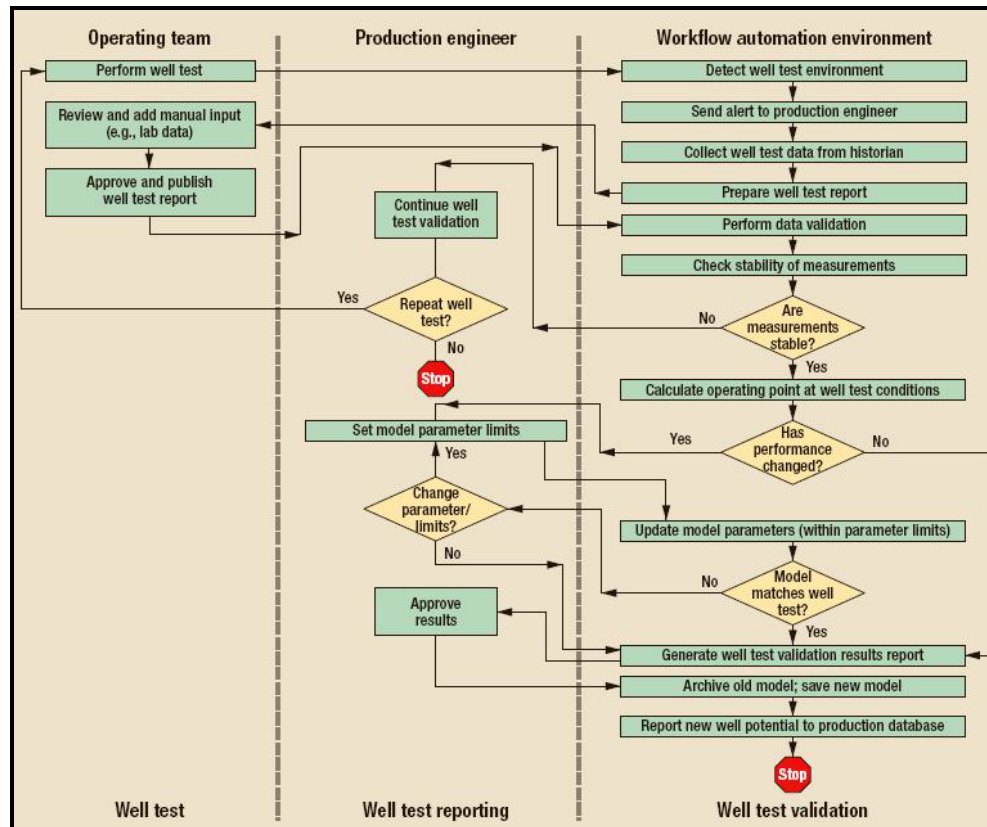


Figure 4: Well-Test Validation Automated Workflow.

Using the iSight integration technology, the Halliburton team was able to automate many of the simple, yet time-consuming, manual steps of the well-test process. This process can be described in 4 basic steps:

Step 1. Detect the well test event through continuous monitoring of well-valve positions from a real-time data collection system. The engineer is alerted of the event and prompted for confirmation of the valid well test.

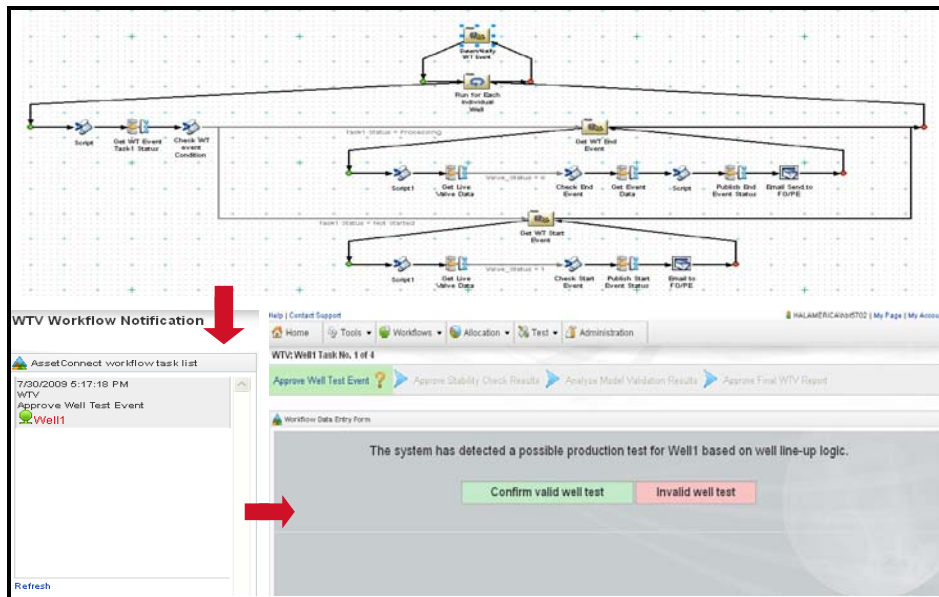


Figure 5: Detect Well Test Event.

