Genesis
Gerenciando Incertezas BRASIL

Planning & Follow up
Methodology for Improving Performance through Process Control

Genesis would like to introduce the methodology that we have been applying in the planning & follow up wells in the pre-salt projects offshore Brazil.

What are the benefits from the Planning & Follow up Methodology?

Petrobras reduces pre-salt well drilling time by 55%

1 July 2014

Petrobras has been drilling wells in the pre-salt in ever shorter times, leveraging its acquired experience and the introduction of new technologies. The average well drilling time in the pre-salt layer of Lula and Sapinhoá fields has declined by 55%, from 126 days in 2010 to 60 days in 2013. In these areas, the company has already achieved durations of close to 30 days between the first and last meter drilled ("dry hole").

News Release issued by our client:
http://brazilbusiness.einnews.com/article/211932552/Ex8kKJ9bLks_AENH

The process control built-in on our methodology, which has been used in pre-salt wells since 2010, provides a baseline enabling the evaluation of project execution against planned metrics. It also monitors the progress over the years, capturing the factors impacting the reduction of well drilling time, such as new technologies, new well designs and improved practices.

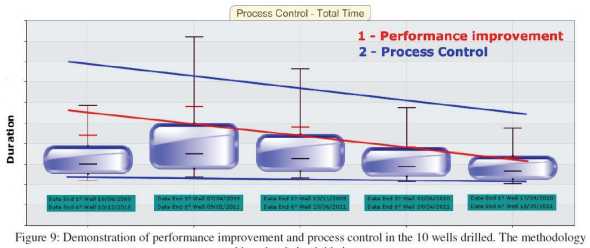


Figure 9: Demonstration of performance improvement and process control in the 10 wells drilled. The methodology presented here has helped this improvement.

Paper Presented at Rio Oil & Gas 2012
How we Improved Operations in Drilling Pre-Salt Wells

The figure shows reduction in the well construction mean time, as well shows a process control improvement

The box plot is an interesting chart for the evaluation of operations because it provides two types of visual information: performance and process control (the standard deviation).

The case study above was done with 10 wells drilled between 2009 and 2011.

What is Planning & Follow up Methodology?

The paper presented at Rio Oil & Gas 2012 ends with the following conclusion:

Progresses made with this methodology:

Before the Methodology	After the Methodology
Deterministic approach for planning	Probabilistic Planning - STEP 1
Time estimation was dependent of the planner's experience	Time estimation based in the knowledge base - STEP 2
NPT analysis at phase level	NPT analysis at operation's level - STEP 3
Intervention follow up using TxD plot (deterministic)	Intervention follow-up using risk analysis (probabilistic) - STEP 4
No systematic rig performance follow up	Systematic and probabilistic rig performance evaluation - STEP 5
Intervention performance only at planned vc executed level	Intervention performance using quartiles' concept - STEP 6

This table is an excellent guide to explain our methodology step by step, which we describe below.

STEP 1 Probabilistic Planning

In order to have a good base for plan we need to start building a knowledge base.

This is done by coding each line of the daily drilling report (DDR) already executed, according to an ontology of operations, which is a reference document defining items for all well operations.The main definitions for our methodology are:

- Operation name
- operation step for starting operation
- operation step for ending operation

As we know the exactly line in the DDR that operation starts and end, the duration of these operations can be compared across different wells. They form a statistical base to calculate mean and standard deviation for duration of each operation.

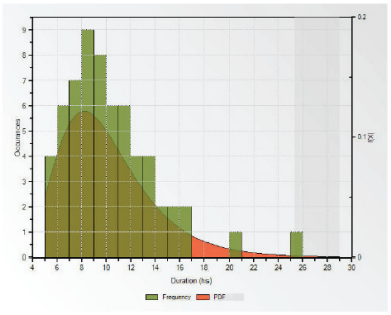
These operations can be filtered by many parameters such as year of execution, field, water depth, etc.

Also, the coding defines what is productive time and what is non productive time (risk for the execution of operation).

The durations of each executed operation are grouped and fitted into a lognormal distribution.

