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Flat Time Activities Form Catalyst for Performance Optimization

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Abstract

Flat time activities represent a significant portion of drilling operations. In order to improve flat time activities compared to overall drilling operation performance, it is important to share the learnings of a wellbore manufacturing process and realize the importance of focusing on both people and process.

Performance optimization improvement is generally focused on the drilling operation and making hole – bit performance and the BHA. But the same effort that goes into maximizing the rate of penetration is not always evident once casing point is reached.

In fact, case studies have demonstrated that major sources of lost time occur during flat time activities – starting from the trip out of the hole to when the bit is on the bottom. Minimizing the time spent on the critical path is key, and invisible lost time opportunities become more significant.

Process, approach and technology of drilling transitions into a more people-dependent procedure, resulting in the need for performance optimization to be focused on people and process. Methodologies can be applied to highlight best practices, and the results of a variety of drilling operations will be shared with the goal of stimulating discussion around transferring best practices from rig to rig.

Introduction

The purpose of this paper is to stimulate a discussion that promotes performance improvement in flat time operations as equal, or more important, than the optimization of the drilling process. Drilling professionals are experts at maximizing the ROP from a particular bit and BHA combination. They know how to select the optimum well design with drilling performance in mind. Generally, the Operator is in complete control of drilled sections; however, once casing point is reached, there is more reliance on the expertise of the Drilling Contractor and the Casing and Cementing crews. As operations become more mature, the impact of flat time increases and the need to investigate how to minimize critical path activities is the leading component of a performance driven process. At this point, flat time will be defined as the time between the bit reaching TD for a section and the commencement of drilling operations on the next section. In other words, the operational sequence will include the following as a minimum:

- Trip out from TD, including washing, reaming and circulating
- BHA handling and lay down; MWD download may be a significant part of this
- Casing operations
- Cementing operations, including casing pressure test
- BOP installation and testing
- Picking up a new BHA; testing MWD tools and other downhole components
- RIH and drill out of the casing shoe
- Formation integrity or leak-off test may also be included (depending on Operator preferences).

The paper will explore how performance can be managed through a focus on manufacturing wellbores. This is an often used term in the industry, but how can it be applied in practice? Technology can help in many areas[1]; however, performance is generally driven by people and by process, particularly when discussing activities such as casing and cementing.

The concept of manufacturing wellbores is not new; nevertheless it has taken on a new meaning with the advent of the North American shale operations. In fact, the techniques have been applied globally for many years. Operators understand that repeatability of operations is key to success, yet repeatability on its own will not lead to performance improvement, measured by days on the well.

Operators want to know how current well construction performance compares to past performance and why.

1. Why performance is changing?
2. How the best historical safety and cost performance can be repeated and further improved?
3. The potential value of implementing improved practices?
4. How to prevent high NPT events and accidents from occurring or reoccurring?
5. How to predict the time and cost of future wells for making investment decisions?

6. How each rig is performing in real time to optimize daily decision-making?
7. Which practices/rigs/teams consistently produce the highest performance?
8. How to help all people/teams/rigs improve their performance.

The problem Operators face in trying to satisfy the above eight points, is that historical drilling data may be complex and difficult to analyze.

1. Every well is unique.
2. Reporting data is imperfect and inconsistent.
3. Comparison of section times is difficult due to varying casing points.
4. As the amount of data increases, so does the level of complexity, and the difficulty of executing analysis with spreadsheets or databases.
5. There may not be sufficient consistent data to build a best composite curve, or to define an ideal best well.

Many of the case studies available focus on the use of a best composite well time. The Drilling Engineer is challenged to present a plan that shows a closing of the gap between current performance and the best composite time. The drill crews are challenged to execute the plan and to deliver those time savings. This can be very successful in a fixed campaign.

The weakness of a best composite (or best in class) approach is that the measures are usually based on that Operator's past performance and thus the Operator is effectively looking at performance from an internal point of view. A far better target is to compare against the best well in the basin, using external benchmarking, such as Rushmore Reviews. The requirement is to be sure that the drilling plans represent the required quartile performance, when compared to peer groups. Certainly, internal performance can improve substantially, but how does the Engineer know they are not planning a third quartile well, even if it is the best drilled by that Operator?

