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Integrated Operation Performance and Optimization Analysis Based on Technical Limit and Invisible Lost Time

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Abstract

Technical Limit (TL) and invisible lost time (ILT) are concepts that have contributed to the success of several oil and gas projects around the world since late 90s, many of them documented and presented in international conferences. The TL represents the optimum time for a given operation, based on statistical analysis or operation team commitment. Defining TL could be challenging when unique activities are programmed or there is a lack of offset data, on these situations the TL estimated may be biased. The objective of this paper is to describe a methodology that allows to define a TL based on specific conditions of the well, to identify not only the ILT from operational performance, but also identify imprecisions on the daily operation reports (DOR), the program and well design.

ILT is the difference between the productive time and TL, this value allows to estimate efficiency. Identified invisible lost time (IILT) is the ILT portion that can be measured with real time data and/or DOR. The other portion is defined as unidentified ILT (UILT). IILT and UILT were estimated to productive and non- productive time (NPT). Geological correlation was used to estimate ILT derived from drilling performance.

Introduction

More than two decades ago, Bond et al. (1996) presented a well construction process disruptive idea that impacted deeply the way oil companies planned and executed drilling and completion projects. Bond proposed and defined Technical Limit (TL) as the "best possible" time for a given set of design parameters. He also introduced the Invisible Lost Time (ILT), defined as the time taken to perform those activities included in a "normal" well but excluded on a theoretical well at which each operation is considered to achieve its best performance. TL allows one to estimate the operational efficiency and identified opportunities for improvement even when a well is constructed problem-free. TL is the foundation to different technical analyses that have been presented in posters and papers from different companies, documenting important time and cost saving achievements in projects around the world.

Most of the literature consulted consider the use of statistics and drilling teams commitments to set the TL, which could lead to bias goal. This paper proposes a methodology to maximize the use of engineer's tools as well as the expert judgement when setting the TL for a given operation.

Related Literature

The literature in SPE archive related to Techinal Limit is extensive, which can be brokenit into three categories. The foundation, TL philosophy, improves the well construction process around the world. Data Analytics and Visualization, technology is combined with process to get the TL philosophy to a new level. Machine Learning (ML), advanced algoriths are applied to real time data to enhance patter recognition related to ILT.

The Foundation

Bond et al. (1996) demonstrated that improving the well construction process can make a big impact on project performance. Bond et al. presented the TL approach posing a key question:

- "What would be possible if everything went perfectly on every operation making up the well time? This is not the usual trouble-free time but a well time built up of individual components, with each component representing its theoretical best performance."

Bond et al. paper led to Drilling The Limit* (DTL), a Shell Trademark. Schreuder et al. (1999) published a DTL paper that define ILT as the total of previously acceptable wasteful events, caused by e.g., use of sub-optimal equipment, lack of resources or procedures. Many of these times are absorbed in what is conventionally termed as "Productive Time". Examples of invisible lost time are bit trips before reaching section depth, wiper trips, conditioning mud prior to cementing, adjusting and double checking of drilling components such as directional motors and MWD tools. The theoretical limit is established, forming a target, based on a fixed set of assumptions, representing the perfect world (ideal and optimized operating conditions).

Based on the Technical Limit, Iyoho et al. (2004) introduced the terms Best Composite Time (BCT) and Best Composite Cost (BCC). Iyoho defined the BCT as "the summation of the best time recorded for drilling activity and hole section in a series of similar wells drilled in a filed", and BCC "is the dollars equivalent to BCT". Iyoco described how statistical analysis can be applied to develop a technical limit or BCT, for similar wells, demonstrating the value of an organized knowledge-based data-management system to cross-correlate relevant drilling and geologic parameters. One of the strategies to apply BCT is to provide a measure of what can be achieve, based on what already has been achieved, in order to mitigate that field personnel, perceive the TL as theoretical and impractical goal to pursue.

Data Analytics and Visualization

TL philosophy has demonstrated that process can be improved, adopting systematic procedures, and when is combined with technology the results can be much forceful. Maidla et al. (2010) use surface sensors data to improve drilling connections performance based on ILT. Spoerker et al. (2011) presented a similar analysis but considering pipe tripping connections and casing connections. Lakhanpal et al. (2017) applied advanced signal reconstruction concepts to surface sensor data to calculate non-productive time (NPT) and ILT.

Shamsi et al. (2018) and Torres et al. (2019) implemented the TL philosophy and used dashboards as a data visualization tool to communicate the results and explore the data to maximize its value.

Ouahrani et al. (2018) presented an outstanding paper that demonstrates the value of combining TL philosophy with advanced data analysis and data visualization in real time. Ouahrani used real time data from surface sensors and operations reports to track and display multi-well drilling operation activities comparison, enabling the project team to compare and identify any miss-reporting that may have occurred on the Daily Operation Reports (DOR) when compared to the real time data log. Thus, allowing to accurately allocate time to each activity reported in the DOR and to resolve discrepancies. Both data sets complement each other. Ouahrani et al. applied the TL philosophy as well as the statistical procedure, that is referred as best composite curve, to update the TL as the operation efficiency improved.

