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Improving Upstream Operational Outcomes Through Advanced Analytics and Decision Support Systems

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Contents

Introduction

The upstream sector is under immense pressure. Hit by a perfect storm of low oil prices and faltering demand as a result of the coronavirus pandemic, company finances and operations are facing intense stress.

The ratings agency Fitch expects average 2020 oil prices to range from USD$35/bbl in a base scenario down to $20/bbl in a severe stress scenario[1]. This compares to an average of $65 last year. As a result, says Fitch, European majors have cut capital expenditure by around 20% and have announced spending optimization plans[2].

Nor is the pain limited to European players. Commenting on "a nightmare" month for the upstream sector as Brent moved into sub-$40/bbl territory, analyst firm Markit said: "This crash could add the finishing touches to the grand reshuffling of the upstream service sector that started in 2014."[3]

With the long-term impacts of the coronavirus pandemic still uncertain, Fitch estimates oil prices are unlikely to rise above $55/bbl in the long term[4]. For operators, the implication is that spare cash should be channeled immediately into measures that can deliver sustained operational savings and efficiency.

> ***"Demand destruction as a result of COVID-19 and the oil market price war are the key factors derailing the recovery. Both are unforeseen and their future development are highly uncertain. The upstream supply chain must brace itself for an uncertain and volatile future."***
> **Markit**

Yet suitable measures may be hard to find in a mature sector that has already spent many decades perfecting its operations. What else is there to try?

This white paper introduces a concept called operations research/ management science (ORMS) and discusses its possible applications and benefits within an upstream sector setting. The content for this paper has been developed in association with Revonos, a Colorado-based provider of ORMS technologies for the upstream oil and gas industry.

How ORMS Can Help Reduce Upstream Operating Expenses

The research publisher IGI Global defines ORMS as "an interdisciplinary branch of applied mathematics, engineering and sciences that uses various scientific research-based principles, strategies, and analytical methods including mathematical modeling, statistics, and algorithms to improve an organization's ability to enact rational and meaningful management decisions."[5]

More succinctly, the field could be viewed as the application of mathematical and scientific processes to turn data into insights, allowing organizations to tackle complex challenges. It has been developed as a decision support tool since the first half of the 20th century and is particularly suited to solving problems that involve a large number of variables.

These problems might typically be related to product transport or worker scheduling and logistics. ORMS uses mathematical techniques such as linear programming to analyze all the variables involved in a particular decision.

The variables can be assigned values to achieve given outcomes, such as minimizing cost. "The problems are general and then you apply the data and you get an output for that problem, given the data," explains Wes Dyk, CEO at Revonos.

ORMS is more than machine learning

Dyk is keen to point out that ORMS is more all-encompassing than in-vogue machine learning (ML) and artificial intelligence (AI). While ML and AI require vast amounts of past data for algorithms to carry out descriptive and predictive functions, ORMS can be used for prescriptive analytics applications with more precision and managerial direction than ML or AI.

"Machine learning techniques can help predict when equipment maintenance is needed or when a well might need servicing," says Dyk. "These data can be put in an operations research model that helps the manager understand the best way to deploy those resources, coming up with an assignment of certain personnel to certain assets and the schedule with which those personnel should visit those assets to perform the tasks that are needed."

ORMS achieves this by eliminating non-optimal approaches to a given problem, until it reaches an outcome that is as close as possible to the best.

In common with other types of analytics, ORMS is largely dependent on computing power for the resolution of complex problems. Within upstream oil and gas, it is especially suited to solving field-wide challenges such as how to maximize the value of a large group of assets.

One example might be how you allocate 10 technicians to service a field with 500 wells. Working out the optimum allocation, while considering the different needs of each well, is almost impossible on a manual basis.

Another possible application is in water hauling dispatch. In the absence of ORMS, someone would usually have to look at large amounts of data and essentially make an educated guess as to the best routing and delivery schedule.

The guess may be good or bad, but decision makers have no way of knowing. “Given constraints on water hauling, they might not know how much better they could do even if they spent another hour looking at more of the possible solutions,” says Dyk.

Moving from a manual process to ORMS can usually add an extra 10% to 15% of efficiency to a process.

With ORMS, on the other hand, managers cannot only get an optimal answer to the problem, but also see how close any answer is to being perfect. Moving from a process managed manually to one managed using ORMS can generally add an extra 10% to 15% of efficiency to a process, Dyk says.

On top of that, ORMS can help reduce the time required for data analysis and decision making, freeing up qualified personnel to engage in higher-value activities. The 10% to 15% improvement is an average across industries and could be vastly improved upon in some areas of upstream operations.

For instance, says Dyk, in one recent Revonos project a 35% improvement was “easily obtainable” without even implementing an optimal solution. “They can get to a better place but know they can go even further,” he says.