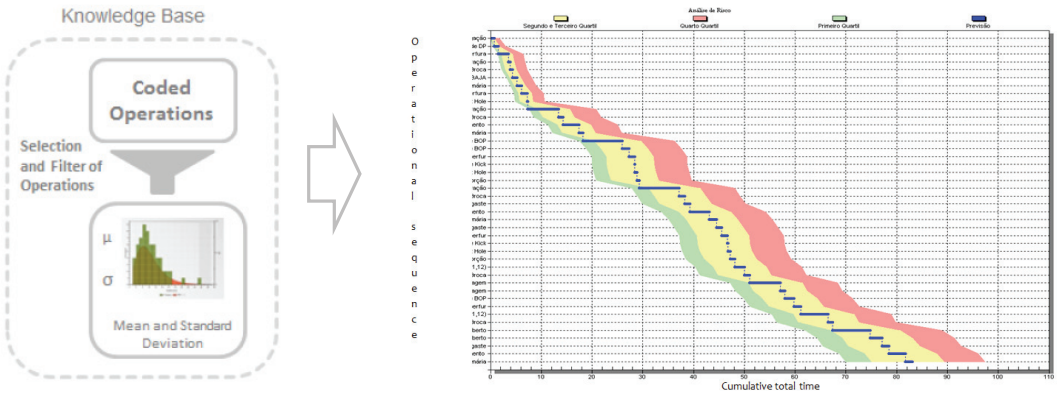
In order to calculate the cumulative uncertainty of a new sequence of operations, the methodology runs a Monte Carlo simulation for the entire operational sequence, sampling each operation's distribution. This is normally done for 10,000 samples, which can give a quite accurate prediction for the whole plan.

Example of well's operation duration fitted into a lognormal distribution



STEP 2 Times Estimation Based in the Knowledge Base

With the Monte Carlo simulation, the user can ascertain the uncertainty, ranging from P10 to P90. This allows a clear definition of the expected planned time for each operation and for the whole sequence.



In this plot we can see a Gant chart for the operational sequence listed in Y axis and the risk scenario, where the limits of green, yellow and red areas are: P10; P25; P75; P90

STEP 3 NPT Analysis at Operations Level

In the knowledge base the duration of each operation is separated in productive time and non productive time (uncertainty of the operation). We consider these two durations in the simulation of total time of each operation and for the total well construction.

Every six months we analyze the outlier cases of each operation and decide together with our client whether it is solved or can occur again.

The risk assessment of our planning is less dependent of the planner's experience and based in what really happened in the past and has not been definitely solved yet.

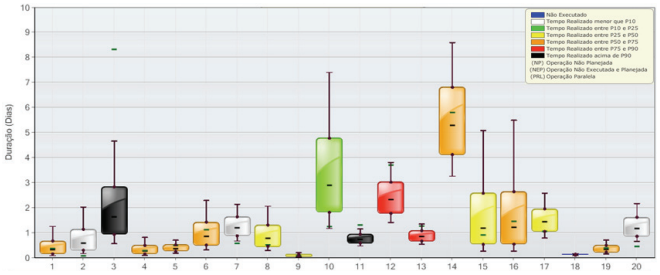
STEP 4 Intervention Follow up Using Risk Analysis (Probabilistic)

Our workflow:

1. Builds the Knowledge Base and defines filters
2. Codes operational sequence according to Ontology
3. Issues uncertainty scenario and box plot
4. Well operations follow up starts with well execution
5. Define a new filter every 6 months after starts methodology

1. Genesis codes the DDR of executed wells accordingly to ontology of operations and defines together with Client the set of wells that will provide the statistic filter with operations duration, as well perform an outlier analysis.
2. Genesis receives from well engineer the planned operational sequence for next well and codes according to operation's ontology
3. Genesis produce risk scenario and box plot
4. Client starts well execution and Genesis prepare on weekly basis the follow up report for risk scenario and box plot

Box plot follow up:



The color code indicates the quartile the operation was executed compared to its historical performance:

Best in class – White (actual duration < P10);
1st quartile – green (P10< actual duration< P25);
2nd quartile – yellow (P25< actual duration< P50);
3rd quartile – Orange (P50< actual duration< P75);
4th quartile – Red (P75< actual duration< P90);
Worst in class – Black (actual duration > P90)

The Box plot is the representation of probabilistic distribution for operation duration history data.