Machine Learning

Coley et al. (2019) presented a paper that covers the development of a generalizable rig state engine based on the application of supervised ML classifier to identify rig-state. The model allowed to predict the current operation or rig-state to derive metrics, Key Performance Indicators (KPI) and ILT which were stored alongside the original real time and contextual data. Mora et al. (2021) compared different approaches, based in TL defined by experience, statistics, and ML, to measure ILT in drilling connections and point out the advantage and disadvantage of each method.

Priyadarshy et al. (2017) created a framework to predict NPT and ILT causes from massive degree of unstructured data collected during the drilling operations and other reports, applying natural language processing to classify NPT and ILT causes.

The Challenge of Defining the Technical Limit

The risk of drilling and completion teams perceive that TL is not realistic nor achievable have being documented in different papers. Gallagher et al. (2005) noted that it was difficult to convince crews that TL does not mean "rush-rush," so very careful attention must be paid to implementation. Also, there is a fine line between loading someone up until they are stretched and setting unrealistic goals through overloading. Therefore, it is critically important to set goals with the right amount of stretch to challenge and to motivate without over-stressing employees. Shamsi et al. and Torres et al. identified as challenging to obtain alignment across the different teams and overcome the resistance to change. Shamsi et al. also considered this condition a risk to short cuts and potential trigger for HSE (Health, Safety and Environment) incidents or well integrity issues, hence, ILT target was defined in agreement with all the crews and service companies based on the ideas proposed in ILT workshops. One of the conclusions in Scott et al. (1988) paper was that performance to TL standard cannot be demanded, bought, or coerced. These forms of motivation can only deliver a minimum standard and tend to be energy sapping and distracting. It needs individual commitment and positive motivation.

The related literature about this risk consulted, as the best understanding of the author of this paper, in most cases define the TL from best performance in historical data, in other cases from domain expert experience or agreements with the planning and execution teams. Those procedures have led to amazing results on increasing efficiency and reducing costs. Additionally, these procedures may have mitigated the risk of communicating challenging targets that can be interpreted by the team as unrealistic. However, it is very difficult to find two or more identical wells due to the uncertainty related to downhole services, changes in trajectory, execution on different time of the year, terms and conditions of some services, downhole conditions on differences field coordinates, among others. The variability on the data because of changes in conditions during the execution may generated bias when identifying some ILT.

Some well operations such as installing the wellhead, rigging up equipment, installing surface sensors, etc., are performed under similar conditions and may be suitable to be analyzed applying statistics. Other activities such as cementing, reaming prior connections, running wireline, etc., may be performed under different conditions among offset wells. On those cases it is proposed to use conventional engineering calculation to define the optimum time under the current conditions. The recommended approach in this paper is to estimate the the TL applying conventional engineering calculations under the specific conditions, statistical analysis on those operations that can be statistical perceive as homogeneous and expert domain judgement when there is not a reference to compare.

To identify ILT related to performance the TL should be defined considering the current conditions as much as it is possible. Otherwise, it may be situation when it is difficult to determine if inefficiency is due to performance or technology. To answer the original question formulated by Bond et al., "What would be possible if everything went perfectly on every operation making up the well time?", we first need to know what the best performance possible is, under exactly the current conditions, or it may be the case that ILT is identified even when everything was performed perfect, and that may be perceived as frustrating.

Engineering team should set a TL that allows to identified representative ILT identified to make improvement plans for future wells. At the same time, strategic and stretch golas can be communicated to the team to ensure that are perceive as realistic. In other words, set an engineering target and a performance target. Management must provide the resources to achieve the goals and promote a "no blame culture" as recommended by Bond et al. (1996) at the very begging of the TL implementation.

Methodology

Following the steps to apply the methodology:

Define The Technical Limit

The first step is to define the operation sequence, and then define a TL to each activity on that sequence based on statistics, engineering, or expert judgement.

Whenever is possible, engineering should be used to estimate the TL under current conditions. For instance, hydraulic surge analysis will provide an optimum block velocity while tripping, lag time will be a referenced to define the time needed to clean the hole based on depth, hydraulics also can be used to estimate the optimum pumping time to keep the pressure under rig specifications, etc. Considering engineering calculations from the operational program will allow to evaluate how certain is the program, could we have run pipe faster? Could we have reduced the pumping time? etc. We can quantitatively estimate the value of having a certain pore pressure prediction, accurate hydraulics models, cement tests, and others.

Statistics must be applied when there is data available for a given operation under the similar conditions. If the sample is large enough its distributions is likely to approximate the true distribution of this activity and more detailed statistic analysis can be performed. The typical example is the slip-to-slip drill pipe connection, on a single bit trip dozens of records can be collected. Historical data of slip-to-slip connection from the same rig is an excellent starting point for set the TL. Another example suit for use of historical data is installing the wellhead, testing blow out preventers (BOP), installing logging unit, etc.

