WELL COST OPTIMISATION

in the

US$ 30 per bbl. Market

May 2020

iWells Management Consultancy:
iWells, Dubai, UAE is a specialized management consultancy company in the upstream oil and gas industry. Our core expertise is on three major disciplines (1) all subsurface work including but not limited to development of full FDP, evaluating asset potential and WRFM and (2) management consultants for drilling of oil and gas wells in areas of establishing integrated project management concepts, well cost optimization, technical and operational integrity, effective drilling execution strategies, risk mitigation and prevention, integration of multi-disciplined approach to deliver complex projects through a defined well delivery process etc. and (3) developing high end software models for the drilling of oil and gas wells, coaching and developing innovative solutions to serve the drilling industry through novel concepts and platforms.

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1.0 The Paradox of Well Cost Optimization

From 2003 until 2015, the average day rate of an offshore rig rose by 100-150% and that of the services between 30-70%. Due to high crude oil price, the oil and gas companies were able to afford such increased cost of services without much focus on cost optimization or attempts to reduce the cost of rig and services. Due to lower focus on optimization and efficiency, lack of quality engineering and process driven models, inadequate performance values and improperly managed learning curves, the well costs also rose by at least 50% and in some cases 100% during this period as compared to the costs of 2003-2007. However, except for few, majority of the oil and gas companies accepted the higher costs of the rig, services and well costs as the cost of production was much lower than the price of oil.

After a short period of low oil prices in 2008-2009 during the subprime induced global economic meltdown, the next 5-6 years until late 2015 saw an unprecedented and exceptional oil price run at US$ 100+ per bbl. which provided high returns for oil producers and investors. The high margin of returns allowed investors and operators to expand the drilling activities beyond a scale that was not seen in the industry until then which created a high demand for rigs, services, equipment and manpower resulting in very high costs for contracting them.

In this scenario which was primarily driven by high returns of profit, cost optimization and service quality had only a marginal role in the industry. Only a few prudent oil and gas companies seriously followed a working culture that applied cost optimization strategies and service quality models while others kept drilling to increase production oblivious to the increasing well costs even with compromised quality and well objectives. Due to the shortage of truly skilled resources, the high demand allowed low calibre and undeserving people to get promoted to critical decision making positions that further reduced the service quality and well delivery standards.

After nearly a decade of high oil prices of $ 80-100+ per bbl., except for a short duration in 2008-2009, the industry experienced a shock triggered by the subprime induced global economic meltdown that dropped the oil prices drastically to fall below US$ 35 per bbl. in early 2016. This forced a paradigm shift to the industry which saw the prices of rig and services dropping by more than 30-70% and well cost optimization gaining predominance which was ignored at the $100 oil prices. Operators were able to drill the wells at much cheaper costs than the previous decade.

Due to the efforts of few oil exporting nations led by Saudi Arabia, the OPEC + non-OPEC Producers agreed for a production cut of 1.2-1.6 million barrels per day in early 2017 that lasted for 3 years until March 2020. Due to this and several other reasons, the oil price slowly moved up and stayed between US$ 50-65 per bbl. for nearly 3 years from early 2017. Due to this, although some stability was achieved and the volatility was reduced, the industry was cautious and hence investments to the upstream oil and gas industry were restricted or highly controlled. The industry was slowly crawling back to growth.

However, in February 2020, the global demand for oil started to drop due to the impact of the COVID-19 pandemic and by March 2020 the demand for oil dropped by almost 10%+ or nearly 10 million barrels per day. This started to increase the surplus of oil in the market. Coincidentally the agreement for the 1.6 million barrels per day production cut that started in 2017 was ending on 31st March 2020. So OPEC and non-OPEC members met in the first week of March 2020 to discuss on extending the production cut. Saudi Arabia proposed an increased production cut to combat the effects of COVID-19 on the economy by another 1.5 million barrels per day in addition to the already agreed cut which was in existence for nearly three years. The talks failed which resulted in an unprecedented price war and fight for market share led by Saudi Arabia and Russia. This resulted in a huge drop in oil prices from around $60 per bbl. to less than US$ 20/bbl. by April 2020. At the time of writing this report, the oil prices has slowly crawled back up to around US$ 30 per bbl.

