Offshore

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Ontology of Operations can streamline completions, workovers

Standardization key to the methodology

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A Petrobras offshore business unit is applying Deming's well-known PDCA Cycle (Plan, Do, Check, and Act) to continuously optimize well completions and workovers. A system based on Ontology of Operations aids this process of continuous improvement.

This method defines intervention planning as a sequence of standardized operations. These standardized operations are key to the methodology. More than 180 operations were identified and defined based on ontology of operations (Miura, 2004). The activity durations are in an historical database of more than 600 interventions, spliced in conformity with standardized operations. Splicing the interventions in operations can give more similarity among the executed tasks than entire interventions, and that allows its statistical treatment.

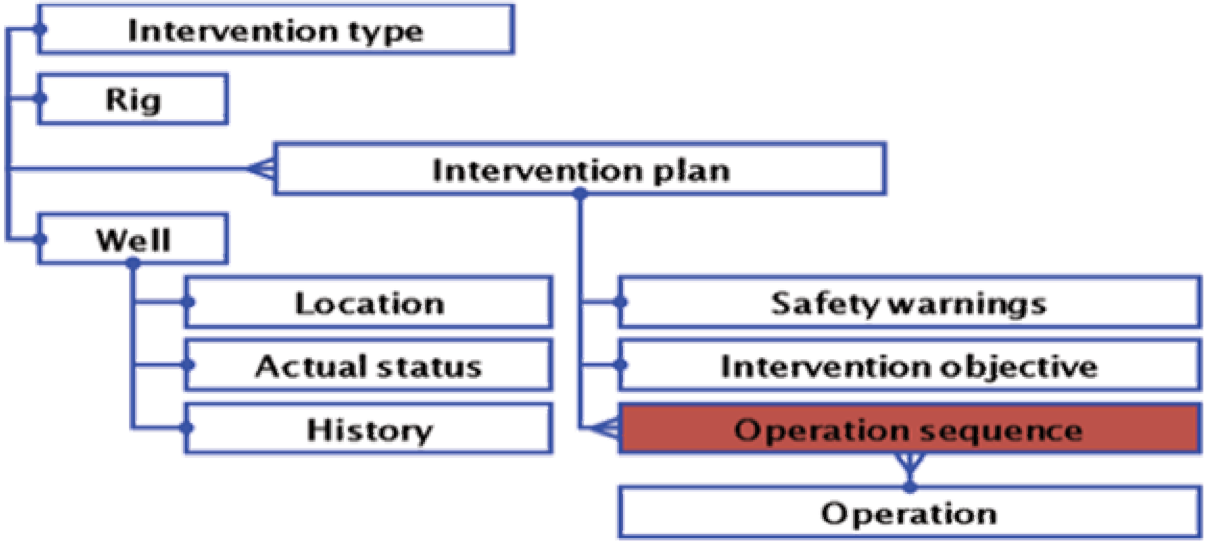
This same statistical database is useful to follow up performance of an intervention through simulations to get a statistical variation of operational times. For instance, Monte Carlo simulations applied in the operational sequence allow risk analysis of operation times. Historical data can be queried by year, rig type, oil field, etc, and thus can give the best statistical distribution curve to fit with the operations times. Analysis of these data suggests that lognormal distribution is the best pattern for these time-related operation data.

Virtual intervention simulation can be interpreted as a normalization process for operational sequences and it can be used to benchmark performance of all players involved in workover activities.

This also makes the intervention post-analysis possible. The post-analysis discovers operations executed with extremely long or extremely short times, showing both the best durations to be pursued and the worst durations to be avoided. Abnormal operations are studied in full detail and the lessons learned are incorporated into templates used to plan future interventions. This can assure continuous quality improvement through positive feedback.

Workover operation efficiency is difficult to quantify. Days versus depth as used for a drilling operation does not work since there can be a multitude of various tasks that in combination make up the workover. It is also difficult to compare one workover to another unless the same tasks are performed on each well. The same holds for well completions, with different fields and technologies. Completions and workovers require a single metric in order to be compared.

Maunder proposes a solution: Breakdown the intervention into tasks to determine time metrics. For example, he identifies four common tasks in all interventions -- moving in and rig up; nipple down tree/nipple up and test BOP; nipple down BOP/nipple up and test tree; and rig down and moving out -- and suggests that trips through the rotary table serve as start and end for a given task.



Ontology of the Intervention Program. (Kazuo, M.)

This seems easy, but to breakdown the intervention into common tasks is not that simple. Tasks are abstracts and dependent on the observer. In a community with hundreds of players, each with a different perception of the task, it can be difficult to reach unanimous consensus of task descriptions.

