digital energy journal

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pany involve safety, emissions and productivity. But then the first step to achieving these goals is usually to achieve a certain level of reliability with the operations. There will be certain assets which are more critical than others in achieving a reliable safety level. Or reliability may depend on certain aspects of your supply chain.

"Then you will be able to decide - what is the missing part in all of this, in order to reach the right outcome," he says.

Baker Hughes worked in this way with Petrobras. It did not start by saying "here's a new system we're trying to sell you". It started off with asking, "tell us the problem you face," Mr Qasem says.

Petrobras said it had over 6,000 sensor systems across all of its assets, but had difficulty figuring out how the whole sites were connecting together. Having this connected view was important for being able to answer questions such as, do we have enough feedstock.

Petrobras also had specific goals it wanted to achieve, like "reduced greenhouse gas emissions".

Once these high level goals are defined, the next steps might be to install better ways to measure flaring or methane emissions, and connect this into a comprehensive digital ecosystem. "You will be able to find a better way to connect the dots," Mr Qasem says.

Depth and breadth

Providing such outcome based digital solutions involves both depth and breadth.

The depth element involves understanding how company's businesses work, and how new technologies work. For example, Baker Hughes has projects to use AI on drill bit data, enabling better insights into the condition of drill bits. It helps customers better understand how new technologies may be relevant to them, such as applying CT scanning devices from the healthcare industry, or using 3D printing.

The breadth aspect involves connecting different elements and understanding to get the right outcome. Companies are seeking to break out of their old 'silo' structures and move to having a horizontal digital enabled structure, with better joining of the dots. Achieving breadth can also mean deploying technologies at the right scale, across the client's entire operations, not just in one place.

Another example of breadth is where it helps a client tackle multiple goals at once. For example methane monitoring devices and systems can help with emissions, safety and production at the same time.

Inventory management

An important part of achieving reliable operations, and one which is often overlooked, is better management of inventory of spare parts and feedstock. Companies need to be sure they have whatever they might need quickly available, but they do not have unlimited capital and space available for goods in storage. But the demand is often unpredictable.

Baker Hughes has been working together with the company C3.AI as its strategic partner, developing AI based methods to plan inventory.

Mr Qasem's business unit has worked with C3.AI for its internal purposes, to reduce its inventory of stocks and to plan future manufacturing, including making predictions of future customer demand.

Baker Hughes Digital Solutions

Baker Hughes Digital Solutions is a multi-billion-dollar business unit.

It provides a range of digital devices under a number of brands, including condition monitoring (Bently Nevada), sensing such as for flow and temperature (Druck, Panametrics, Reuter-Stokes), control systems and cybersecurity (Nexus Controls). Also industrial inspection (Waygate Technologies, Process & Pipeline Services).

It also provides monitoring systems, software and services to connect all their data together in a digital ecosystem. It serves 20 industries, not just oil and gas.

The company has its own R&D centre in Oklahoma City, USA, which it calls its "Energy Innovation Center".

Using unstructured data to reduce down time

A lot of the insights which might help to reduce equipment downtime and improve maintenance planning are hidden in unstructured data in historical records. Subrat Nanda of ABS explains how this might be utilised

By Subrat Nanda, Chief Data Scientist, ABS

In the offshore industry, we are currently sat at the tip of an iceberg in regard to unlocking the potential held inside unstructured data.

If leveraged effectively, these data driven insights can inform decisions across an enormous scope of critical business functions – from improved operations and informed planning to focused training and personnel development.

The potential to advance safety performance is also significant.

Unplanned downtime, as we know, is costly for all offshore operators. A study by Baker Hughes found that 1% of unplanned downtime (i.e. 3.65 days a year) costs offshore oil and gas organizations on average $5.037 million annually.

The industry averages a little over 27 days of downtime every 12 months, which translates into costs of about $38 million. For the worst performers, figures are upwards of $88 million.

An effective asset management strategy can start with combining data analytics with historical data and operational experience to reduce unplanned downtime and achieve higher operational availability.

This involves fusing data generated from operations and prior maintenance, covering diverse datasets from sources such as equipment design information, sensor time series data, maintenance records, inspection records, performance reports and class-survey reports.

From this, an understanding of observed failure trends and risks can be gained, which in turn provides the data-driven insights needed to underpin condition based maintenance (CBM).

Subrat Nanda, Chief Data Scientist, ABS

Unlocking unstructured data

One of the largest obstacles to obtaining maximum value from this exercise is that the maintenance history and operator observational data is typically unstructured.

