Expert Insights

How AI can pump new life into oilfields

Fueling oil and gas industry performance

IBM **Institute for Business Value**

IBM

Experts on this topic

Ole Evensen

Leader, IBM Global Chemicals and Petroleum and Industrial Products Center of Competency
ole.evensen@no.ibm.com
https://www.linkedin.com/in/evensen/

Ole Evensen has over 25 years of experience with global organizations, serving as business division leader, technology advisor, and management consulting partner. He helps clients develop and realize their business and technology strategies.

David Womack

Director, IBM Chemicals and Petroleum Global Strategy and Eminence
dmwomack@us.ibm.com
https://www.linkedin.com/in/david-womack-4b81454/

David Womack is responsible for identifying new market and solution opportunities, managing the development of the industry-specific solution portfolio, implementing go-to-market plans for business growth, and leading alliances with key business partners associated with these strategies. He is a member of the IBM Industry Academy.

The goal of production optimization for the oil and gas industry is to protect the subsurface potential by reducing constraints in surface facilities.

Talking points

Production optimization is complex
Activities to enhance productivity of a field requires a balance of objectives and the ability to change decision criteria over time.

The opportunity for AI
By better understanding the subsurface and surrounding environment, AI can address production systems' boundaries.

Keep the flow going
Help manage bottlenecks, predict, analyze, and limit the negative implications of planned activities and unplanned events.

—

The economic life of an oilfield

An oilfield is a business asset like any other where one must spend money to make money. When it comes to how the oil and gas industry invests to generate cash flow, unique aspects must be considered. These include operational risks, a long timeline, and significant obligations during and after cessation of production. But the primary investment objective is to fully realize the economic return of the field. To do so involves technical and economic disciplines in which artificial intelligence (AI) can have a significant and positive impact on performance.

The sweet spot for production optimization

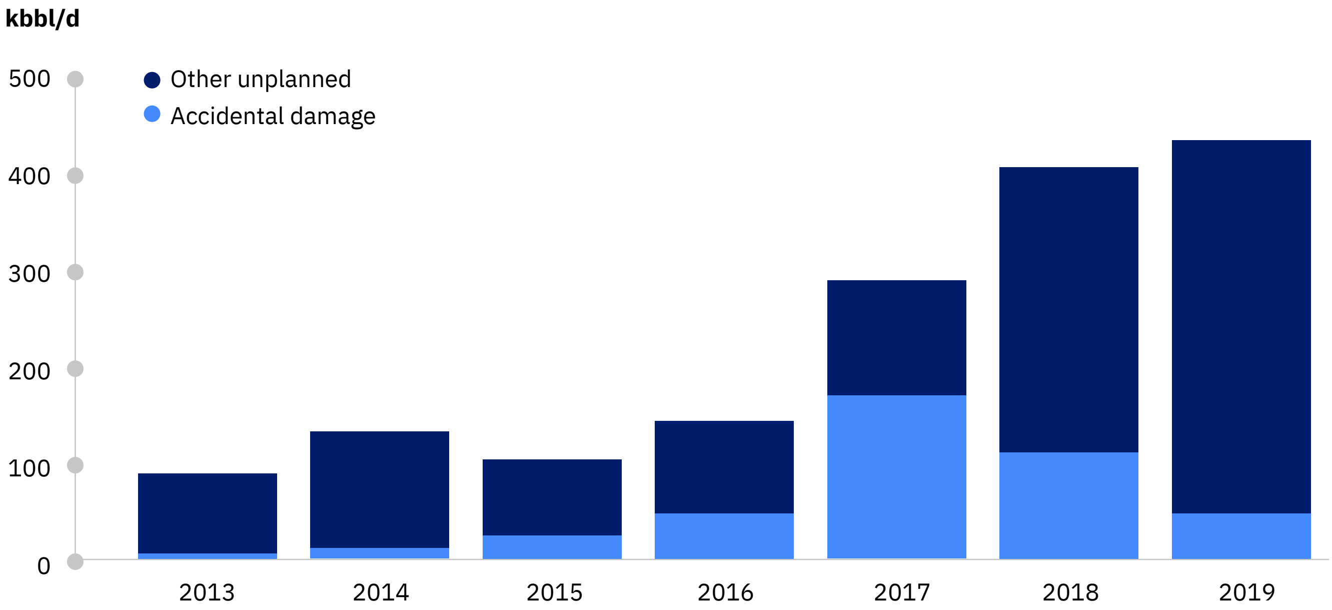
Worldwide unplanned outages caused by damage or failure can result in production lags of thousands of barrels of oil per day (see Figure 1). While production losses caused by accidental damage are on the decline, unplanned failures are on the rise. An average offshore oil and gas company experiences about 27 days of unplanned downtime a year, which can lead to annual losses from USD 38 million to upwards of USD 88 million.[1]