Expert domain judgment should be considered when there is no reference data to a given activity. For example, if a new down hole tool will be run in a development project, there would probably be enough records to estimate the time for a standard BHA, but the additional time to connect the new tool may be provided by expert domain judgment, until can it be measure and be add to the records.

Estimating the Invisible Lost Time

In this paper ILT is referred as the difference between the TL defined on the planning phase and the actual productive time, but also ILT is calculated to routine operations during NPT, such as bit trips, making and braking bottom hole assemblies (BHA), etc.

If real time data is available, it can be used to identified source of inefficiency by measuring ILT on drilling connections, time to pull a stand, circulating time, etc. These ILT are defined as Identified Invisible Lost Time (IILT). The difference between ILT and IILT is defined as Unidentified Invisible Lost Time (UILT).

Figure 1 shows a diagrammatic representation of these concepts. Some of the total ILT can be explained using real time data or other reports, but there is a portion that requires further investigation to determine if it comes from a biased TL, inaccurate report, or others.

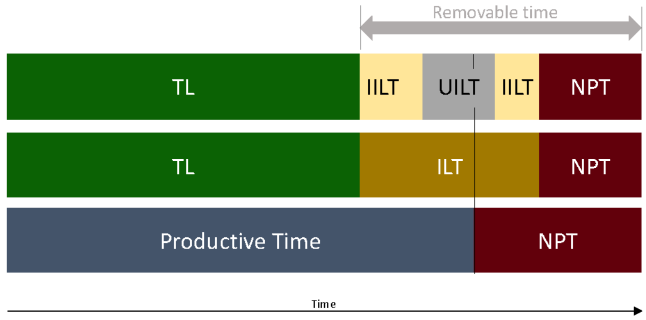


Figure 1—Time Distribution Diagram inspired by Bond et al. (1996) diagram.

Data Visualization

Once the ILT is estimated, it should be visualized among the data collected from reports and sensors, to complement the improvements in process. High technological dashboards allow to explore the data in real time and see hidden pattern in the data that can enhance its value. Current technologies allow to share those sophisticated dashboards via internet or intranet.

Evaluation

The results and data collected are analyzed to estimate the operation efficiency, quality of TL defined in the program, DOR precision and other potentials inefficiencies that are not identified through the real time data.

Even when technical limit is achieved, a root cause analysis (RCA) should be performed to evaluate operation performance, DOR accuracy and program quality. Lessons learned and best practices are captured through these RCA to make adjustment in de current operation or to be implemented in future projects.

Case Study

The following case study will allow to put the described methodology into context. The data corresponds to the drilling of a 12.25 in hole, considering the operations from making up directional drilling BHA until the last BHA was laid down to run wireline logs. This project is a post operation analysis. Therefore, the findings were not communicated to the drilling team during the execution.Table 1 shows how the TL was calculated to each operation.

Table 1—Procedures to calculate the technical limit on each activity planned.

Activity	Description	Engineering	Statistics	Expert Judgment
L/D DD BHA	Time to Lay Down (L/D) directional drilling (DD) BHA.		Records from DD BHA in previos wells on the same rigs and offset well under similar conditions.	Validate those records from previous wells under similar conditions.
P/U DD BHA	Time to Pick Up (P/D) or Make Up DD BHA.			
Drill Ahead	Time since the bit is on bottom until circulation is started to POOH or change activity.	The best rate of penetration (ROP) is estimated from previous wells applying correlation. Reaming time is calculated from hydraulic to ensure cutting travel to a safe distance to the bit and based on the ROP and hole angle. Survey time is defined based on the MWD specifications.	Slip-to-slip connection time records from the same rig, in previous stages and previous wells, with the same drill pipe connection.	
Circulate Hole Clean to POOH	Circulate a bottom up to ensure hole cleaning prior tripping to surface.	Calculating lag time to ensure hole is clean before tripping out.		
RIH	Time since start to run the bit in the hole (RIH), until reach hole bottom or change activity.	Block velocity based on swap and surge simulations. Pore pressure prediction with geomechanical model. Time to fill up the well and pipe from calculations.	Slip-to-slip connection time records from the same rig, in previous stages and previous wells, with the same drill pipe connection. Discriminating if the connection was RIH or POOH.	
POOH	Time since start pulling the bit out of the hole (POOH), until L/D BHA or change activity.			
Slip & Cut Drilling Line	Time to replace the drilling line wrapped around the crown block and traveling block.		Records for the same rigs and offset well under similar conditions.	
Test BOP	Time to test blow out preventers (BOP).			
Wash down relogging (LWD)	Time to log an open hole section already drilled, with Logging While Drilling tools.	Time to achieve the sample per foot required at the tool record rate.		

After calculating the TL, ILT were estimated. However, some inconsistencies were observed in the results. The DOR was validated with the real time data, finding some activity that were shifted from the actual time that started and/or ended. Therefore, the time each activity on the DOR started and ended were validated or corrected to improve the quality of the analysis. Figure 2 shows an example were the DOR had to be adjusted as the time for cutting and slip drilling line was off with respect to the real time data.

