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Are we all data managers?

E-commerce standards - aiming too high?

Managing software on drilling rigs

The digital value engineer

Trondheim Integrated Operations conference - with an astronaut

Shell and reservoir areal monitoring

BP's Field of the Future enters phase 3

Integrated Operations at ConocoPhillips' Ekofisk

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ceptable.

For the majority of non-critical failures, repairs are scheduled to take place within a designated timeframe, or when the opportunity arises.

Testing and preventative repairs have an associated cost and an impact on the operator's short-term productivity, whilst equipment failures have different costs and perhaps an impact on long-term productivity, or potential safety and environmental consequences.

Having the capability to evaluate, in real time, the mean time to failure of a selection of equipment can help to reduce operating costs substantially by adopting risk-based inspection frequencies, and feed-back of the performance experience to well designers can result in more reliable equipment selection for new wells.

It is important to have the complete history of a well and the integrity status of its near neighbours in order to make an informed decision when it comes to correcting an issue with a well.

Otherwise there a risk that they might not solve a problem, they could make it worse.

Also while sustained annulus pressure or individual well issues can be controlled and addressed in isolation, the danger is that a combination of issues occurring in offset wells simultaneously can lead to unexpected escalation of consequences if the full picture is not visible.

Different users

There can be tens, if not hundreds of potential users requiring access to well integrity data and all will have slightly different aims and requirements.

A well integrity engineer will need access to well component reliability data.

An operations supervisor would be more interested in being able to access a schedule of tasks and receive notification of due dates.

Drilling engineers might use a well integrity system to check for details of the well design to select an optimum workover programme.

Reservoir engineers concerned with optimising production will confirm that wells are operating within the defined well operating window and check whether impending well integrity issues will interfere with production or reservoir drainage plans.

Other information needed for decision making includes:

Production information, to confirm that all fluids in the well are within their safe operating limits for flow rates, pressures and temperatures

Barrier tests, to check that safety-critical equipment is leak-free

Well design data, to support informed well workover plans

Well history, to track all actions on the well and handover events

Having all necessary data readily available via a management dashboard provides executives with an accurate picture of the company's exposure at all levels, enabling them to measure performance against any given set of key performance indicators.

Views are customisable at a company level, enabling users to tailor fields, views and outputs to suit their well integrity philosophy and help ensure regulatory compliance and mitigate risk.

Intetech is an Aberdeen company which provides well integrity management and asset integrity services. See www.intetech.com

Managing software on new drilling rigs

As control software on drilling rigs gets more complex, it gets more important to have a formal 'management of change process to follow when the software needs to be changed. Stephen Hadley and Christopher Goetz of Kingston Systems explain how to do it

Managing software has long been a peripheral concern in rig operation.

However as new rigs with increasingly complex control systems are delivered, effective software change management is critical in avoiding down time.

Software Management of Change (SMOC) is a set of procedures and policies designed to control, track, and understand changes to software systems for the purpose of increasing predictability, disaster recovery, auditability, and overall reliability.

Unfortunately, many operators are learning about SMOC the hard way through increases in accidents, data loss, unpredictable system behavior and non-productive time (NPT).

An industry problem

Managing software change is a new concept in our industry. It is taking time to learn to understand that software is an asset that needs to be controlled.

SMOC is not a form filling or access restriction exercise.

Paperwork provides accountability, but unless the details of the proposed changes are well understood, problems are likely to occur.

Considering the risk of injury and damage that can be caused by incorrect operation, it is essential that the testing of even minor software changes be thorough and complete.

All the machines controlled by the modified program should be function tested as well as each system that it interacts with.

Special attention should be paid to emergency stop, critical operations, zone management, position limits and other safety interlocks.

Amount of testing

In a typical software company, a software release will be tested by a minimum of 3 people (Developer, Quality Assurance Department, and Client).

It will be deployed to around 5 systems before being released to production and retested at each stage (Development, QA, Client Test, Parallel test, and Production) before it is released for use.

Currently, the offshore drilling industry does not have anywhere near this level of quality checking.

This is odd considering the risks involved.