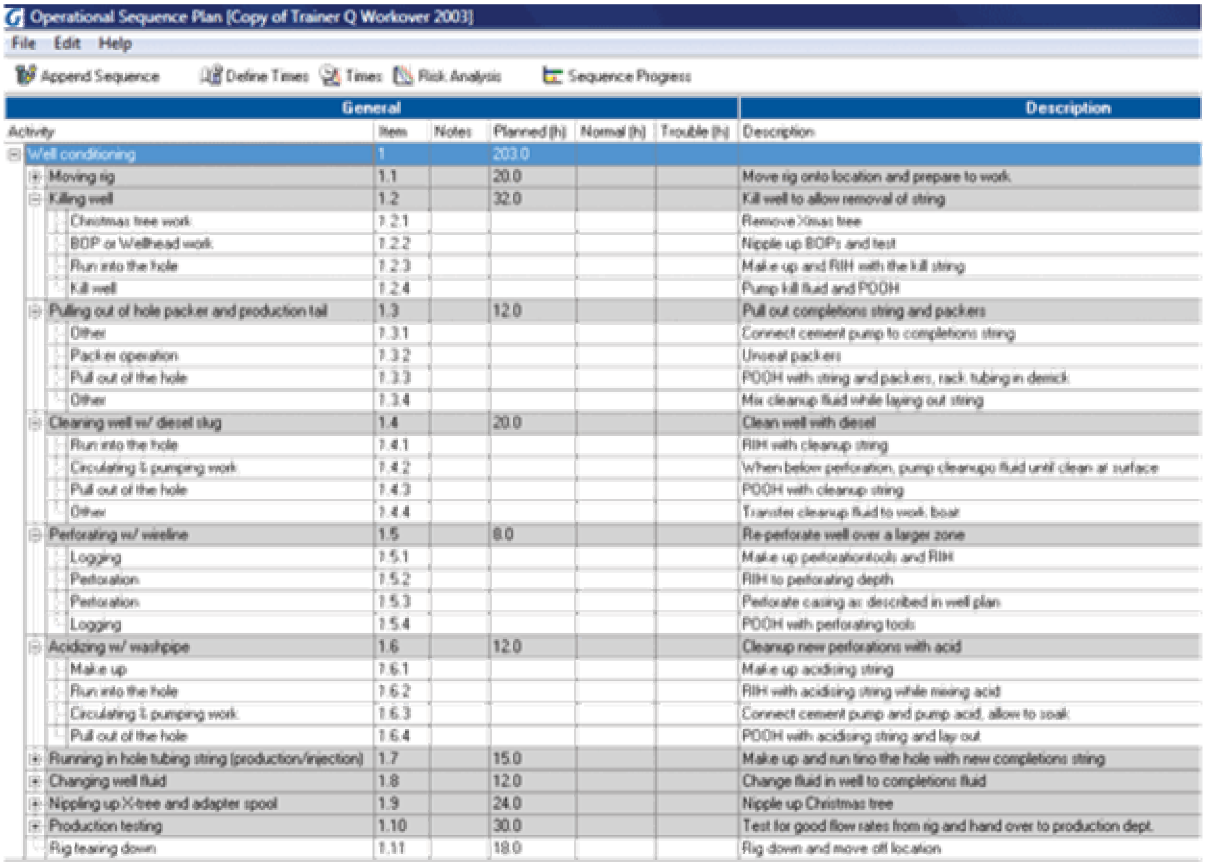
Offshore well engineering scenario

Offshore well engineering is a high-risk activity. Most wells produce oil using accumulated energy (controlled eruption) and have complex logistics with just-in-time resources (materials, services, and personnel) that varies from a simple gasket to a rig with a complete team to supply resources like drinking water, energy, and food.

A shared knowledge base is necessary for the various specialists to communicate with each other. This knowledge base is known as “enterprise ontology” (USCHOLD et al; 1998). The adaptation of this ontology to completion and workover we call “ontology of operations.”

By establishing and maintaining the ontology of operations, mapping the expertise, operational templates, and the resources needed for each operation, and using this as the basic intervention program unit, ontology helps execute the intervention plans.

Explanation of the ontology of operations speeds communication within the community. Ontology can be compared to lubricant in the gears of a well-oiled machine. It serves as common knowledge base so experts can communicate needs to each other. Without this common “language,” integration of the activities in the complex of Campos basin environment offshore Brazil would not be possible.



General						Description
Activity	Item	Notes	Planned (h)	Normal (h)	Trouble (h)	Description
Well conditioning	1		203.0			
Moving rig	1.1		20.0			Move rig onto location and prepare to work
Killing well	1.2		32.0			Kill well to allow removal of string
Christmas tree work	1.2.1					Remove Xmas tree
BOP or Wellhead work	1.2.2					Nipple up BOPs and test
Run into the hole	1.2.3					Make up and RIH with the kill string
Kill well	1.2.4					Pump kill fluid and POOH
Pulling out of hole packer and production tail	1.3		12.0			Pull out completions string and packers
Other	1.3.1					Connect cement pump to completions string
Packer operation	1.3.2					Unseat packers
Pull out of the hole	1.3.3					POOH with string and packers, rack tubing in derrick
Other	1.3.4					Mix cleanup fluid while laying out string
Cleaning well w/ diesel slug	1.4		20.0			Clean well with diesel
Run into the hole	1.4.1					RIH with cleanup string
Circulating & pumping work	1.4.2					When below perforation, pump cleanupo fluid until clean at surface
Pull out of the hole	1.4.3					POOH with cleanup string
Other	1.4.4					Transfer cleanup fluid to work boat
Perforating w/ wireline	1.5		8.0			Re-perforate well over a larger zone
Logging	1.5.1					Make up perforationtools and RIH
Perforation	1.5.2					RIH to perforating depth
Perforation	1.5.3					Perforate casing as described in well plan
Logging	1.5.4					POOH with perforating tools
Acidizing w/ washpipe	1.6		12.0			Cleanup new perforations with acid
Make up	1.6.1					Make up acidising string
Run into the hole	1.6.2					RIH with acidising string while mixing acid
Circulating & pumping work	1.6.3					Connect cement pump and pump acid, allow to soak
Pull out of the hole	1.6.4					POOH with acidising string and lay out
Running in hole tubing string (production/injection)	1.7		15.0			Make up and run tino the hole with new completions string
Changing well fluid	1.8		12.0			Change fluid in well to completions fluid
Nippling up X-tree and adapter spool	1.9		24.0			Nipple up Christmas tree
Production testing	1.10		30.0			Test for good flow rates from rig and hand over to production dept.
Rig tearing down	1.11		18.0			Rig down and move off location