The predictions for 2020-2021 is still conservative as the duration of the impact of COVID-19 pandemic on global economy is still uncertain. Some predictions indicate that oil prices may reach US$ 45 per bbl. mark around end 2020 or second half of 2021. However, predictions and trends in the oil business have failed in the past as oil is not just about a demand-supply model like any other commodity. Hence, despite the promise of oil prices rising back to US$ 45-50 per bbl. level in the next 9-12 months, the industry will not return back to normal operating mode in that time frame.

Oil and Gas Companies are the hardest hit due to the fall in the oil prices to the current levels. With significant drop in their revenues, cash flow and ROI and the impact of COVID-19 on execution of projects, many projects are already getting suspended or dropped and investment decisions are delayed indefinitely. Similar to what happened in 2016, there will a fundamental shift from volume to value as many Operators will focus on increasing production efficiency to existing wells rather than drilling new wells.

However, several Operators may be forced continue drilling new wells to achieve commercial oil production in ongoing development projects which cannot be stopped due to the high CAPEX that is already spent for infrastructure development. Other operators may need to drill new wells to sustain volume due to declining production levels, need of cash flow to manage debts/other financial commitments and to comply with minimum work programme commitments to the Governments to avoid penalties. Some Operators may decide to continue to drill new development wells to take advantage of the market conditions to drill the wells at significantly lower well costs with a choice to hold the production until oil prices turn back. Few others, especially oil importing countries, may take advantage of the low cost environment to drill exploratory wells for new commercial discoveries. Although rare, few oil and gas companies have to continue drilling due to committed minimum contract duration for the rig and services to avoid significant penalty for early termination.

The drilling rig contractors, drilling services companies, equipment manufacturers and suppliers enjoyed a long comfortable high cost oil environment for almost 12 years from 2004 to 2015. The oil shock of 2015 forced a paradigm shift to the way these companies operated and brought their rates drastically down by 30-70% (in some cases even by 100%). Despite the oil prices hovering around US$ 50-65 per bbl. range in last three years from 2017 to 2020, it did not provide lot of confidence to the service sector to indulge in major investments and growth, except probably a few. Instead of growth, sustainment was the major goal for the service sector as the fear of another sudden drop in industry activity lingered as a possibility due to the continuing volatility of global economics. Hence, the service companies followed a cautious approach and strived to sustain the business and to hold the highly trained, skilled and quality personnel despite costs at new lows that they have not experienced for almost a decade.

However, by 2016, the industry model had changed significantly with respect to statutory compliance. Post 2015-2016 oil price crisis, the investors model also became highly controlled with clear deliverables, frequent reporting and sometimes direct monitoring of progress. Hence, both the operators and service companies were unable to compromise on technical and operational performance, must comply with safety, statutory, environment and regulatory standards and where applicable host communities/local content requirements.

Well cost optimization and cost reduction strategies developed a new meaning in the drilling industry with the inclusion of well delivery rather than drilling and handing over a well. Today, the well delivery model has a list expanded deliverables. The oil and gas companies and service providers had to work on a paradigm shift to their business and operating model to effectively manage the massive shifts in global market conditions (cannot be at local level), reduced funding and cash flow levels and potential lack of quality due to forced low cost operations. All these can be achieved only by positive engagement to achieve innovative contract models, development and adoption of efficient technology and excellence in execution. By applying modern concepts of well delivery, both the operators and service providers jointly will be able to turn the market complexity and uncertainty into an opportunity for growth with the support of the Government Regulatory Bodies.

The oil shock of 2020 will demand further enhancement of the well delivery optimization model that will include not only cost reduction but excellence in execution for delivering all the objectives without a compromise.

2.0 Well Cost Optimization in Today's US$ 30 bbl. Market

Whatever the reason for drilling new wells, the ultimate goal for every Operator in the US$ 30/bbl. world is to drill and complete the wells at a low cost. However, if the low cost is not defined appropriately, Operators run the risk of drilling cheap wells of low quality which would become expensive in the long run. The right definition of a low cost well is "to drill and complete the wells at the lowest cost possible without compromising safety, environment, objectives and quality". This definition is termed as "Effective Cost of Well" or "ECW". The ECW translates in to the most practical and optimal cost of a well that can be achieved without compromising the factors listed above.