Deploying ORMS upstream

At a time when upstream operators face a tough economic climate, it is important that any investments in operational efficiency should come with minimal risk. In this respect, ORMS is a valuable tool for larger operators because systems can be contracted under a performance-based model where payment is a portion of the savings experienced by the operator.

This option is not available to smaller operators, typically producing less than 8,000 barrels a day. For these, ORMS can be deployed subject to an upfront payment but the benefit might be lower as the operations being analyzed are less complex to begin with.

For companies interested in deploying ORMS, implementation times will depend on existing levels of digitization. A company that already uses e-ticketing for water hauling, for example, could implement ORMS in a couple of weeks “and you would be able to see the results immediately following the implementation,” says Dyk.

On the other hand, a company that lacks an e-ticketing system would need to install it first, which could delay the benefits available from ORMS, potentially for months. ORMS can be integrated into the following IT systems:

- Amazon Web Services cloud computing services.
- AMPL algebraic modeling system.
- Apache Hadoop software library.
- ARIES petroleum economics and reserves software.
- General Algebraic Modeling System.
- MATLAB data analysis software.
- Merak Peep petroleum economic evaluation and decline analysis software.
- Microsoft SQL Server relational database management system.
- MySQL open-source relational database management system.
- Oracle Database.
- P2 Enterprise Upstream financial and production management software.
- P2 ProCount hydrocarbon accounting software.
- SQL Server Reporting Services.
- TIBCO Spotfire analytics.
- WordPress free open-source content management system.

Case Study: Water Hauling in the Denver-Julesburg Basin

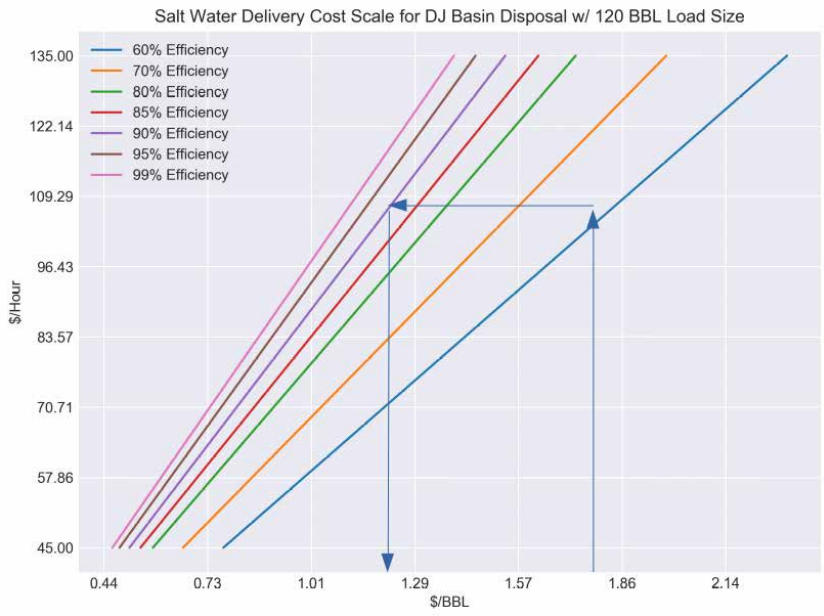

Fig. 1 – Saltwater delivery cost scales modeled using the Revonos Limitless Delivery Office Analytics module.

Revonos has analyzed the impact of implementing ORMS at one of the top 10 upstream operators in the Denver-Julesburg Basin during the summer of 2019, with an assumed water hauling cost of $1.77 per barrel. The analysis shows that ORMS could help the company achieve a cost of $1.25 per barrel.

This 29% reduction in cost represents a saving of $3 million per year for the company. “We know that’s realistic because of our experience in the industry and when we present to customers those numbers resonate with them,” says Dyk.

Multiplied across the eight top operators in the basin, this could add up to annual operational expenditure savings of close to $25 million. “That’s a huge opportunity for them,” Dyk says.

Once savings have been realized, says Dyk, the cost of the ORMS system would be reduced to a maintenance level.

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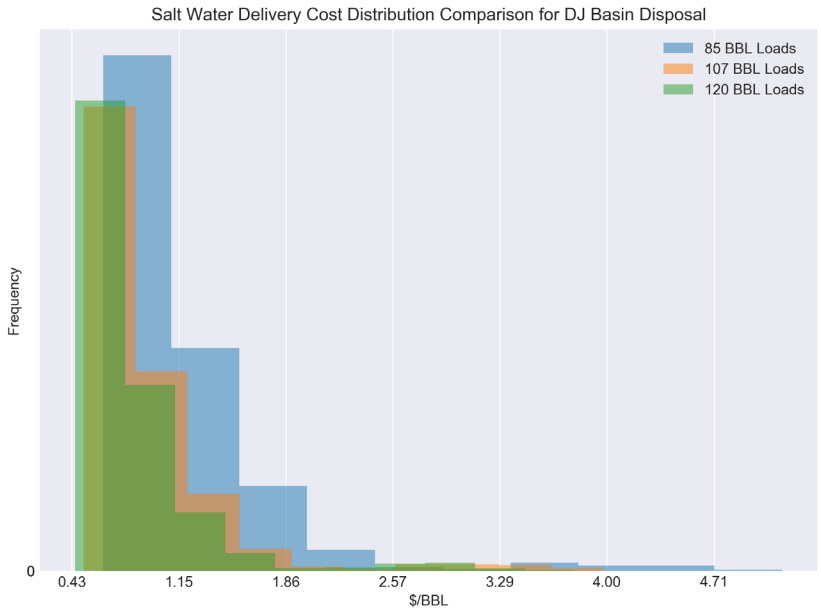