This limits the achievement of CBM insights to be based mostly on structured parameter sensor data and in-situ or offline tests such as vibration and oil quality.

Part of my recent work has been looking at ways to better unlock the value of unstructured data, usually stored in an operator's computerized maintenance management system, repair and spare logs and other repositories.

A typical offshore maintenance management system allows users to input free-text status reports. Many of the drop-down fields have missing or incomplete entries.

The problem with free-text fields is that they are written in a natural language format. How a person would speak, or using community-specific terminology. This makes it a major contributor to the poor quality of data generally found in a maintenance management system.

Specific examples of data quality issues include non-standard abbreviations used by different operators and crew; inconsistent equipment taxonomy; leaving critical software fields blank due to lack of time or knowledge; common spelling and grammar mistakes; variation in sentence structures used to describe the same situation.

All of this means that datasets must be analysed to extract useful information locked in an unstructured form before further analyses can be performed – a process which can be the difference between uncovering a systemic problem and letting it slip through the net.

AI for unstructured data

Historical maintenance records have been used to train artificial intelligence algorithms capable of working with unstructured free-form data to automate the task of identifying maintenance action types, differentiating maintenance scope and also isolating maintenance triggers.

This results in faster, repeatable and more accurate analysis, leading to being able to identify emergent issues, and model the reliability risks in an asset fleet.

This formed a key part of our recent studies, which involved developing advanced methods to perform natural language processing customized to the unique problem domain of marine machinery & equipment maintenance.

We concentrated efforts on measuring, identifying and improving data quality issues. This involved building models to perform automated annotation via various machine learning techniques.

Several models using different hypothesis spaces and relative strengths were tested for building model ensembles. These included randomization-based methods, kernel-based techniques, probabilistic models and instance-based learning ideas.

Following this work, we now have generalizable, accurate and automated modelling processes to extract insights from otherwise unstructured and free text information, coming from the domain of diverse marine and offshore assets.

In so doing, we have also developed a set of artificial intelligence methods to address the data quality challenge posed by unstructured operations generated data sources.

It facilitates faster and more reliable data processing and provides robustness against variations in expression of semantics which are commonplace in marine and offshore working environments.

It grants the ability to perform data fusion, treating multiple sources of data as one as opposed to in siloes.

Condition based maintenance

Condition-based maintenance (CBM) is a maintenance strategy that dictates decisions about what work needs to be carried out based on the actual condition of an asset.

Under CBM, maintenance should only be performed when certain indicators are triggered and when it is economically optimal.

In other words, it should be done when there are signs of decreasing performance or upcoming failures. The maintenance should be performed at a time or location which makes it optimal from not only technical but also safety and economic perspectives.

The need for CBM arises in part due to the challenges of time-based maintenance practices, as well as a need to reduce uncertainty during maintenance events, and requirements to safely extend the service life of equipment to achieve maximum availability.

Condition-based maintenance is not a replacement for subject matter experts (in fact, CBM relies on their input to train and utilize their experiential knowledge to guide improvements). Rather, it is a methodology to inform maintenance strategies.

Such information is only valuable if the data fuelling CBM is of high quality – this is where data science comes in.

Quality maintenance data (and thus improved analytics over time) can inform other fundamental business operations such as human development and training.

For equipment manufacturers, it can highlight common faults on the production line, or identify equipment issues before they go on to become widespread across the deployed fleet.

Digital.ai – keeping hackers out of mobile apps

The apps which many oil and gas companies make, to provide their staff with sensor data, can also provide a pathway for hackers. Digital.ai has some tools to keep them out of mobile apps

Digital.ai, a company based in Burlington, Massachusetts, has services and software products to help oil and gas companies manage apps they build, to ensure that they cannot be accessed by hackers.

It has a number of oil and gas industry customers, mainly with apps providing data from sensors.

Managing security of apps is a big challenge for oil and gas companies, because once software is in operation, the software creator can have no visibility of how it is being used, or ability to control or manage it.

The apps are often developed by outside companies, and can be widely distributed, including to outside contractors. And the security risks are often not well understood, says Paul Dant, Vice President of Product Management, security with Digital.ai.

Reverse engineering

One of the biggest dangers with apps is that a hacker can open up the code and see it directly. The app code contains digital instructions for how to communicate with corporate data systems, because someone would use the app to engage with corporate systems. Once a hacker can see the code, they can build a new app which can interfere with corporate systems in a malicious way. This is known as "reverse engineering" – based on taking apart a finished product.

For example, whoever designed the Stuxnet hacking software must have had access to the code, which was running Siemens turbines, in