The ECW is not based on Technical Limit Drilling (TLD). While the TLD, that was introduced in the late 1990s allowed the reduction of time (days) in a well, it also had the potential to compromise quality. Industry had learnt through hard way that well optimization is not based only on reducing time and corresponding cost and that such approach invariably leads to compromises and become more expensive in the long run.

ECW is critical to understand as despite the oil prices falling by more than 40-50% from its level of $60 per bbl. to $30 today, cost of (1) rig and services, (2) steel for tubulars, (3) fuel, (4) products and consumable and (5) qualified manpower cannot drop to the same level. They don't have a linear relationship with the oil prices movement.

Reducing the well costs in 2016 when the oil prices fell down $ 100+ to $ 30-40 was easier as there were a lot of low hanging fruits that were left un-plucked for nearly a decade due to high oil prices. No one really bothered about optimization of well costs despite the word "optimization" was used wildly. In fact Supply Chain Management was very ineffective at $ 100 per bbl. oil which allowed the prices of rig and services to sky rocket for nearly a decade pushing the cost of the wells at least by 25-70% depending on the drilling environment. The oil shock of 2016 brought the correction that was badly needed in the industry and to bring some sense to the costs of the rig, services, consultants and well construction. The prices of the rig and services in 2016 dropped to a low that was not seen for more than a decade.

However, having learnt the lessons in 2016, the current oil shock scenario in 2020 cannot bring another major shift to the industry especially to the service sector as many of them are still struggling at lower prices established in 2016 and tough competition.

So today well cost reduction requires a more innovative approach than what was followed in 2016 which mainly consisted of:

- *(a) supply chain negotiations to bring prices down by 25-50%;*
- *(b) performance based contracts to some extent;*
- *(c) use of quality resources who were available cheaper than the previous decade;*
- *(d) operational improvements like reducing non-productive time and application of improved drilling practices which were ignored earlier due to low demand on performance;*
- *(e) improving efficiency by focusing on selected projects only;*
- *(f) managing performance by monitoring, evaluating and improving real time;*

The above approach alone is no longer feasible in today's world as the cost of the rig and services cannot be discounted from the current levels beyond a limit because they had already reached a benchmark level in 2016 itself. Hence, the price reduction for rig and services in 2020 under the current scenario of $ 30/bbl. oil will be limited most likely between 5-20%.

Hence, well cost optimization in today's US$ 30/bbl. world require an expanded optimization and tighter adherence to achieve effectiveness:

(1) Most critical is to achieve sustainable cost reductions of rig, services and tangibles to the lowest practical level without compromising the quality of services. The risk in cost reduction is some rig contractors and service providers may attempt to reduce costs beyond a practical level to sustain/gain market share or to keep the system warm with the hope that when the oil prices turn back, they would have the ability to expand faster to meet the expected increase in demand. However, with impractical low prices, the service quality and as a result well delivery will invariably be compromised.

(2) The second critical aspect is that today many operators drill more complex wells using expensive technologies and downhole tools. This combination of complex well design and advanced specialized tools require high service quality and skilled personnel. They both may not be cheap and in fact as the routine services will fetch a low revenue, the specialized and advanced services may become costlier or even unavailable.

(3) Understanding the process deficiencies rather than developing procedures and following up on after action reviews. While the procedures and after action reviews help to reduce the learning curve and improve performance, the process deficiencies lead to productivity issues, unsteady state conditions, repeating learning curves, disintegrated work culture and compromised objectives.

(4) The average well cost model is inadequate to optimize cost in real time. Hence, creating a baseline cost model to fully understand the costs really required to drill the well and remove any unnecessary tasks or activities from the well plan. Expand the cost model to daily cash flow to allow real time cost monitoring, efficient tracking and budget control.