Here lies the sweet spot for production optimization where traditional predictive analytics can be augmented by AI-enabled predictions and natural language understanding. AI can help fix costly downtime by monitoring and predicting equipment failures and highlighting the business impact of unprepared loss of production capacity.[2]

Production optimization is at the core of operations and critical workflow, and a fundamental capability for operators. It spans activities performed to get the greatest output from facilities and fields. While the objective might sound simple, it contains nuances that influence which disciplines will be involved and which decisions must be made.

—

Figure 1
Barrels of oil lost daily to downtime (global average)



Source: Rystad Energy OilMarketCube, https://www.rystadenergy.com/newsevents/news/press-releases/ai-could-fix-costly-downtime/

The analytical approach can’t be static

Boosting daily hydrocarbon output from one surface facility is a contained optimization challenge, also referred to as “asset sweating.” Meeting hydrocarbon volume demand from multiple facilities that don’t all produce at their highest capacity requires multi-plant optimization. Optimization needs to extend to individual plant allocation, where cost, activities that impact production, and sustainability are sorted by short, mid, and long-term timeframes.

Historically, operators have used heuristic—or discovery—techniques to address complexities in modeling options to capture a current state and predict a future one. Today, discovery is a key aspect of machine learning—one subset of AI. For example, data discovery impacting production is the probability of machine failure under certain operational conditions. Data takes many forms: sensory from systems, volumes measured in production processes, or even weather forecasts that allow AI models to discover patterns that can highlight the risk of disruption.

Production optimization challenges

The concept of production optimization can be perceived differently by various disciplines in the workflow. For example, a sole focus on amplifying daily revenue is a poor proxy metric if the intention is to increase the net present value of the life of a field. In that case, models must go beyond physical boundaries of individual production facilities to explore influenceable, producible volume and consequences over time.

Outside production facilities, geoscientists might identify different reservoir drainage options that will impact recoverable volumes, cost, and variances over time. For example, what might allow for higher production volume in the early phase of a field could also negatively impact what's ultimately recovered during its lifetime. Higher initial volumes require more processing capacity than lower—and more sustainable—volumes over time. This tradeoff not only illustrates the complexity of production optimization, it highlights the need to define and truly understand what is meant by "improved performance."

Success depends on collaboration

A corporate strategy to have higher short-term volumes could mean sacrificing the amount of oil that can ultimately be recovered. In mature fields, also known as "brownfields," operational expenditure is under intense pressure as existing wells deteriorate and older equipment needs maintenance. If fewer new wells come online, operations costs must be carried by fewer produced barrels, resulting in higher lifting cost per barrel of oil and a shortened economic life of the field.

An integrated philosophy promotes collaboration, and a shared situational awareness and view of activities and interdependencies that impact decision making from rock pore to pump. Getting there requires a holistic and detailed view of the field, a clear understanding of the subsurface, the surrounding environment, and the production system and its boundaries.

Insight: AI isn't only one technology[3]

A set of technologies and building blocks, natural language processing (NLP), machine and deep learning, neural networks, virtual agents, autonomics, and computer vision all contribute to AI.

An AI platform that learns from data to understand operational states and failure modes of assets can warn of impending asset failures.

Applying AI to improve production optimization must be done flexibly to weigh objectives and be able to change decision criteria over time. Organizations need to understand what levers can be changed and prioritize those in the context of non-influenceable aspects, such as the market price of oil.