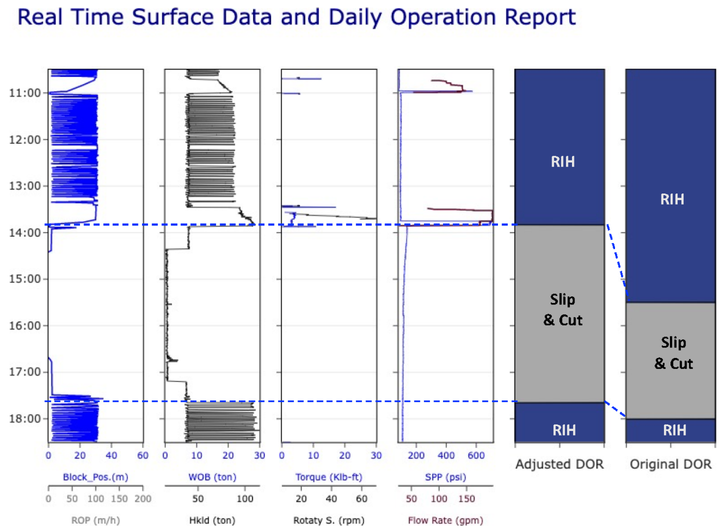
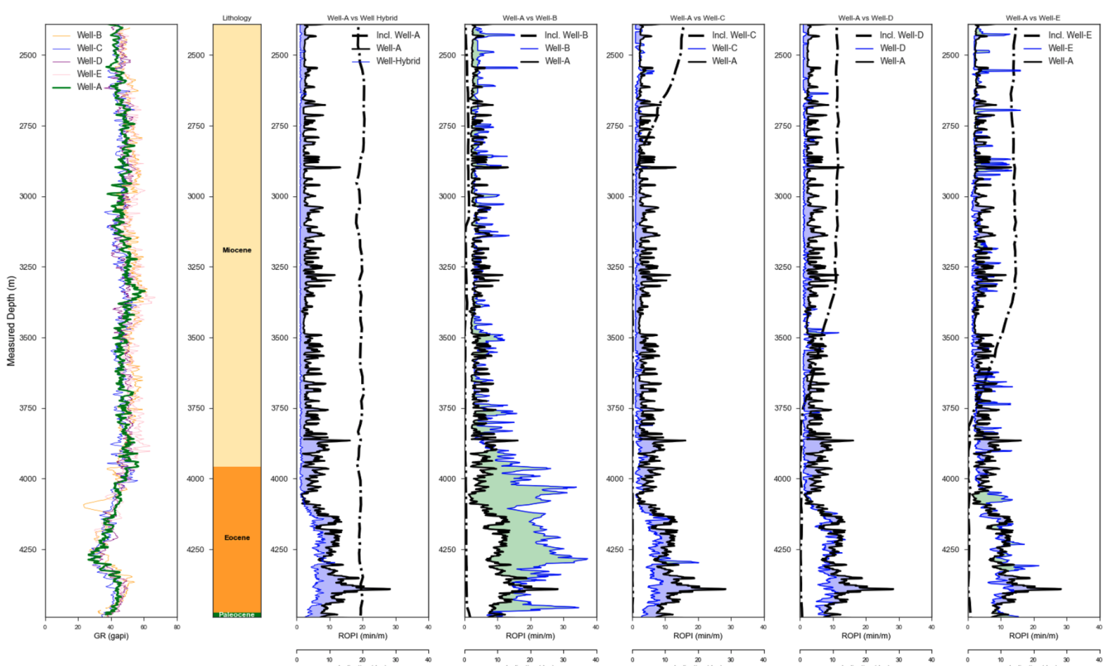


Figure 2—Comparison between DOR and real time data. The adjudgment done to the report is shown in track 5.

As the ROP is not time dependent but depth dependent, it was not affected by the adjustments on the DOR. Figure 3 shows how the correlation was used to estimate the best ROP, that in this case is expressed in inverse ROP (ROPI). The blue shade zones indicates where Well-A had a bad performance compared to the well displayed on each track. The integration of the blue shade zones indicates the ILT for drilling performance. The green shade zones indicates where Well-A outperformed the offset wells. This analysis is considered better than comparing average, because allow to identify what formation needs more engineering analysis. When comparing only mean values, a bit run that starts with an outstanding performance but at the end performs poorly, may finish the run achieving the average, and giving the impression of not need for major improvements.



Track 1 shows the gama ray (GR) correlation (from LWD) to each offset well, being Well-A, the target well. Track 2 shows the lithology. Track 3 shows the ROPI from Well-A and the hybrid well, which means a composite ROPI from the offset wells considering the well inclination. Track 3 also shows the inclination of Well-A and dot black line. From track 4 to 6, ROPI in blue is shown from the offset wells that were also drilled with 12.25" PDC bit, in black dot line the inclination of each well and in black line the ROPI from the Well-A to compare performance.

Figure 3—ILT from drilling performance analysis considering well inclination and lithology.