It is beyond the scope of this paper to consider which targets make the most sense in a drilling campaign. The reader is referred to Peter Rushmore's provocative article on NPT for more information on this topic[2].

For the rest of this paper an assumption will be made that the initial drilling plan, or program, represents the best that can be achieved with the available technology, people and process. Further, it is assumed that external benchmarking has been utilized in developing the best possible plan.

The question therefore, is how to execute that plan in a safe and efficient manner, whilst at the same time delivering savings from both drilling and flat time operations.

The Complexity of Flat Time Operations

Whilst the analysis of flat time should be relatively straightforward, there are a number of human and procedural factors that influence the success or otherwise of the operations involved. As we have already noted, flat time consists of a number of discrete processes, many of which require manual intervention especially with onshore operations.

- Flat time often has multiple service companies involved that are interfacing with the Drilling Contractor, which may lead to technical interface issues.
- Communication interface issues often arise, due to inadequate preparation and personnel focused solely on their particular task, equipment or operation.
- Procedural interface issues may arise where planning is not conducted in depth and personnel assume they understand how the work place is organized.
- Planning issues can be magnified where personnel often show up just in time, which means planning and preparation may be on critical path and thus rushed. There is also insufficient time to test equipment and ensure integrity of the same.
- Learning issues (continuous improvement opportunities) as the service personnel are usually not assigned to specific rigs or crews. There is a risk that mistakes may be repeated, resulting in NPT. Relationship and team building may also be disadvantaged.
- Flat time often does not have vehicles and tools to easily analyze each discreet operation for improvement and learning (although techniques do exist, many operations do not employ them), whereas software exists to time connection times and record drilling parameters.
- Flat time accounts for more ILT because of the complexity involved and due to the just in time nature of some operations.

The key to any successful operation is taking the time to plan effectively, making sure everyone understands their role and how they interface with the other members of the rig team. Similarly, at the end of the job, it is important to debrief, conduct an after action review and ensure the learning is gathered before everyone leaves the job site, something that is often easier said than done.

Wellbore Manufacturing Model

There are many different approaches to performance optimization, from the Technical Limit type analysis to more of a Right First Time approach. Each has its own merits and each has applicability, depending on the well type to be delivered. The onshore environment is unique, in that many wells are iterations of the same design with simplified casing and straightforward completions. Thus it is possible to implement a manufacturing approach to well construction, since tasks are comparable and repeatable.

Simply stated, Wellbore Manufacturing refers to multiple rigs in the same field or basin, drilling wells of a similar design. The rigs may be from different contractors, but the wells are all substantially similar. The manufacturing approach allows an Operator to take all the successful solutions that are out there, find the best approach and see who is best at what task. Imagine five (5) rigs drilling in the same field, each with two Company Men. Immediately there are ten possible resolutions to the same issue.

The real challenge is to pull together the various Company Men and Rig Contractors and convince them of the desirability to share information. To achieve the best results a collaborative approach is needed, one which creates consensus on the best approach, gets the best knowledge in the right place at the right time and recognizes it is not just about data. The data is required to discover the field best practices, but the power is in the way in which the best practices are coached to and implemented by, the rig teams.

At this stage it is important to understand how knowledge is derived, by first reviewing the difference between the terms data, information and knowledge. Data is raw facts and figures, while information consists of patterns of data. Knowledge, although derived from information, is richer and more meaningful than information and is created through an interactive social process[3]. Explicit and Tacit are the two categories of knowledge, of which, explicit knowledge refers to documented information such as processes, methodologies, services etc. and tacit knowledge refers to people's knowledge such as their experiences, ideas, relationships, skills etc[4].

Why is this important? Those of us in oil and gas tend to have a competitive nature. Rig Contractors and Operators alike tend to shield their success from their competitors and focus on creating that competitive edge. Knowledge tends to explicit when necessary – safety systems, BOP test procedures, drilling policies for example. However, much knowledge is tacit, in that it remains with the individual rig teams and is much harder to document.

Wellbore Manufacturing[5] aims to break down those barriers between different rig teams working for the same Operator. The goal is to discover those best practices which can then be documented and implemented across all rigs. This is where the data becomes so important. Presented in a meaningful way, it is possible to see which rigs perform which tasks best. Consider the two examples presented.