(5) In today’s world, well delivery is the predominating criteria rather than constructing the well in less number of days or cost alone. Speed to achieve technical limit is not always the right approach as it may lead to compromise on other objectives of the well. Standard NPT analysis and eliminating visible lost time models are inadequate in the current scenario.

Depending on the drilling environment, more than 40-60% of the well cost is related to time i.e. number of days in a well. Hence, a day saved results in saving significant cost of a well. Creating a baseline time model will help to fully understand the contribution of every activity in the well construction. It will also help to critically analyze the actual performance in real time and to eliminate the layers responsible for slow performance one by one methodically.

Notes:
Saving a day does not mean taking short cuts or discarding best drilling practices. Managements invariably get attracted to operating team’s ambitious approach of reducing number of days in a well instead of reducing the cost holistically by applying best and optimal drilling practices. Most drilling projects fail or compromised due to approach to speed to achieve reduced days without considering well delivery principles. Hence, managements must prevent and discourage such culture.

(6) The change must come from the top. The senior management must set the example by encouraging technical and operational integrity, unconventional and out of the box thinking, discipline leaderships to ensure effective management and curtailment of natural resistance to change and timely and effective decision making process through (a) informed decisions with data from multiple sources, (b) instilling credibility and trust through proper and appropriate delegation of authority to de-centralize decision making process and (d) companywide visibility with empowerment, adequate tools and processes to drive the corporate message to the lowest functional level.

By applying the principles listed above as an integrated model involving all the stakeholders of the process, it is possible to reduce the well costs by 10-20% (or more) and to achieve the Effective Cost of a Well.

3.0 Time and Cost Estimates

Estimating the right time and cost to drill a well is still a challenge in the industry despite the sixty years of collective global experience, advanced software models, availability of large number of data and expanded resources.

iWells have developed a strategic well time and cost estimate model and is also developing a complete manual titled "Habits of Highly Effective Drilling Engineers". Few strategies are explained below in Section 4:

(1) Well Cost Model

For effective cost optimization, the first step is to distribute the total well cost into defined categories and expand the cost centers for effective estimating, modelling, monitoring and controlling. Many well cost models across the world are based on financial requirements/definitions which are not useful from a drilling perspective to monitor and control.

The following logical categories will help to develop specific and effective optimization or cost reduction strategies.

(1) Time Dependent Costs – Rig and Services

Applies to all the services including the rig that are paid on day rate or time basis.

A better and effective optimization can be achieved if the time dependent costs are segregated section wise instead of an average value per day for the entire well.

Few of the major time dependent costs are listed below:

(a) drilling rig;

(b) vessels;

(c) cementing unit, associated equipment and personnel;

(d) mud lab and drilling fluids services;

(e) mud logging services and personnel;

(f) wireline logging services and personnel;

(g) tubular running services and personnel;

(h) directional drilling services and personnel;

(i) measurement while drilling services and personnel;

(j) logging while drilling services and personnel;

(k) drilling tools rental;

(l) fishing tools rental;

(m) wellhead engineers and service tools rental;

(n) well testing services and personnel;

(o) completion services and personnel;

(p) *Liner hanger service equipment and personnel;*

(q) *casing exit service equipment and personnel;*

(r) *pile driving services and personnel;*

(s) *remote operated vehicle services and personnel;*

(t) *several other miscellaneous services;*

The list above is not exhaustive.

(2) Time Dependent Costs – Manpower, Fuel and Others

Manpower must be segregated for;

(a) *office based supervision;*

(b) *rig based supervision;*

(c) *shore base based team;*

(d) *remotely working project consultants and personnel;*

(e) *advisors and reviewers;*

(f) *call out consultants;*

(g) *others;*

A better and effective optimization can be achieved if the time dependent costs are segregated section wise instead of an average value per day for the entire well.

Fuel, water and other utility costs must be segregated as per operational mode such as drilling, testing, completion, logging, rig move etc. to arrive at a better accuracy rather than average per day or well.

(3) Depth Dependent Costs or Consumables

Applies to all the cost that vary with depth like but not limited to:

(a) *cement and cementing additives;*

(b) *drilling fluid chemicals;*

(c) *testing and completion chemicals;*

(d) *bits;*

(e) *shaker screens;*

(f) *all other consumables;*

(g) *repairs or redressing;*

A better and effective optimization can be achieved if the depth dependent costs are segregated section wise instead of an average value for the entire well.