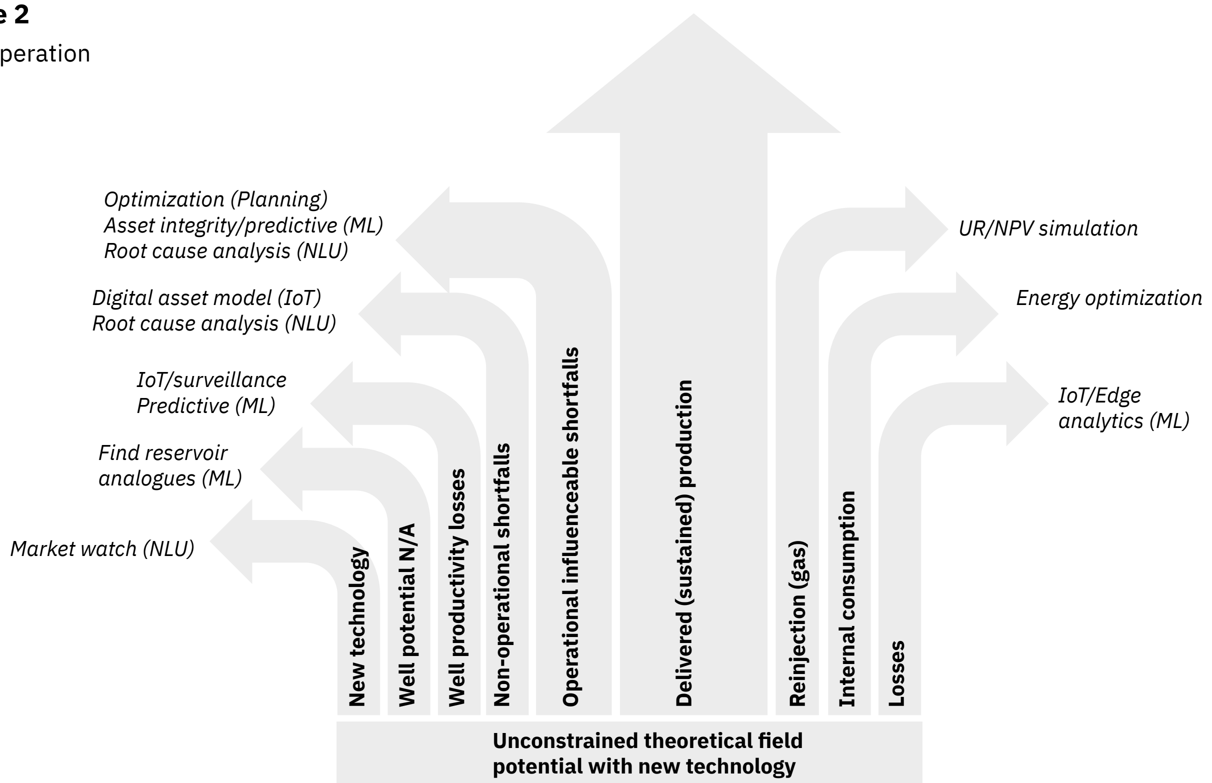
AI will impact economic life and returns as far as operators can exploit the possibilities of an unconstrained theoretical field potential (see Figure 2). Actual production can be influenced by disciplines involved and how categories of AI are applied. For example:

- Machine learning (ML) can identify patterns preceding undesired events in sensory data, which may trigger intelligent workflows and enable automation to maintain asset integrity. AI/ML can help identify similar fields, or analogues.
- Natural language understanding (NLU) can analyze text, such as incidence reports and work-orders, to find lessons learned, recurring problems, and root causes of unplanned downtime that threaten production efficiency. AL/NLU analysis of unstructured data can support surface options considered, applied, and their results.
- Improved data capture from intelligent devices and the Internet of Things (IoT) can enable AI supported optimization decisions in the field, creating more holistic analysis.
- Ultimate recovery—of hydrocarbons—and the net present value (UR/NPV) of a field depends on technologies and processes applied, investments required, and the resulting cash flow.

—

Figure 2

AI in operation



Source: IBM Global Markets analysis.

Data scientists have addressed some areas with success, such as predictive models to improve insight of asset health. The opportunity, now addressed by AI, is augmenting principle physical models with the increasingly available sensory data now available. Using AI with machine learning and different techniques of supervised and unsupervised learning is significantly improving insight and warning time, allowing for remedial actions to avoid or reduce non-productive time.