This drilling performance analysis is possible when lithology correlation is available. It can also be donde building physic and/or machine learning models able to predict performance. There are numerous papers that have documented how to predict performance building robust machine learning models, but this is out of the scope of this paper.

Figure 4 shows the impact on the ILT after adjusting the DOR operation start and finish times. As it can be noticed on the left plot, there is a different in almost all the activities ILT, but the right plot shows the total times and there is almost not different when adding up all the activities. This is another example of the value of analyzing a break down of the stage instead the performance as a hole.

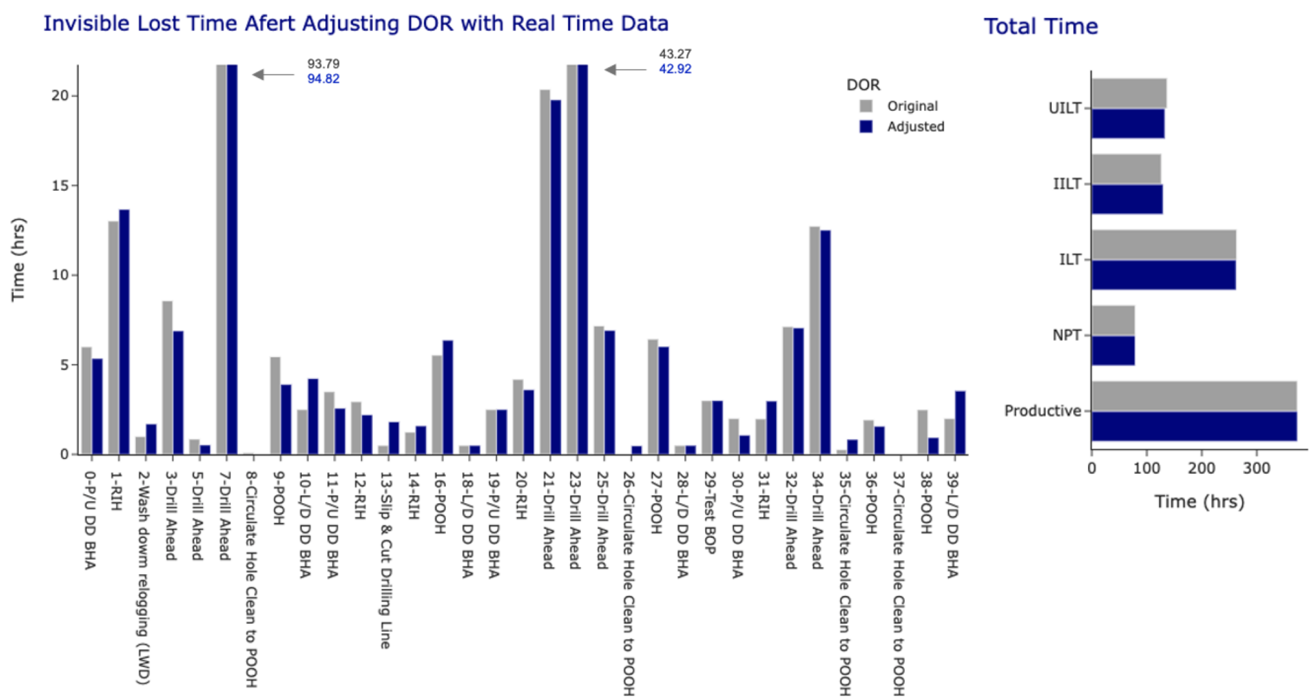


Figure 4—Impact of DOR ajudments after its validation with real time data.

Appendix A shows the table with the TL defined to each activity and the ILT for each version of the DOR, adjusted and original. At this point the ILT does not consider IILT measured by surface sensors. BothDOR versions show the same valuesof IILT from drilling performance ("Drill Ahead" activity) because it is not time dependent. From this point on, the adjusted DOR will be used to the rest of analysis.

Slip-to-slip connection time can be measured with real time data. Figure 5 shows three histograms form the connections database, under the specification mentioned on Table 1. The records were classified as RIH, POOH and drilling as they show different distributions. The TL define for each connection type is shown in red. It is important to point out that when TL for a given operation is defined from surface sensor data, a quality control of the data is needed. Missing data, bad reading, noise, etc., may affect the quality of the data and hence set a bias TL.