Step 2. Perform a stability check to ensure proper test-data quality. The engineer can accept or reject the test data.

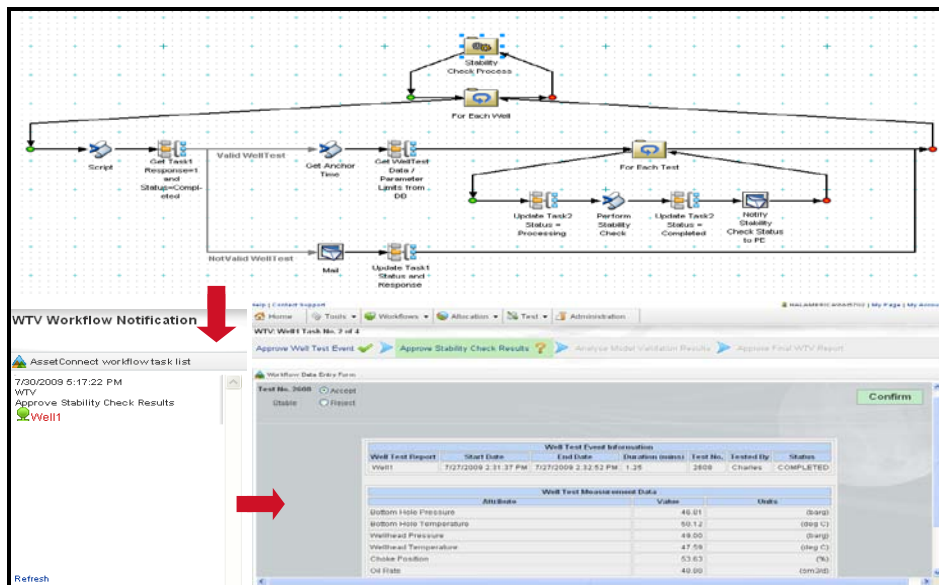


Figure 6: Perform Stability Check.

Step 3. Perform data validation against the well model (i.e., PROSPER used in the case). The engineer can accept or reject the validation results.

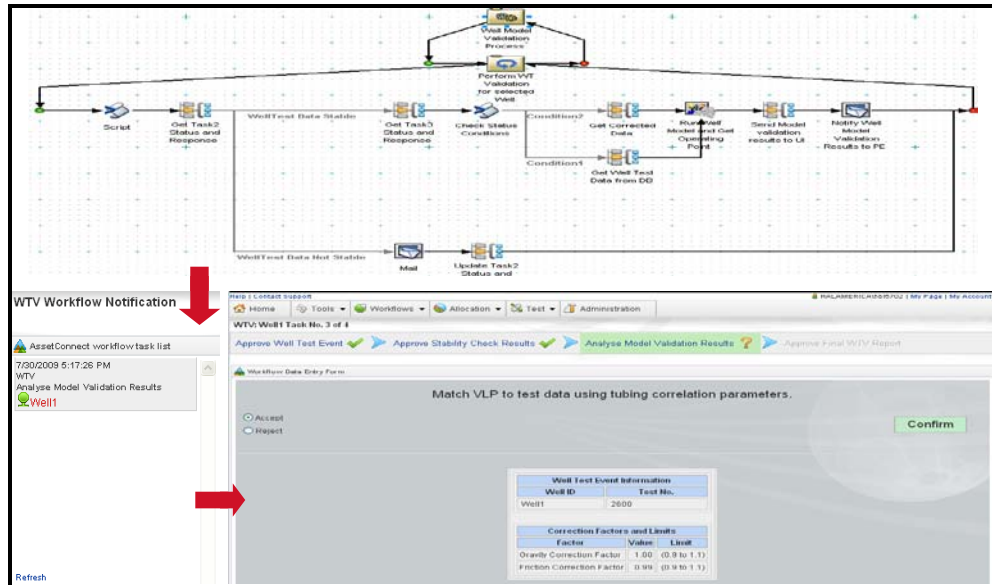


Figure 7: Model Validation.

Step 4. Generate the well-test validation report from the test data stored in the production database.