The list above is not exhaustive.

(4) Fixed Costs and Pre-Spud Costs

Applies to all costs that are fixed for the well or cost spent pre-spud.

Pre-spud costs include but not limited to:

(a) mobilization of rig and all the services;

(b) rig building (onshore) and rig positioning (offshore);

(c) site construction (onshore);

(d) installation of units on the rig;

(e) site survey;

(f) Insurance;

(g) establishment of shore base, communications cost of preparation until spud;

(h) Others;

The list above is not exhaustive.

(5) Tangible Costs

Applies to all tangibles that include but not limited to:

(a) casings;

(b) Casing accessories – float equipment, centralization equipment, pup joints, cross overs etc;

(c) liner hangers;

(d) completion tubing;

(e) completion screens;

(f) completion accessories – tubing pup joints, packers, gas lift mandrels, down hole pressure gauges, chemical injector valves, nipples, expansion joints, blast joints, surface controlled sub surface safety valves etc;

(g) casing exit equipment like whipstock etc;

(h) wellhead and x-mas trees, etc.

A better and effective optimization can be achieved if the tangible costs are segregated section wise instead of an average value for the entire well.

The list above is not exhaustive.

(6) Contingent Cost

Most managements or finance personnel do not prefer any reference to contingent cost in a well cost model. In most well cost estimates, a random value or a percentage is added at the end as an overall contingency number. This is a poor approach.

Defining contingency properly is an issue in the industry. Most people consider contingency as risk cost. The risked cost estimate is completely different from that of a P50 or Most Likely cost estimates and it is a much more complex model.

The contingency cost referred here is contingency within a P10/P50/P90 estimate and it is operational contingency not necessarily due to a risk.

Evaluating and segregating the contingency as part of the well cost model is critical to avoid excessive or inadequate contingency.

Expand the contingency cost for following but not limited to:

(a) contingency time in days based on estimated NPT
(b) time in days based on geological uncertainties
(c) average spread rate model
(d) cost of readiness for mitigation of risks (not the management of risks but the preparation of mitigation measures as a contingency model).
(d) other contingencies that may occur.

The contingency must be incorporated in to each category of well cost model rather than as a single number or percentage at the bottom of the AFE ("Authorization for Expenditure").

It is also critical that the maximum limit of contingency for a P10 or P50 or P90 is defined in the system to avoid excessive estimations.

(2) Probabilistic Cost Estimate

The P10-P50-P90 cost estimates for drilling are entirely different from that of a geologist's P10-P50P-90 in place volume or a reservoir engineer's P10-P50P-90 reserve estimates. In drilling time and cost estimates, P90 refers to high estimate and P10 the low estimate. This is exactly opposite to a subsurface model where P90 refers to the low estimate and P10 high estimate.

Lot of people in the industry believe that the "P" stands for Probability. This is not correct. The "P" actually stands for Percentile.

General belief in the industry, even among experienced engineers, is that the P50 is the median or mean of P10 and P50. This is not correct. In a deterministic symmetric distribution model, this will be closer to a median but in a properly estimated probabilistic skewed distribution model, the P50 is way different from a median value.

In most models used in the industry, the P10, P50 and P90 are estimated from a deterministic approach. This results in a pre-determined P10-P50-P90 values based on the expertise and the relevance of data available/used.

Another model used in the industry is "Composite Well Time" model that is commonly followed for "Drilling to the Limit" or "Technical Limit Drilling". This involves using the best performance of each activity among the set of available data and chose the best possible time estimate. This becomes the P10 or P_{DLT} or P_{TLD} estimate. The P50 and P90 are also estimated using the same approach. However, the composite well time model is impractical and fails largely except in a few cases the estimates are made connecting the fundamental execution principles that governed the data (both surface and subsurface elements) and integrating the practical elements of planned wells instead of just using the data as "numbers" for developing composite well times.