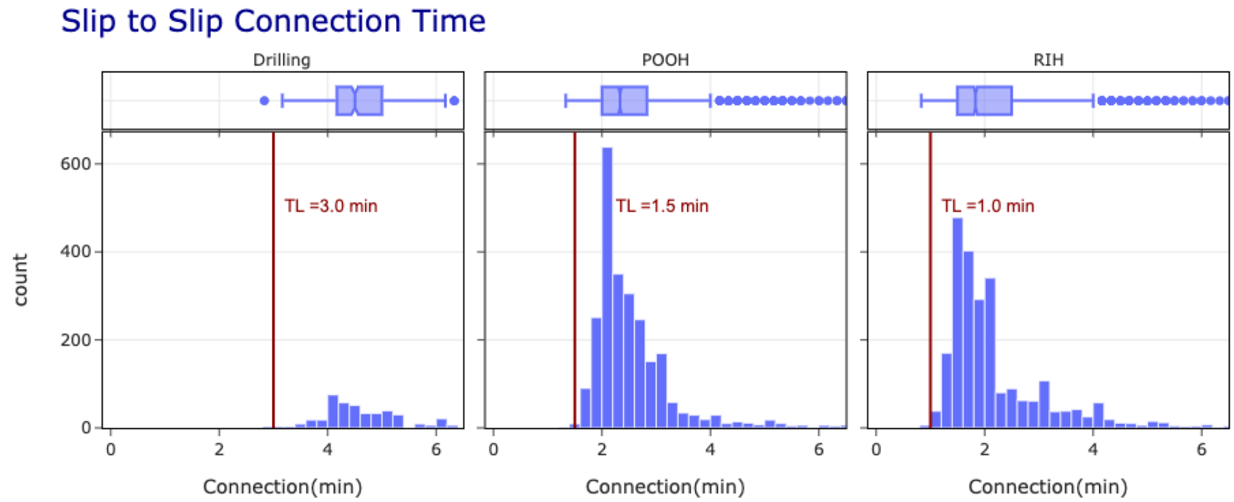
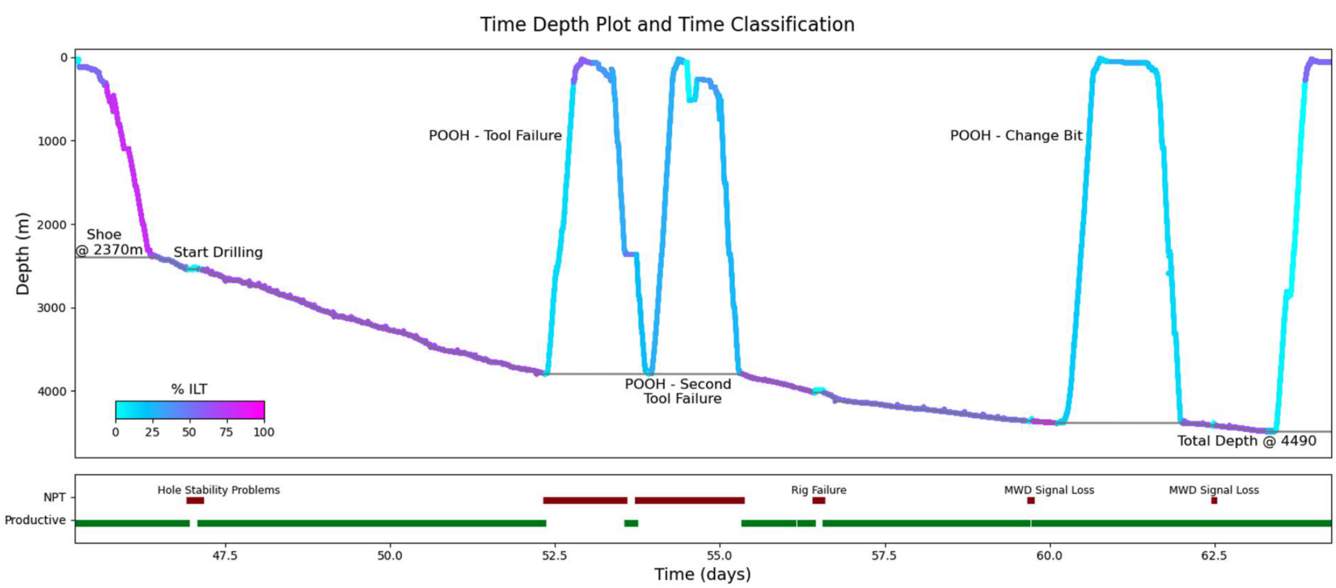


Figure 5—Slip to Slip connection time distribution for drilling, POOH and RIH. TL is also shown for each case.

In this case the data was recorded every 10 seconds, therefore 10 seconds are added to the best record to account for data resolution. The distributions described by RIH and POOH shown it takes less time to connect the pipe while running in hole as the pipe is dried. The records located outside the minimum and maximum of the top box plots, are considered outliers, as they are numerically distant from the rest of the data. Even though, in this case the drilling connection TL was defined by an "outlier" value as it was quality checked and confirmed with the real time data, in order words, there is hard evidence that the slip-to-slip drilling connection can be done in less than 4 minutes under the current conditions.

Figure 6 summarize the drilling of the 12.25" hole section. The first trip to bottom was highly inefficient, as well as the drilling performance in the first 1,000 meters, as shown in Figure 3. Most of the NPT was related to two consecutive tool failures. However, during this time the tripping efficiency improved in relation to the first trip to bottom. The bit was changed in the Eocene as per program.



The top plot shows a Depth versus Time plot with the bit and hole depth curves. Bit depth curved as color coded with a color map to indicate the operation performed the highest ILT. The scale is from zero to 100% of ILT on the activity for both productive and non-productive time. In the bottom a scatter plot indicated what activities were classified as productive or non-productive in the DOR.