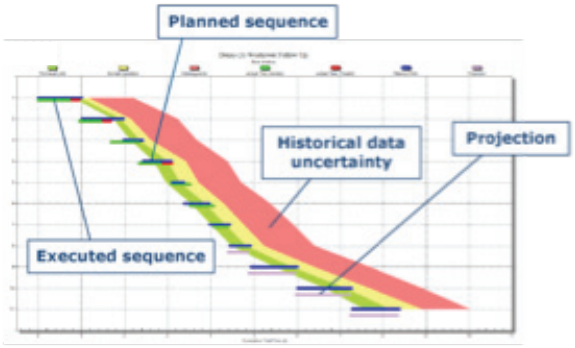
The quality of process control is proportional to the standard deviation (distance from min to max values)

Risk Scenario Follow up:

Every week our client uses those reports in the well execution team meeting for the following analysis:

- Duration of operations executed are verified against:
  - risk scenario; and
  - quartile of execution, considering the operation history.

They are checking the results in the Plan – Do – Check - Act cycle, which is the basis for the continuous improvement. Many times the operational team decides to act in a operation which reaches the red area.



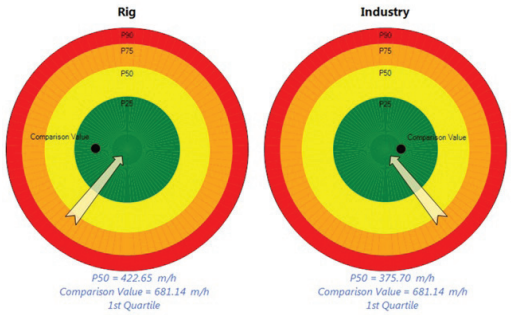
At the end of intervention the Knowledge Base is automatically fed with one more well's data ready to be used in the near future.

5- Defining a new filter every 6~12 months.
We include new wells executed in the last 6~12 months and remove older wells from the filter, intending to include in statistics the learning curve. So the planning team keeps challenging the well execution team for more performance.

Also we perform some analysis in order to identify whether operations are getting better or worse in terms of performance and process control. We explain these analyses in more details in Step 6.

STEP 5 Systematic and probabilistic rig performance evaluation and improvement

The same approach developed for process control in well operations is applied for rig dependent operations. We monitor and benchmark speed of trip in/out, running BOP and running casing for each rig operation. Our aim is to improve the rig performance and consequently reaching a well cost reduction.



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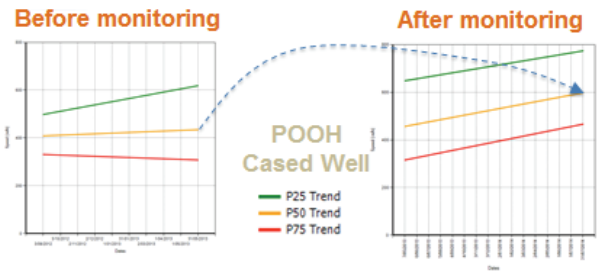
At the end of each monitored operation we send the follow up plot to operations manager and to rig personnel. The target plot is composed in the same concept of box plot. The borders for each area are P25, P50, P75 and P90. The target on the left uses only rig's historic data and on the right uses historic data from similar rigs that we have in our benchmarking data base. In this way we provide internal and external benchmarking

We define a "loss" as one of two following cases:
- Operation was executed with speed bellow P90 (worst in class) – The reason to be considered a "loss" is the time lost causing the e low speed
- Operation was executed with speed above P10 (best in class) – The reason to be considered a "loss" is the risk for Lost Time Incident, which we might consider as a "loss".