Crystal Ball and Monte Carlo Simulation models are also used to generate estimates but their effectiveness depends on the input parameters. MCS is a statistical model that requires a large set of data to provide higher accuracy in simulation. Without a large set of data, MCS is not useful for drilling time and cost estimates. At the same time, if large set of data are available, MCS is not required as the data itself will provide clarity to uncertainties. Secondly if the simulation is made using random sampling, 80% of values will lie closer to the mean which eliminates outliers. The histogram is concentrated towards an individual's defined mean and hence the output becomes dependent on the expertise rather than natural outcome of the simulation through its fundamentals of variance.

A pure probabilistic model is prepared rarely in the industry with the right parameters and simulation model.

Solution:

(a) Use the largest available data and develop a variance model to understand the uncertainties that governed the offset wells performance.

(b) Evaluate the current execution model including capacities, capabilities, limitations, circumstances and environment and develop an empirical relationship between the current and past.

(c) Develop the Most Likely Case or P50 using the empirical relationship and integrating the practical elements that would govern the execution of the planned well.

Note:

The above method will not necessarily provide the lowest time and cost estimate. However, it will provide the best practically achievable time and cost for a well or otherwise the "Effective Cost of the Well". That is the best output the oil and gas company or the investor can have because this will reflect the reality of cost and will help to arrive at the most optimal and better accuracy economic model.

Unfortunately very optimistic or very pessimistic models developed based only on data and expertise to meet the expectations will invariably result in cost over runs and failed economics model.

4.0 Application of Cost Optimization Principles

In continuation of the Section 3, a few strategies from iWells manual of "Habits of Highly Effective Drilling Engineers" are presented below.

(a) Drilling Project Management

The drilling process must be managed as a project and executed through a robust drilling project management system ("DPMS") whether for a single well or multiple wells. It cannot be achieved effectively without a consolidated and integrated model. The management systems must be developed for each well from fundamental policies to achieve a robust delivery process rather than blindly following a set of procedures established through the experience of someone else who are not part of the project and who is mostly unknown.

The DPMS is a process driven system. It is not made of only procedures. The procedures are rather developed from the processes, policies and principles of execution.

The DPMS primarily consists of:

(a) Standardization of specifications, designs, policies, principles and processes

(b) Simplification of well delivery process to achieve lean drilling execution model

(c) Definitions of services and equipment scope through standardization to reduce costs of supply chain

(d) Defined standard well plans and programs to prevent complexity unless driven by subsurface and target goal models

(e) Defined drilling procedures that are designed based on limitations of the rig, equipment, crew and circumstances through an Integrated Drilling System Performance Capability "IDSPC" model so that excessive drilling loads are prevented and non-productive times are reduced

(f) Robust real time monitoring, data capturing, analyzing, evaluating, reporting and controlling system through a project engineering team

(g) Competent project gap analysis through integrated schedule, activity register and reporting models

(h) Integration of team through capability and calibre analysis and distribution of responsibilities and accountabilities based on competency and delivery quality rather presence of a resource in the team

IDSPC - Integrated Drilling System Performance Capability

IDSPC is the term introduced by iWells for the first time in the industry. IDSPC was created after evaluating the fundamental root causes of drilling project failures and the reasons for inefficient well delivery with compromised objectives.

Today the well delivery model is not limited to drilling, completing and handing over a well. It is much more than that especially due to the industry shift and investors and lender's expectations. The well delivery model today consists of at least twelve objectives. Probably more than 80% of the wells drilled in the world today, despite the last sixty years of continuous advancements in the industry.

Understanding IDSPC is the most critical aspect of drilling and delivering a well meeting all the objectives including but not limited to:

(1) Corporate Objectives

(2) Subsurface Objectives

(3) Well Engineering Objectives

(4) Evaluation Objectives

(5) Completion / Production Objectives (this also feeds in to WRFM – Well Reservoir Facilities Management)

(6) Life Cycle Well Integrity and Asset Integrity

(7) Time

(8) Cost

(9) HSE Risk

(10) Low to Very Low Technical Risk

(11) Low to Very Low Execution Risk

(12) Low to Very Low Economical Risk

(13) Low to Very Low Environmental Risk

(14) Sustainment of Company Credibility

Developing a drilling plan without considering IDSPC will invariably lead to a well delivery with compromised objectives. IDSPC eliminates the errors in the estimates, planning and design process as it is derived by system's limitations rather than system's performance expectations.

iWells has developed an integrated process model to evaluate IDSPC. For further details, contact iWells, Dubai.