An example of the operational sequence.

Beck and Pinto; 2004, defined “ontology” as a set of concepts captured in agreement within the community and defined explicitly, for both its use and restrictions.

Knowledge represented in the ontology must be agreeable within the community of users, so it can be applied in other knowledge-based systems. Ontology works as a backbone to organize domain knowledge. The most important part of the ontology is the meaning associated to the concepts, usually called “ontology content.”

Ontology of Operations

The intervention program is generated by a programmer who selects the standardized operations and defines their execution sequence based on the objectives. Once the operation sequence is defined, the intervention timetable can be generated automatically based on the information from past experiences (duration of the operation and rate of abnormalities).

During execution, the contractor can study the operation step-by-step and assess the risk of each step based on the intervention program. Since the steps (operations) are defined in the ontology, it is up to each specialty to record when its step began and finished, as well as to record the operational parameters and resources used. Plus, by entering the end of one operation and beginning of the next, the execution timetable can be automatically updated.

Those responsible for logistics do not need to be expert in operations, because they can find the resources packaged using the ontology of operations. With the list of required resources are categorized by type and procedure, logistics support can be facilitated by converting the execution timetable into a resource need timetable.

The rig company man can make a timely call for transport of resources for each operation, without being an expert in tools and resources, once again using the ontology of operations to find the list of resources for the operation, checking the required date.

Knowing the rig’s space and load limitations, the current situation, and the resources needed and ready for transport, can determine the rig’s transport priority.

With these requests packaged in advance and with the projected need dictated by the rig company man, transport personnel can optimize embarkations to meet several simultaneous requests.

In other words, all those involved in the intervention (monitoring, logistics support, inspection, executing parties, and transport) base their operations on the same information: The execution timetable derived from the Ontology of Operations

This example of ontology shows the operation's standardized name in English as well as the local language (Portuguese); the description and context of this operation's applications; specialists involved; applicable internal procedures; parameters to be gathered during the operation; step-by-step to run the operation; and necessary resources.

By using a standardized name, each group of specialists know what information is important for the others. Those who prepare resources can obtain the list of resources using the same standardized name. Those who perform the operation on the rig can obtain the applicable step-by-step and average times. And so on.

The intervention program elaborated as a sequence of standardized operations serves not only to rig personnel but also the logistics personnel who must prepare just-in-time resources. Details on the well intervention program are shown below.

Well intervention planning

The intervention program or timetable is a document that formalizes what should be done in the intervention to achieve the objective. This document is used not only on the rig but also by logistics and monitoring personnel at operational bases to make just-in-time deliveries.

Since monitoring personnel might have to manage up to 30 simultaneous interventions, structure is needed. In this sense, the ontology of the intervention program as defined below facilitates the necessary structuring.

The intervention plan is defined by the type of intervention, the rig to be used, and the well involved. The well defines the location and also current and historical status of previous interventions. The rig defines capacities and limitations.

The safety warning is the operator's formal commitment to safety, the environment, and health, and contains the applicable telephone list and contingency plans.

The intervention objective is the goal of the intervention.

The operation sequence is based on the ontology of operations.

Following is an example of an operational sequence. It has a hierarchical and sequential structure for the standardized operations and tips the programmer inserted for each operation. The proposed operational times for each standardized operation are shown.

Editor's note: This is a summary of a paper presented at PennWell's 2009 Offshore Asia Conference & Exhibition. The paper was the recipient of the Best Technical Innovation award.

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This formal representation, known as ER (Entity Relationship) Diagram, describes the relational data model. (Miura; 2004.)

An operation is carried out to achieve programmed parameters and it is comprised of a Sequence of Phases with Programmed Parameters and it is executed with a Procedure Standard that defines the Specialties and Resources for the Sequence of Phases. Abnormalities can occur while executing the operation. Each operation has someone responsible for its optimization.

With this ontology we mapped 168 operations in the completion and workover activity of offshore wells in the Business Unit where the methodology is being applied.

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