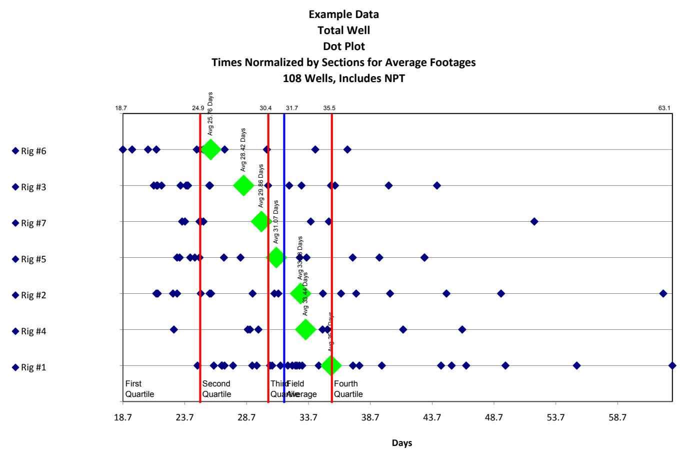

Figure 1: Example Total Well Dot Plot

The above chart (figure 1) shows seven (7) rigs ranked by total time to drill similar wells. The blue diamonds are the individual well times and the green diamond represents the average. The red vertical lines delineate the quartile rankings and the blue vertical line is the field average. Clearly Rig 6 is the leader and the rig around which the best practices might be built. Now, even the best rig can improve, as the chart below shows.

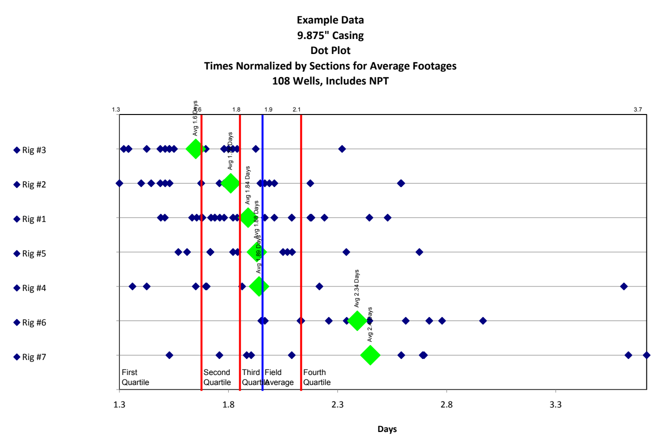

Figure 2: Example 9 5/8" Casing Dot Plot

This chart (figure 2) looks purely at the 9 5/8" casing running and a total of 108 wells have been analyzed. Rig 6 is now seen to be fourth quartile at this specific task. Clearly, there is room for improvement; in this case Rig 6's average casing times is 0.7 days behind Rig 3's average.

The example above demonstrates the issue with just looking at the total well time. To achieve the best manufacturing time it is necessary to examine each specific task in detail, identify who performed best and uncover the when, where and how behind the operation. In a multi-rig project, each rig may make some contribution to the best practice well. Remember it is not just about the rig with the best overall well time. That rig may drill fast, but lag in flat time.

Uncovering the best practice is just a start. The next task is to discuss in a productive way, how each rig can adopt the same processes. This phase requires a focus on people and process, in an open manner, through coaching and collaboration. The discussion may lead to further challenge and the refinement of the best practice.

The end product will be an operational best practice manual, which is a live document, to be updated after each task, or each well (figure 3).

Operational Best Practices **Nipple Down Riser**
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3.0 Nipple Down Riser

Offline Preparations

- Review JSA and update if necessary.
- Review previous lessons learned for Nippling down riser.
- Hold a planning review to ensure best practices remain updated.

Note: Tools need to be gathered and staged for this job prior to pulling out of the hole with BHA.

TOOLS NEEDED FOR THE TASK	
4-Way sling with shackles and keepers	Pipe wrench to release turn buckles
Crescent wrench	Cellar pump to drain cellar
High pressure grease gun	Saw dust and pallets
Pressure release fitting	Sledge hammer
Confined space permit	2 ¼ socket for rotating head
1 13/16 socket for flow line to rotating head	

INDIVIDUAL TASKS	
Man 1	Gather the tools need and stage them close by
Man 2	Rig down flow line.
Man 3	Centralize the riser with chain falls.
Man 4	Stage saw dust and pallets needed for cellar.
Man 5	Stage cellar pump in the cellar deck.