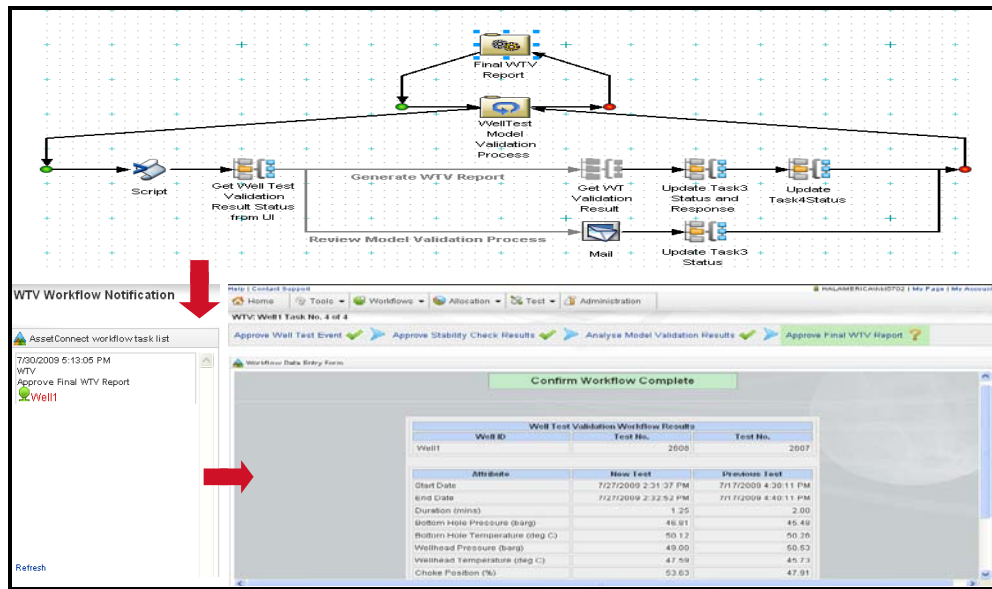


Figure 8: Generate Well-Test Validation Report.

By using the iSight technology, Halliburton was able to cut the time required to validate a well test from one day to a mere 15 minutes.

While the above example of a well-test validation represents a somewhat simplistic and streamlined view of the process for demonstration purposes, the actual implementation of this workflow within a world-class, state-of-the-art production operating environment may look something like **Figure 9**.

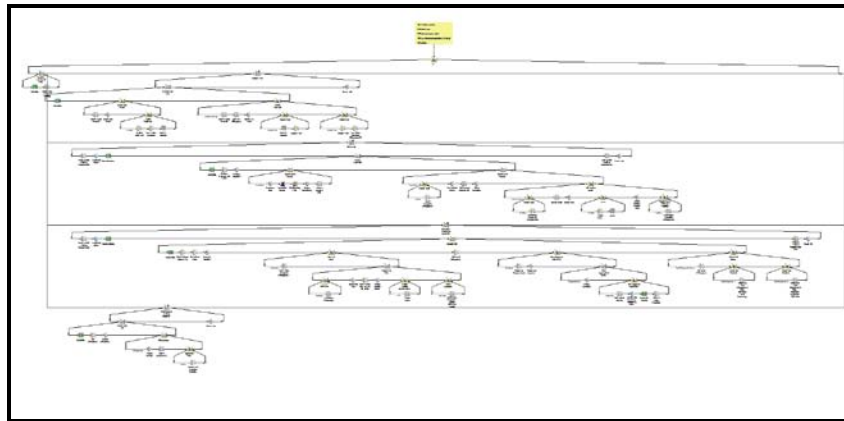


Figure 9: Realistic iSight workflow model representing well-test validation.

6. Benefits

Halliburton recently implemented the iSight and FIPER technologies (including AssetConnect along with data management and portal visualization software from the Landmark DecisionSpace for Production suite) into a deepwater greenfield FPSO (Floating Production, Storage, and Off-loading). The documented benefits realized to date include:

- Optimization of well rates resulting in **50,000 BOPD** gain
- Availability of the Landmark DecisionSpace for Production system by first oil enabled availability of key field information in “relevant time” to asset personnel at both offshore and onshore locations and remote access to field data for experts outside the production asset to support flawless startup operations. Well availability and facilities uptime were significantly greater (about **95% compared to 50-65%** projection) for the first 6 months of production.
- Avoidance of lost production opportunity as a result of timely access and analysis of data directly results in significant savings. A conservative estimate of actual savings resulting from LPO avoidance (despite variations in oil price) is predicted at **over \$10MM** for the first year alone. The value delivery is still on going and relies on system sustenance for continuous future benefits.
- Automation of interdependent and repetitive work processes enabled a **98% reduction** in engineers’ non-productive time associated with data gathering, sorting, analysis, and reporting.
- The Landmark DecisionSpace for Production system incorporates best practices and asset team know-how in workflows through automation. This system helps to capture knowledge and reduce attrition of expertise when asset team members are relocated. Further, workflows provide a structured method to induct new employees into asset business processes.

What Landmark delivered to the customer in this engagement was a complete technical workflow solution consisting of data access from multiple sources, data visualization and monitoring, and workflow execution and orchestration. The system currently supports over 30 different workflows many of which run on a constant 24/7 basis. The SIMULIA FIPER technology now called Simulation Engine Environment (SEE) was critical to managing the large number of workflows being executed and maintained.

7. Conclusion

SIMULIA has helped Halliburton maintain a significant technology lead over its competitors in delivering digital oil field solutions. Halliburton is continuously looking for other technologies from outside our industry to leverage into our valuable Integrated Production Operations systems.

8. References

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