Figure 6—Time vs Depth plot that summarize the drilling of the 12.25" hole section

Figure 7 shows the time distribution of the analysis in the conventional productive and NPT classification, in the detailed distribution inspired on Bond et al. (1996) diagram, and in a proposed distribution that includes IILT and UILT. The plots in Figure 7, show that the operation was inefficient as a hole. The TL represents 37% of the total time, while the ILT represent an 49% (for both productive and NPT) of the total time, adding up 9.2 days. Fig 8 identified the fraction of each IILT in a pie chart, where can be noticed that drilling performance (label as ROP) accounts for 46.1% of the ILT, extra reaming and circulation for a 26.1% and 8.6% of the ILT isUILT.

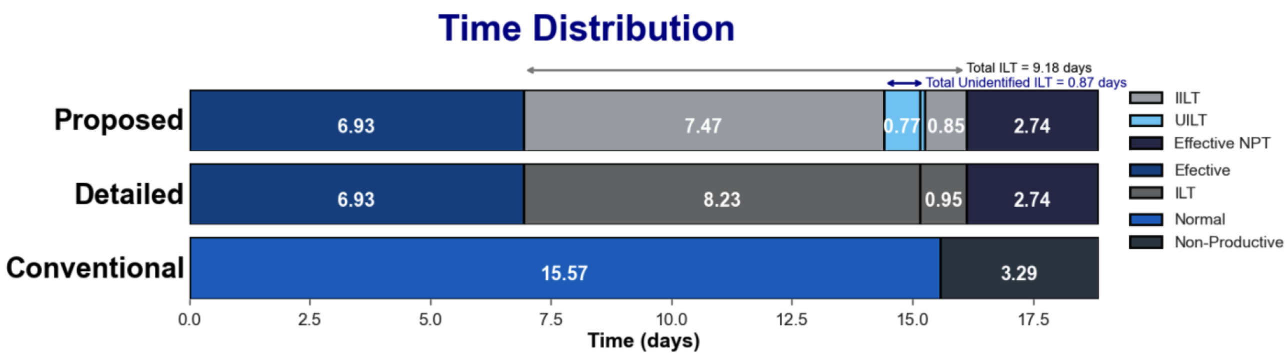


Figure 7—Time distribution considering productive time, NPT and ILT.

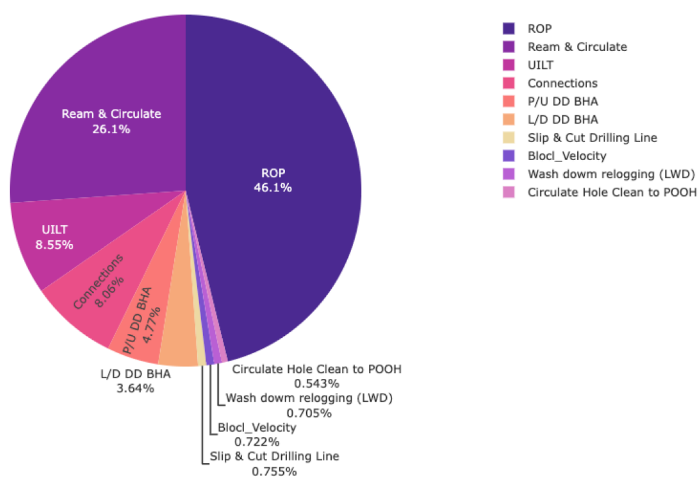


Figure 8—Invisible Lost Time Dristribution.

Notice that productive time ILT represents the 53% of the total productive time, because of the ILT from low rate of penetration (4.63 days). If the portion of drilling performance would not be considered the ILT would represent the 23% of the total productive time, that is very close to 29% of ILT estimated for NPT.

Results and Discussion

The well construction process can be evaluated in a holistic manner considering the performance of different areas of the organization and measuring the impact and correlation on each other through real time data, operation reports and data visualization tools. Applying machine learning algorithms and or physic-based models can enhance the results.

The case of study presented in this paper demonstrated how combining DOR, real time data, and visualization tools, it is possible to identify sources of inefficiency. Applying engineering calculations when defining the TL allows to evaluate the efficiency of the operation under current conditions and the quality of both operational program and DOR.

Some of the causes of the UILT include:

- There is not real time data available it is difficult to know how much ILT correspond to connection, block velocity and reaming/circulating.
- If the quality of the real time data is low, there may be missing data or bad reading that do not allow to identify the ILT mentioned in the previous point.
- The time resolution of the DOR is too high.For example, it is not possible to discriminate operation less than 30 minutes such as taking reduce pressure, inspecting drilling equipment, performing a flow check, etc. The best practice is to assign the actual time to the start and end of each activity reported.
- Combining sub-activities as one activity, for instance, "POOH and L/D BHA". In those cases, DOR will not allow to know the time it took for the trip and the BHA handling.
- No correlation is available to evaluate the drilling performance meter to meter.