- Remove bushing from rig floor.
- Lower two tuggers through rig floor and connect to rotating head
- Set the rotating head on the BOP deck.
- Use 1 13/16 socket to detach flow line from housing.
- Install riser lifting cap on the riser joint using 4 bolts.
- Install lifting plug (hammer tight).
- Install gate around the hole on the table.
- Hook up two winches to lift plug (use shackles).
- Split apart pollution pan and tie back out of the way.
- De-energize the riser joint from the conductor and lift up to perform rough cut on casing.
- Centralize the riser with two or three chain falls and straps before cutting the casing.**(Fig.1)**
- Tie onto the casing with two or four part sling using tugger lines.**(Fig.2)**
- Pick up riser high enough to skid.**(Fig.3)**
- Cut the casing and lay it down with tugger lines.
- Tie onto the V-Door and lift it up, if rig skid is the next operation.

Fig. 1 – Centralizing the riser

Fig. 2 – Tie onto the casing

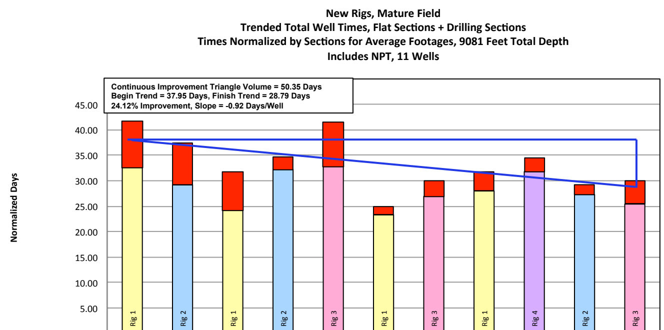
Fig. 3 – Lift up the riser

Figure 3: Example Operational Best Practice Document

Case Study – Middle East

An Operator in The Middle East agreed to a turnkey drilling program in a mature field. Offset well information provided a good basis for well planning, but there was a great deal of variability in the data. The team selected a modified wellbore manufacturing approach with Performance Coaches in the field, driving the implementation of best practice. The data analysis provided the team with a target, however the focus was on capturing operational best practice and sharing that between new rigs as they entered the field. Thus the operational learning was distributed between rigs, ensuring that the knowledge gained became more viral and less tribal.

The results show that the overall well times improved as more wells were drilled across the field (figure 4). The wells compared in this study are similar in nature and not prone to significant geological variability. The NPT has been included.

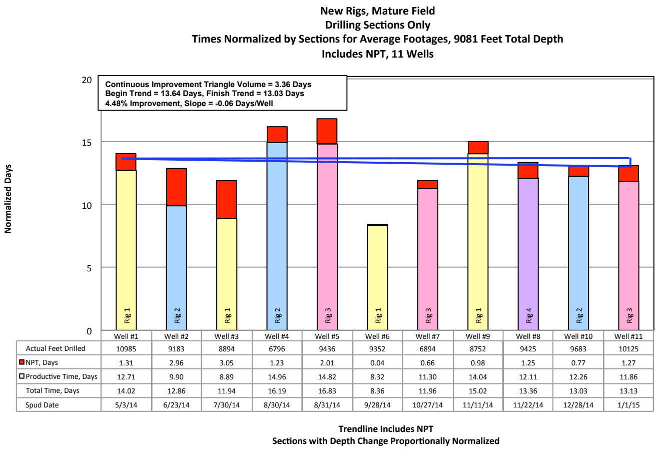


	Well #1	Well #2	Well #3	Well #4	Well #5	Well #6	Well #7	Well #9	Well #8	Well #10	Well #11
Actual Feet Drilled	10985	9183	8894	6796	9436	9352	6894	8752	9425	9683	10125
NPT, Days	9.04	8.21	7.67	2.44	8.72	1.56	2.97	3.70	2.75	1.92	4.54
Productive Time, Days	32.61	29.17	24.14	32.23	32.78	23.28	26.93	27.98	31.78	27.27	25.41
Total Time, Days	41.65	37.38	31.81	34.67	41.50	24.84	29.89	31.68	34.53	29.19	29.95
Spud Date	5/3/14	6/23/14	7/30/14	8/30/14	8/31/14	9/28/14	10/27/14	11/11/14	11/22/14	12/28/14	1/1/15

Figure 4: Total Well Time Improvement (Middle East)

The continuous improvement triangle illustrates a significant learning curve, even as new rigs enter the field (none of the four (4) rigs had drilled in the region previously). A 24.12% improvement in well times is evident.