(b) Most Practically Achievable Time (”MPAT”)

Ambitious targets are encouraged by several management levels as well as operating teams based on inappropriate analogy and someone else experience instead of evaluating the existing whole system and understanding reality; please refer to IDSPC in the sub-section (a) of this section;

- setting tighter targets seem to be an excellent idea to push the team to perform better but in most cases it only leads to compromises and failures;

- unfortunately if someone had become successful by setting ambitious tight targets based on the systems IDSPC, the industry picks it up as a norm without understanding the fundamentals of IDSPC that governed that success; due to this, several others projects that try to copy the model without adapting the fundamentals fail;

- instead if the capacity and capabilities of the team and system are inadequate, then the limitations or boundary conditions must be expanded ruthlessly instead of struggling to achieve the targets with a low capacity and low capability system;

- or the other option, the most practical, is to identify the IDSPC of the existing system and develop the well design, drilling plans and practices, time and cost estimate for drilling a well in accordance with the IDSPC;

Ambitious and tight targets are achievable but only after the processes, design and execution plans are standardized and optimized in a drilling campaign. IDSPC model will have to be updated after every well with increased understanding of the capabilities of the system which will then drive the system towards ambitious targets.

The Time Dependent Costs contribute to 40-60% of the total well cost depending on the drilling environment offshore and/or deep water/HPHT operations. Hence any reduction to the total time in days on the well will have a significant effect on costs.

Hence, the first step is to develop a Most Practically Achievable Time ("MPAT") using the IDSPC model.

To estimate MPAT, first do the time estimate based on the model described in Section 3 and in line with the following as a minimum:

(a) Review the IDSPC output and the limitations derived through that model;

(b) detailed analysis of offset well performance to make the learning curve less steep or as low as practically possible;

(c) by carving out good practices used in the offset wells that improved the well performance and mitigation for those that created operational NPT or specific well problems;

(d) by analyzing unresolved problems and inconsistencies in the offset wells to develop mitigation plans and drilling practices for new wells;

(e) to ensure that the time estimates is appropriate by understanding the limitations and boundary conditions of the engineering and execution teams, the rig and services engaged;

(f) through a set of defined well delivery criteria and parameters instead of average estimate models;

The P50 is generally considered to be Most Likely Case ("MLC") but they are not always the practical time that can be truly achieved. Hence from the values of P10, P50 and P90, a Most Practically Achievable Time ("MPAT") must be derived.

The MPAT is not a technical limit but is the most practical achievable for the particular well. MPAT can tend towards technical limit if consistently applied in a multiple wells drilling campaign.

An AFE must be based on MPAT and not P50 or most likely time estimate.

(c) Executable Well Program

To achieve MPAT estimate in a well, the next step is to develop an "Executable Well Program" or "EWP". A drilling program shall not be a desire model of drilling engineers but an holistic document that represents the buy-in of all stake holders especially the execution team.

The EWP is a program that is practically executable by the execution team.

The EWP shall be based on as a minimum:

(a) optimize subsurface targets to reduce complexity and uncertainty;

(b) stabilize the well delivery plans by avoiding last minute changes or too many options in the plan which makes the planning inefficient;

(c) optimize casing point selection and casing policy based on detailed risk analysis and design rather than practice;

(d) optimize well trajectory with adequate target tolerance derived from proper subsurface model to minimize time spent on anti-collision (if any) and directional control in complex trajectories; avoid unnecessary tight target tolerance just for achieving bull's eye;

(e) standardize well design for back to back wells to reduce learning curves, minimize well complexity and improve operational efficiency; avoid experimental or research or information seeking well plans if possible unless justified;

(f) effective management strategy, not just procedures, to manage hole stability, stress mechanisms, hole cleaning, optimal mud design (critical) and other mechanical design/parameters etc. by proper analysis and studies rather than by practice;