Every time we identify a loss, we warn rig personnel and they prepare an action plan to solve the root cause of the loss. The root cause must be associated with improvement opportunity in the operational procedure or in the compliance with operational procedure requirements. This routine leads to a better process control in the operation and a consequently cost reduction, as per the case bellow:



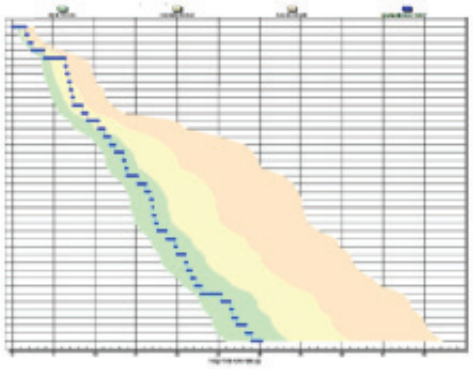
POOH speed increases by 33% while monitoring with a total potential savings of 4 drilling-days (US$4M).

STEP 6 Intervention Performance Using Quartile's Concept, Aiming the Process Control

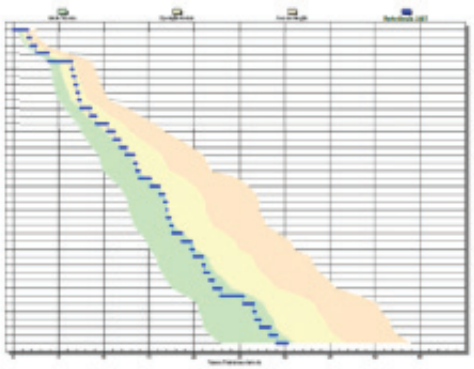
Following step 4- item 5 in our workflow, at time to define a new filter, we perform the following analysis:

1. ITT (Index for Total Executed Time) compares the results from the simulation of risk analysis for the same sequence of operations in different years.

2012

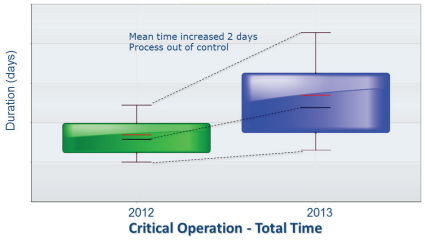


2013

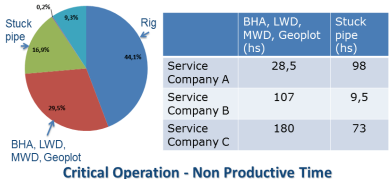


The area of risk scenario is thinner in 2013 than in 2012. This shows the process control improvement from one previous to actual year.

2. We evaluate the process control for critical operations (bigger P50 and bigger dispersion). A case study is showed bellow:

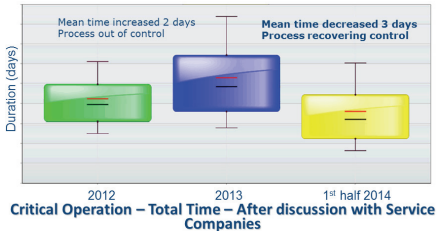


Process control getting worse



	BHA, LWD, MWD, Geoplot (hs)	Stuck pipe (hs)
Service Company A	28,5	98
Service Company B	107	9,5
Service Company C	180	73

Problem stratification, looking for root causes



From 2012 to 2013 mean time increased in 2 day; from 2013 to 1st half 2014 mean time improved 3 days

The analysis shown above intends to improve the performance and process control for the whole well intervention, as well for each critical operation.

Other features

- We use similar methodology, to evaluate duration of well campaigns.
- We generate the well probabilistic AFE based on probabilistic duration of each operation.
- We support Logistic plan informing and updating the expected date the resources necessary for each operations will be needed on the rig, as well the time the resources can be returned from the rig. All information based on the probabilistic duration of each operation.
- We also support the record and dissemination of Lessons Learnt for each operation in the operational sequence.

Genesis
Gerenciando Incertezas BRASIL
Tel: + 55 (21) 2497-2632 | Av. das Américas, 1155 / Sl. 804
Barra da Tijuca - 22631-000 - Rio de Janeiro - RJ - Brasil