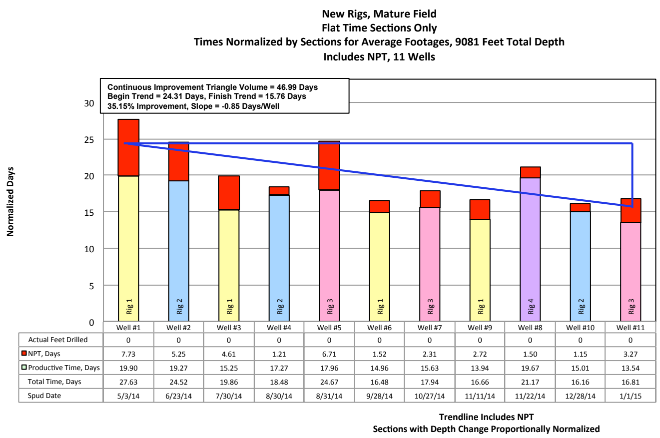
The chart below (figure 5) shows the drilling time only broken out. It is immediately evident that the drilling performance has only improved 4.48%; despite the manufacturing approach ensuring operational best practice has been shared across the rigs. In other words the drilling procedures are now mature and producing small performance gains. An additional gain may be possible through technology changes; however, there are limitations on both contracts and logistics in the region.



	Well #1	Well #2	Well #3	Well #4	Well #5	Well #6	Well #7	Well #9	Well #8	Well #10	Well #11
	Rig 1	Rig 2	Rig 1	Rig 2	Rig 3	Rig 1	Rig 3	Rig 1	Rig 4	Rig 2	Rig 3
Actual Feet Drilled	10985	9183	8894	6796	9436	9352	6894	8752	9425	9683	10125
NPT, Days	1.31	2.96	3.05	1.23	2.01	0.04	0.66	0.98	1.25	0.77	1.27
Productive Time, Days	12.71	9.90	8.89	14.96	14.82	8.32	11.30	14.04	12.11	12.26	11.86
Total Time, Days	14.02	12.86	11.94	16.19	16.83	8.36	11.96	15.02	13.36	13.03	13.13
Spud Date	5/3/14	6/23/14	7/30/14	8/30/14	8/31/14	9/28/14	10/27/14	11/11/14	11/22/14	12/28/14	1/1/15

Figure 5: Drilling Time Improvement (Middle East)

Figure 6 shows the performance gains from flat time operations. Here the indicated improvement is 35.15%. Crew familiarity is obviously a factor, but the main component is the best practice approach and the documenting of this for all the flat time operations.



	Well #1	Well #2	Well #3	Well #4	Well #5	Well #6	Well #7	Well #9	Well #8	Well #10	Well #11
	Rig 1	Rig 2	Rig 1	Rig 2	Rig 3	Rig 1	Rig 3	Rig 1	Rig 4	Rig 2	Rig 3
Actual Feet Drilled	0	0	0	0	0	0	0	0	0	0	0
NPT, Days	7.73	5.25	4.61	1.21	6.71	1.52	2.31	2.72	1.50	1.15	3.27
Productive Time, Days	19.90	19.27	15.25	17.27	17.96	14.96	15.63	13.94	19.67	15.01	13.54
Total Time, Days	27.63	24.52	19.86	18.48	24.67	16.48	17.94	16.66	21.17	16.16	16.81
Spud Date	5/3/14	6/23/14	7/30/14	8/30/14	8/31/14	9/28/14	10/27/14	11/11/14	11/22/14	12/28/14	1/1/15

Figure 6: Flat Time Improvement (Middle East)

In other words, the focus on people and process demonstrates the performance gains that can be achieved, simply by implementing best practice across all rigs and all crews. Documenting this ensures that the procedures are the same for each crew, ensuring repeatability.

After each section an After Action Review is held in order to capture what has gone well and what needs to be avoided. The best practice is then updated to reflect the latest knowledge. Each rig receives an update and can plan accordingly.