(g) develop adequate process driven models for execution rather than expertise experience based practices; the drilling practices must be robust and in line with the IDSPC model to ensure that the performance expectations are within the capability and capacity boundary limits;

(h) drilling project risk model with mitigations for each identified risk that has a potential impact on the drilling performance through the IDSPC process and risk occurrence probability matrix; the mitigation plan must be implementable when needed rather than on paper to satisfy stake holders; being prepared for mitigation has proven to be economical against waiting for mitigation when the risk occurred;

(d) Execution of Executable Well Program ("EWP")

(a) the execution of EWP requires several initiatives, the foremost being the integration of multi-disciplines including service companies to become an effective team for execution; most projects fail because there is no true integration of drilling with every other discipline that has a contributing role on drilling performance and this happens in organizations where the corporate leadership is oblivious to the importance of such integration;

(b) complete synergy between operator, rig and service company teams is an essential component to the drilling performance but this is often ignored due to a serious lack of commitment to performance; most often the service is rendered from a contractual standpoint of each individual's deliverables rather than a collective integrated model towards well delivery; this can be changed by segregating performance and contractual obligations as two distinct identities and managing them appropriately;

(c) standard modes of DWOPs and CWOPs are inadequate in the modern system of drilling project management system; this has to be enhanced by multiple levels of engagement through several mini-workshops, risk and pre-section and pre-job reviews, post job reviews, scheduled service quality assessments,

(d) lean execution is the best strategy for effective drilling performance; tedious and complex execution systems and procedures deter the progress and distract focus; develop executable procedures and meaningful systems that reduce stress and encourage involvement and attention to details;

5.0 Conclusions

The path to achieve well cost reduction in the current scenario by 10-20% is difficult. However, it is possible subject to:

(a) commitment of corporate management to inculcate the culture for holistic optimization and cost reduction as a fundamental goal;

(b) integration of the entire value chain and all the relevant stakeholders to achieve and realize every potential for well cost reduction;

(c) indulgence of senior management and project leadership to eliminate internal resistance to optimization through coaching, encouragement and team building;

(d) change the organization culture to be flexible, innovative and adaptive rather than a heavily burdened environment with too many unnecessary side stream processes from forces external to the drilling project organization;

(e) to maximum possible extent, develop a stable and comprehensive drilling plan with absolute transparency rather than “stop” and “start” process that destroys the learning, efficiency and reliability for not only the internal but the external resources too;

(f) reduce pushing for every possible latest developments, advancement and insights without adequate time for the drilling project team to understand and optimize; this is a challenge that industry will struggle to eliminate due to the low level understanding of the complexity in executing a drilling project by external sources who have no direct skin in the game but have the authority to dictate changes; all stakeholders, internal as well as external, must stay aligned with the drilling project team rather than pushing the boundary from a peripheral vision;

(g) as practically as possible drill several wells in a series or a cluster which allows the learnings to become effective and continuous improvement; drilling project teams can become very efficient if the wells in sequence are of consistent design and complexity which saves significant time and cost, the effect observed from most likely the 3rd well;

(h) apply rigorous performance improvement strategies and plans; ambitious targets can be achieved if the well design, plan, procedures and practices are standardized with improvement realized after each well through the IDSPC model;

(i) the IDSPC model provides the baseline for performance both time and cost; utilize that as a basis to monitor and analyze the improvements and apply appropriate strategies to drive towards ambitious targets;

There will always be barriers and resistance to achieve the target cost optimization by 20% or more in a well under the current scenario. The biggest challenge is most likely an organization’s reluctance or inadequacy to implement true optimization principles and customize the drilling plans and portfolio as described in this document. That is the first step in successfully optimizing the cost – to change the organization’s culture towards a true optimization approach.

If the efforts are driven with integrity and dedicated focus without resistance to change, then there is a high potential to reduce the well cost by 20% or more in the current scenario.

Further Contacts:

For further discussions for;

- benchmarking and developing the IDSPC model for a drilling campaign;
- support in developing detailed models for planning and execution;

- presentations to the project leadership and management
- training / workshops to the project teams

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