Fig. 2 - Visual depictions of cost distributions are used to gain an understanding of how efficiency varies across different average load sizes.

Areas Where ORMS Can Be Applied Within Upstream

ORMS has been used to improve water hauling operations in the Denver-Julesburg Basin and the Marcellus Formation for the last five years. And water hauling remains one of the prime candidates for ORMS implementations elsewhere in the industry, since the systems can be easily integrated into existing supervisory control and data acquisition, production, and e-ticketing platforms.

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In water hauling, ORMS can use tank levels to triage load callouts and move them directly to dispatch according to a model that maximizes delivery while maintaining production and limiting the use of constrained resources. The system can also look at historical or hypothetical scenarios and determine how efficient they are.

Despite this experience in water hauling, ORMS techniques have yet to be widely applied to other upstream processes. Nevertheless, the benefits of ORMS can be achieved in a range of exploration and production operational scenarios. Some of them are listed below.

Route Optimization

Amid growing pressure to reduce operational expenditure, visiting wells according to a fixed schedule might no longer be cost effective in some situations. ORMS allows operators to judge how much optimization can be achieved through changes to routes, and which route changes can deliver the greatest value.

Maintenance Scheduling

Machine learning can help exploration and production companies to identify when equipment should be serviced. But if servicing covers hundreds of assets then ORMS should be used to automate maintenance scheduling and optimize the process to reduce costs or enhance asset lifespans.

Development Planning

Drilling innovation has long been viewed as an important source of efficiency improvement for oil and natural gas producers[6]. In this respect, ORMS can help overcome the complexity of drill and completions scheduling so the order of drilling maximizes return on investment.

Further Applications

In addition to the above, potential candidates for ORMS can include:

- Fractionation of natural gas streams in midstream processing.
- Hauling of materials for completion operations.
- Chemical treatments.

Any business carrying out these processes at scale should consider ORMS as a low-risk way of improving efficiency and reducing cost.

The Outlook for ORMS in the Upstream Oil and Gas Sector

ORMS is an established process for solving complex business challenges. It has already been tested within the upstream sector for water hauling operations in the Denver-Julesburg Basin and the Marcellus Formation.

And the commercial model, where systems are paid with a share of savings, is highly attractive at a time when oil and gas budgets are highly constrained. Despite this, uptake of ORMS remains limited in the upstream sector.

According to Dyk, this is likely because ORMS may require a change in mindset for many operators. Large players are accustomed to relying on in-house experts for decision making, he says.

“If a company is using a control room and they have people looking at a hundred different screens, and they feel good about making decisions just based on their view of that data, then it can be difficult to get through to them,” he says. “They’re looking at all the data and they feel they know their wells better than any mathematician would.”

That philosophy misses the point of ORMS, though. There is no argument that an expert can get to know the behavior of an individual well better than any machine.

The point about ORMS is that it can take over where there are too many variables for even an expert to assimilate, such as how you service all the wells in a region. This lack of appreciation of ORMS could be set to change, though.

Companies that have adopted the technology for machine learning can easily take advantage of ORMS too.

Many operators are already investigating how machine learning can improve operations. And companies that have adopted the technology for machine learning can easily take advantage of ORMS too.

Upstream players are becoming more accepting of new technologies, says Dyk, although there is still a lack of awareness and understanding of ORMS and how it is distinct from machine learning and other tools. Revonos is working with early adopters of ORMS and is looking to establish a track record for the technology in oil and gas.

Given the rapidly mounting pressures facing the industry, it would pay companies not to hesitate too long in trying out the technology.

> ***""Supply chain innovations will likely make the greatest impact to drive down the cost curve."***
> **Ethan Smith, vice president of oil and gas, Frost & Sullivan**

In May 2019, Ethan Smith, vice president of oil and gas at the analyst firm Frost & Sullivan, declared: "Oilfield supply chain is grossly inefficient, outdated, and ripe for disruption. After years of looking the other way, Wall Street is finally putting pressure on operators to focus on efficiency and margins rather than production growth."[7]

Today it is no longer just Wall Street that is piling on the pressure. Maybe a few months ago there were bigger things to worry about than shaving 10% or 15% off a couple of corporate processes.

Today, though, that kind of saving might be make or break for a business.

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