This example shows the performance gains that are possible, even when the drilling technology is fixed, due to contract and logistical issues.

Case Study – Kazakhstan

In this study the Operator was drilling with three (3) rigs in a mature Soviet era basin. The early wells were problematic as the operator was gaining experience in the region. A Technical Limit type approach was undertaken in order to develop the performance culture. The results over a two year period were excellent, as shown in figure 7.

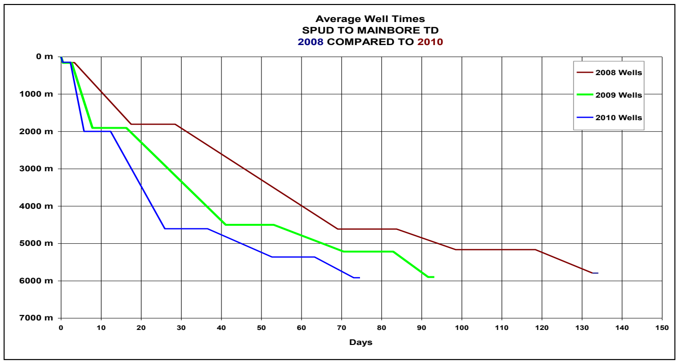


Figure 7: Average Well Time Improvement (Kazakhstan)

Although this did not use the Wellbore Manufacturing approach, certain aspects of that work were utilized, especially the documenting of best practice, in this case through the drilling program. It is readily apparent that the gains made on the wells came in a large part from intermediate hole drilling improvements and also from a focus on flat times. In fact, the latter would have improved further and were interrupted on later wells by a technology trial, designed to improve the safety of the casing running operations.

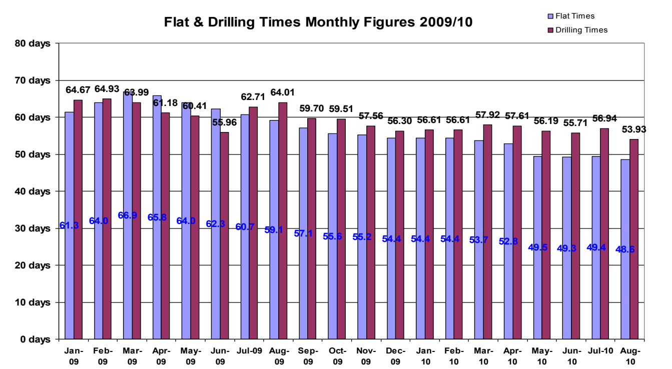


Figure 8: Flat and Drilling Times (Kazakhstan 2009-2010)

The chart above (figure 8) illustrates the reduction in both drilling and flat times. In the case of drilling a 17% reduction in time can be seen, with a corresponding 24% fall in flat times.

Case Studies - US Onshore

The data available for the US Onshore shows some interesting trends. Overall well times have reduced significantly in all three primary areas of this study – Eagle Ford, Bakken and Utica. Much of this is due to changes in drilling techniques, leading to increased footage per simplified casing designs day and the use of pad drilling, which eliminates major rig moves between wells. Operators and Drilling contractors alike are to be congratulated on the efficiency improvements in these key areas.

In order to examine the learning that has taken place, the drilling time has been removed from the charts below and flat time only remains. It should be noted that the rig set in each of the examples is consistent and long term. Therefore the opportunity for knowledge transfer is apparent. The analysis will show that knowledge does remain tacit in many cases, although this is by no means an over-arching statement.

Eagle Ford

Three different Eagle Ford fields have been examined for this study. The Field 1 dataset consists of 145 wells. Field 2 has 72 wells and Field 3 consists of 84 wells.

The three Eagle Ford charts show differing trends. Field Number 1 demonstrates a 10.26% decrease in flat time, almost all of it from the surface casing and the tree installation (figure 9). The N/U of the BOP and lateral casing each show a small, but not significant, improvement of between 2 and 3%.