Conclusions

- Applying engineering calculations when defining the TL allows to evaluate the efficiency of the operation and the quality of operational program, DOR and other reports.
- The methodology presented on this paper allowsto reduce the bias from setting the TL based on commitments or statistical data from operations that may have been performed under different conditions thanthose defined in the operational program.
- Estimating the ILT during NPT is a best practice that can mitigate the risk of the crew decreasing performance as this time may have been charged to a given service company or well related problems.
- Engineers must use all tools available to identify ILT, even if the TL does not look realistic, as it provides a better detail of where the improvement areas are.
- Applying engineer calculations for defining the TL can be an advantage for exploration wells or operations without enough offset data, as the need of historical data is reduced.
- UILT quantify the ILT that cannot be identify with current resources. Its magnitude will be a reference to evaluate the quality of the the process and decide if it is worth allocating resources to address it.

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Appendix A

The following the table shows the TL defined to each activity and the ILT for each version of the DOR, adjusted and original. In this table IILT does not consider ILT measured by surface sensors.

				Productive		NPT		ILT		IILT		UILT	
Activity	Bit_Depth from(m)	Bit_Depth to(m)	TL	Adjusted	Original	Adjusted	Original	Adjusted	Original	Adjusted	Original	Adjusted	Original
P/U DD BHA	0	288	4.5	9.85	10.5			5.35	6	5.35	6		
RIH	288	2390	3.25	16.15	15.5			12.9	12.25			12.9	12.25
Wash dowm relogging (LWD)	2365	2390	1	2.7	2			1.7	1	1.7	1		
Drill Ahead	2390	2542	5.28	10.82	12.5			5.54	7.22	3.87	3.87	1.67	3.35
Circulate Hole Clean due to Hole Stability	2518	2542				3.98	2.5						
Drill Ahead	2542	2551	0.15	0.67	1			0.52	0.85	0.58	0.58		0.27
Circulate Hole Clean due to Hole Stability	2551	2541				0.62	1						
Drill Ahead	2551	3799	40.06	124.53	123.5			84.47	83.44	54.22	54.22	30.25	29.22
Circulate Hole Clean to POOH	3799	3799	1.9			1	2		0.1				0.1
POOH	3799	290	8.21			9.45	11	1.24	2.79			1.24	2.79
L/D DD BHA	0	0	3			7.23	5.5	4.23	2.5			4.23	2.5
P/U DD BHA	0	175	4.5			7.07	8	2.57	3.5			2.57	3.5
RIH	175	2360	3.36			4.77	5.5	1.41	2.14			1.41	2.14
Slip & Cut Drilling Line	2360	2360	2	3.82	2.5			1.82	0.5	1.82	0.5		
RIH	2360	3799	3.33			4.35	4	1.02	0.67			1.02	0.67
Circulate Before Back on Bottom	3799	3799				1.17	2						
POOH	3799	0	8.83			12.33	11.5	3.5	2.67			3.5	2.67
Troubleshoot DD tools	0	0				1.5	1.5						
L/D DD BHA	0	0	3			3.5	3.5	0.5	0.5			0.5	0.5
P/U DD BHA	0	175	4.5			7	7	2.5	2.5			2.5	2.5
RIH	175	3799	6.68			8.92	9.5	2.24	2.82			2.24	2.82
Drill Ahead	3799	4023	8.16	25.92	26.5			17.76	18.34	16.29	16.29	1.47	2.05
Rig Repair	4000	4023				3.52	2						
Drill Ahead	4023	4367	34.66	74.65	75			39.99	40.34	21.31	21.31	18.68	19.03
Troubleshooting / Signal lost	4367	4339				1.5	1.5						
Drill Ahead	4367	4387	1.83	8.75	9			6.92	7.17	3.63	3.63	3.29	3.54
Circulate Hole Clean to POOH	4387	4387	2.19	2.67	2			0.48		0.48			
POOH	4787	170	11.12	13.58	14			2.46	2.88			2.46	2.88
L/D DD BHA	0		3	3.5	3.5			0.5	0.5	0.5	0.5		
Test BOP	0		8	11	11			3	3	3	3		
P/U DD BHA	0	100	4.5	5.57	6.5			1.07	2	1.07	2		
RIH	100	4387	8.15	9.5	8.5			1.35	0.35			1.35	0.35
Drill Ahead	4387	4418	4.32	10.93	11			6.61	6.68	5.06	5.06	1.55	1.62
Troubleshooting / Signal lost	4387	4418				1	1						
Drill Ahead	4418	4490	6.94	18.78	19			11.84	12.06	6.26	6.26	5.58	5.8
Circulate Hole Clean to POOH	4490	4490	2.24	3.07	2.5			0.83	0.26	0.83	0.26		
POOH	4490	2865	4.41	4.65	5			0.24	0.59			0.24	0.59
Circulate Hole Clean to POOH	2865	2865	1.43	1	1								
POOH	2865	140	6.02	4.95	6.5				0.48				0.48
L/D DD BHA	0	0	3	6.55	5			3.55	2	3.55	2		