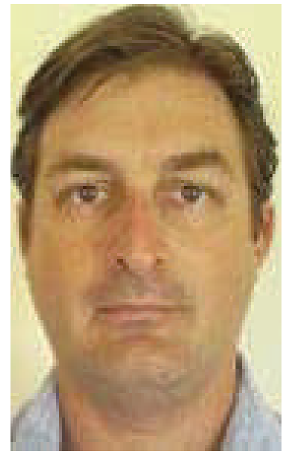
Often, the burden is placed on the owner to insist on a thorough retest after every software change.

Common problems seen in our industry include:

Bad Releases: Because of the nature of developing HMI (human machine interface) software, it is difficult to test the software on shore. Sometimes it seems as if the software was never tested at all, as it is "Dead on Arrival" and a local technician must fix it to make it work.

Technician Error: Some fixes are created on the spot by a local technician/software engineer. It is generally considered very bad practice in the software industry to

The software to control drilling rigs is getting more complex – and updating it can be a nightmare



Stephen Hadley is an Senior Inspector for Kingston Systems, a Control Systems inspection and auditing firm based in Houston. Stephen is a computer scientist who lives with his family in the Dominican Republic and enjoys panning for gold in his spare time.

Christopher Goetz is the founding director of Kingston Systems bringing 20 years of oil and gas experience to the field of rig auditing and operations.

have the same person both make a change and test it. Developers test things to see if they work, not to see if they are broken.

Error Regression: Often an upgrade patch from another rig is converted to be used on the rig. The upgrade patch can then overwrite any changes and fixes made on the local rig.

Error Porting: When a patch is installed on a rig, all rig specific parameters must be manually updated to match the new rig. This is an extremely error prone process.

Installation Error: Sometimes an update has multiple interdependent parts or a specific installation order. If the sequence is incorrect, the error may not be easily detected, causing problems later.

Side Effect Error: The new software may function perfectly but be incompatible with other software already in use.

Network Error: Installations often require the computer to be rebooted or the server restarted. If the restart procedures is not correct network communication problems can interfere with correct operation.

Poor Testing: Poor, incorrect or partial testing, limited by operational constraints, can effectively negate all previous positive efforts by the change initiator. To complete the process fully, pre and post change testing is required.

No Recovery Plan: When install or hardware fails, often owners are caught short lacking back-up and recovery plans.

Risk of small changes

It is a mistake to believe that small changes in software do not require the same level of diligence as large changes. A small change can present a greater risk than large ones where a complete engineering review is more likely to be performed.

Human nature often circumvents known best practices when the task or risk is seen as minor.

The weakness is especially prominent in pre and post testing.

Vendors often resist pre or post change testing, especially with small changes. Their technicians usually want to test only the changed functionality and not the entire system.

This drastically underestimates the amount of testing needed to ensure the changes made do not have unexpected side effects like regression.

This resistance puts the burden on the owner to insist on a retest of the system.

Management of change

Management of Change is a well-executed concept that can be effectively applied to software.

A good Software Management of Change (SMOC) program consists of a set of policies supported by procedures and tools to control and track changes to software and its configuration.

To be effective it is funded, supported by the executive and tied to existing maintenance programs.

SMOC allows management to make educated decisions about what program changes are being made, why, and what they will affect. It also enforces implementation planning, testing and recovery procedure for changes along with an audit trail.

Some key components include:

Clear accountability and communicated roles and responsibilities from Offshore Installation Manager(OIM), Electrical Superintendent, to electronic technician (ET).

A registry of installed software, logging version and configuration changes, giving a list of rig software assets at any given time.

Procedures to ensure systems are recoverable and that equipment failure will not result in serious lost time.

Good and bad

A good SMOC program provides increased system uptime via stability, predictability, and accountability. It ensures only tested well understood software changes are installed, and that any changes made can be recovered in a timely manner. Software changes should be planned, monitored and authorized by appropriate personnel.

A strong SMOC will deliver improved vendor relationships, better disaster recovery and a strong maintenance crew.

A weak SMOC program will likely result in increased NPT, unexplainable incidents with indeterminate causes, and an over reliance on vendors.

With more uncontrolled changes increase the likelihood of unexpected behavior and regression of previous patches. These strain vendor relationships and raise issues regarding liability and data loss.