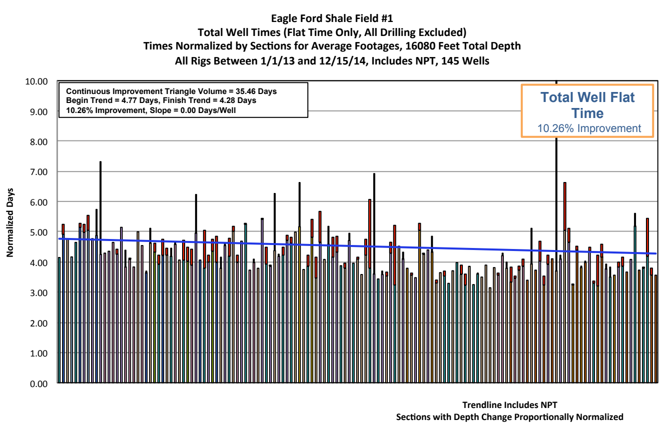


Figure 9: Eagle Ford Shale Flat Times – Field 1

Field Number 2 (figure 10) shows a 29.2% overall improvement in flat time, with improvements across all sections, except for the tree installation.

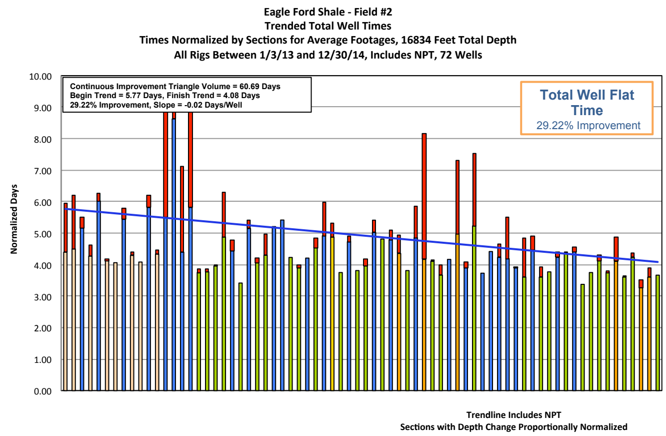


Figure 10: Eagle Ford Shale Flat Times – Field 2

Field Number 3 shows a 5.3% improvement overall. However there is a 30% increase in N/U BOP times and a similar increase in tree installation times (figure 11). Any flat time performance increase comes from the surface casing and the lateral casing.

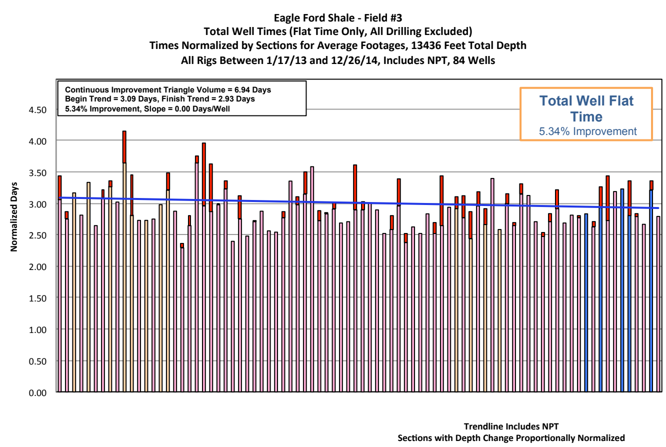


Figure 11: Eagle Ford Shale Flat Times – Field 3

As might be expected in any drilling operation, the dissemination of best practice to the field teams is primarily through the drilling program and the engineering input. Given the number of wells in each dataset it is logical to assume a significant learning curve will be in place. That is not the case in Field 1 and Field 3. The conclusion therefore is that the knowledge relating to the flat time operations is more tacit in nature and not explicit, except where captured by the drilling program or standard operating procedures. There is probably some competition between the individual rig teams and between engineering teams, which may inhibit knowledge transfer, particularly between fields. That said the charts illustrate that there is scope for improvement and a focus on flat time will lead to lower overall well construction times.