Case Studies

Lack of planning: Software upgrade is installed leading to a collision between the top drive and the top of the drill pipe because the update was designed for a rig with a shorter derrick.

The pipe was bent out of position and was in danger of popping out of the vertical pipe handler gripper arm. The upper stop limit set point had been unknowingly changed by the software upgrade.

Poor testing plan: A software change was made to zone management settings and was retested between two machines. The interaction with a third machine was not tested and caused a collision resulting in injury risk and 2 months of critical machinery down time.

Upgrade installation failure: A Software Change Request was filed and approved. Time was allocated under the Permit to Work process and other users were locked out of the network and from access to effected machinery.

Unfortunately, the technician was unknowingly provided with a bad release package. To further complicate the situation, no offsite support was available.

When contact with the home office was reestablished, the missing files were sent but blocked by antivirus software.

Eventually, an alternate route for software delivery was found. After the installation was completed, it was found to be incorrectly programed and was of no use.

Several hours of lost time doing tasks that should have been done offline, preventable through better planning and communication.

Lessons Learned

These case studies emphasize the importance of SMOC and the need to prevent the common problems needlessly encountered throughout our industry.

Vendor Responsibility, Owner Accountability: Good SMOC procedures allow management to control installation processes and for vendors to include the owner in the planning and execution process.

Pre & Post Installation Testing: Technician making and installing the changes should not be doing the testing as they are prone to test for items they changed. Rechecking of functionality across the entire system is critical as there are often unexpected side effects. This is a critical step and requires management support.

Understanding the Interconnectivity and Interdependence: System complexity is often underestimated. Technicians are often specialists in a very narrow subset and are unaware of possible consequences to other systems.

Good Restart Procedures: Servers and terminals sometimes need to be restarted in certain orders. Restarting a server without reinitializing the connected terminals may cause the terminal to hang up after having lost its connection.

Good back out procedures: After a failed update, it is important to be able to restore the system to its original state.

Cleaning frac water with electrical pulses

Cleaning up frac water is a major expense in fracking jobs - but OriginOil of Los Angeles believes they have found a lower cost way to do it

OriginOil, Inc. of Los Angeles has developed a technology for cleaning water using electrical pulsing.

It can be used for cleaning frac water (water used for hydraulic fracturing of wells), or produced water (water which is produced from an oil well).

The system was evaluated by Pacific Advanced Civil Engineering, Inc., a civil engineering consulting firm specialising in water, based in Fountain Valley, California, using a sample of produced water from a Texas Oil Well, which PACE supplied.

PACE found that the system could reduce "chemical oxygen demand" (COD) of frac water by 98 percent. Chemical oxygen demand is a test to indirectly measure the amount of organic compounds in water (because nearly all organic compounds can be oxidised to form carbon dioxide).

So this means it was removing 98 percent of the organic contaminants in frac water. It can do this in a single pass.

The OriginOil system uses electrical pulses which neutralise the repulsive electrical charge of suspended particles and oil droplets in the water, so they can be separated from the water. The charges also promote coagulation of suspended organics and break oil emulsions in the water.

The technology was originally developed by OriginOil as a means of separating microscopic algae from water - enabling producers to create an algae biofuel and chemicals which can be used as petroleum substitutes.

In the first stage of the reaction, the electrical pulses are sent through the fluid as it passes through a reactor tube.

In a second stage, more electrical pulses push them to the surface using a "bubble flotation method". The gas flotation chamber creates a cloud of microbubbles to lift the material to the water's surface, and heavy material can fall to the bottom. This is called a "gas flotation concentrator".

In the third stage, the particles can then be raked off and processed.

No chemicals are required.

The reactors are controlled by a SCADA control system. The algorithms are developed for the type of produced water being processed.

In future it will be possible to make real time adjustments to the pulse characteristics for the specific water parameters, for maximum efficiency and minimum energy usage.

The resulting water might need further treatment (such as filtering) before it can be put into ground water, depending on how much oil there was in it to begin with and the final water quality required.

There is a possibility that the system can provide an additional revenue source, if the produced water creates enough hydrocarbons that it their value exceeds the cost of treating the water or pumping it back deep underground untreated (which is what hap-