Bakken

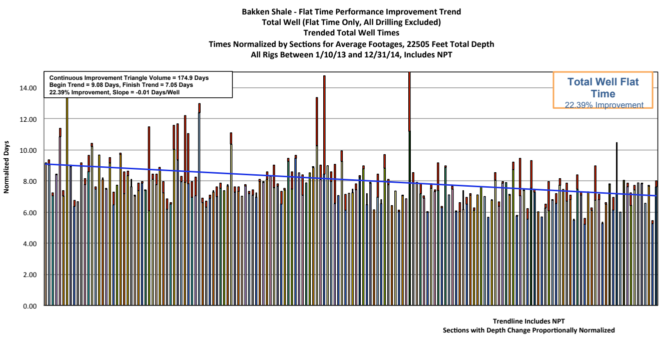


Figure 12: Bakken Shale Flat Times

The Bakken data set consists of 441 wells, demonstrating an overall flat time improvement of 22.39% (figure 12). A more detailed analysis shows significant improvement in most areas under consideration, in particular those associated with tripping the drillstring, for example POOH with liner running tool, RIH and POOH with the BHA. Here the performance improvement ranges between 23% and 39%. The inference is that the drill crews know their role, learning is more explicit and best practice is readily applied towards the handling of the drillstring.

However, the more traditional flat time activities, such as N/U BOP, run and cement casing and RIH frac string, show less significant improvement, ranging between 9% and 14%. Without a more detailed analysis it is difficult to say precisely why this is. However, it does appear to be influenced by human factors (less planning, less time to prepare for the job, less learning), as opposed to procedural issues. Once again the knowledge sharing is not as well developed and is tacit in nature. In other words, procedures and best practice are less well developed.

Utica

The Utica analysis is based on a dataset of 53 wells. Overall, a 36.27% flat time performance improvement is apparent (figure 13). The interesting factor for the Utica data is that the highest impact on flat time occurs with the surface and intermediate casing operations and with the installation of the BOPs. Performance is markedly worse during the operations to run and cement the production casing, as well as during tripping.

The gains made during the upper part of the hole are in the range of 23% to 51%. However, during the production hole operations the flat time is flat, or negative, 0% to -31%. Clearly, more analysis is required to determine the geological and other effects that may influence this part of the well construction process.

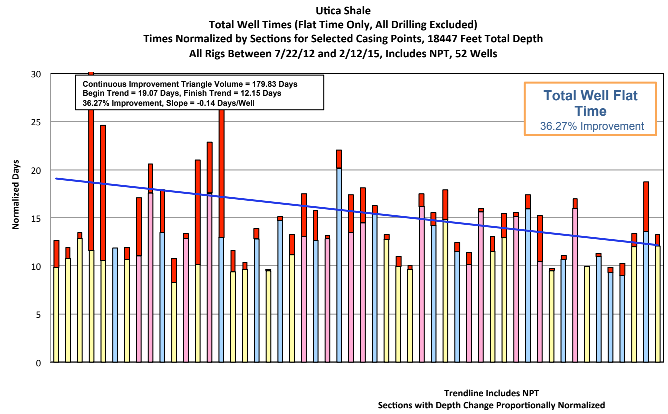


Figure 13: Utica Shale Flat Times

US Onshore Observations

There is evidence that the US onshore operations demonstrate opportunities for further performance improvement from a focus on flat time operations. This is particularly true of those events that are repetitive in nature and not necessarily under the control of the Engineers – BOP N/U, casing and cementing operations, production hole operations, including the tree installation. Major advances in drilling techniques are recorded elsewhere[6]. Flat time operational best practices should be developed, shared across all rigs and continuously improved.

Conclusions

This paper set out to illustrate the importance of flat time when considering performance improvement across wells that are essentially the same. The manufacturing model works well in such environments. There is a tendency to focus on the traditional drilling metrics, such as feet per day, ROP, cost per foot, days per 1000ft and total days on well. All of these have validity given the right context. However, none of them specifically address the flat time and the impact this can have on operations globally.

A specific Wellbore Manufacturing model has been presented, one that requires collaboration to be truly successful. People and process are vitally important to performance improvement. The author suggests that the focus on drilling (making hole) will deliver incremental improvements as the learning curve flattens out. As operations mature, a focus on flat time, will deliver further enhancements to the overall well construction curve, potentially much greater than continuing the attention on drilling time alone.

Acknowledgments

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Nomenclature

BHA = *Bottomhole assembly*
TD = *Total Depth*
MWD = *Measurement While Drilling*
RIH = *Run in Hole*
NPT = *Non Productive Time*
ILT = *Invisible Lost Time*
BOP = *Blow Out Preventer*
N/U = *Nipple Up*
POOH = *Pull Out Of Hole*
ROP = *Rate of Penetration*

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