Production system and AI inflection points

Unlocking the potential of assets means looking at earlier lifecycle stages, including subsurface domains, to conduct upfront evaluations and manage uncertainties. Over the past few years, the number of subsurface technology development partnerships has grown (see sidebar, "BP Ventures and Saudi Aramco Energy Ventures: Open innovation investments"). Analysis of large multidisciplinary data sets is needed to understand the subsurface for reserve planning, categorizing reservoir properties, and field development planning.

An AI system using tools such as machine learning, artificial neural networks, expert systems, and fuzzy logic can analyze data from seismic surveys, geology evaluations, and reservoirs (see sidebar, "Repsol Technology Lab: More effective interaction between humans and computers"). This analytical approach might improve the global average underground recovery factor by up to 10 percent, equivalent to unlocking an extra USD 1 trillion BOE.[4] Subsurface initiatives might yield production improvements of about 15 to 30 percent.[5]

BP Ventures and Saudi Aramco Energy Ventures: Open innovation investment[6]

Venture capital firm BP Ventures' investment in Belmont Technology, and Saudi Aramco Energy Ventures' investment in Earth Science Analytics demonstrate the shift toward open innovation models and technology development partnerships. These startups are developing cloud-based platforms that incorporate AI and machine learning to improve the outcomes of geoscience interpretation workflows.

Repsol Technology Lab: More effective interaction between humans and computers[7]

The Repsol Technology Lab combined its Pegasus Project with Excalibur, a mathematical tool capable of comparing geological reservoirs, to conduct upfront evaluations using AI. Oil models can help improve the safety, efficiency, and profitability of upstream operations, and explore hypothetical scenarios in the search for hydrocarbons. In testing, Repsol obtained an improvement of 9 percent over the best solution published to date by other companies and reputable research institutions.

AI will have a critical impact on the future of oil and gas; 91 percent of industry decision makers said they expect to invest in cognitive computing in the future.[15]

Ambyint: Artificial lift meets artificial intelligence[10]

Canada-based Ambyint offers an AI-driven, artificial lift solution for monitoring, operations, management, optimization, and analytics of oil wells. The combination of the Ambyint platform and high-resolution adaptive controllers that function like a production tech at the well site 24 x 7 can help deliver 20 percent reductions in operational expenses, and 10 percent production improvements.

Solution Seeker: Real-time, data driven production optimization[11]

Technology spin-off Solution Seeker—in partnership with PTT Exploration and Production Public Company Limited (PTTEP)—uses AI to analyze thousands of historical and live production data streams. By identifying field behavior and relations, and automatically and continuously providing up-to-date prediction models, it can determine optimal production settings.

Boundaries and bottlenecks

A number of unknown challenges exist in the production system:

- Continuous change occurs with reservoir, well, and flow dynamics as the reservoir is drained and the production system is modified.
- Production data is typically limited.
- Key sensors might provide inaccurate measurements or fail over time.
- Bottlenecks can arise.
- Current operating parameters need to match the specifications of process equipment.
- Throughput must be balanced with short-, mid-, and long-term objectives.
- Safety is paramount in operating environments.

The production team needs to continuously optimize and tune production settings. Examples include identifying optimal choke settings, flow rates, pressures, gas lift allocation, well routing, and pump speeds. There are tens or hundreds of production settings to be adjusted, and thousands, millions, or even billions of relevant combinations to be considered.[8] This problem is managed using spreadsheets or systems that have become silos of data.

AI and analytics present a holistic view of the data surrounding a production system, analyzing the variables that are critical to production, and recommending optimal operating parameters. Leveraging AI can enable automatic pattern recognition and classification to refine production data for generating insights. With the help of analytics, AI systems can develop estimation and prediction models.

AI can separate reservoir effects from production control responses that include gas lift rates, choke positions, network routing of the wells, and artificial lift equipment (see sidebars, “Ambyint: Artificial lift meets artificial intelligence” and “Solution Seeker: Real-time, data driven production optimization”). For example, The Intelligent Plant Ltd. Project is developing technology that may potentially increase production from complex facilities by more than 1 percent of each field.[9] Instead of testing wells individually, this new technology uses data and machine learning to optimize the entire system.

Predicting, analyzing, and limiting events

Production engineers and operations managers plan for and do their utmost to protect assets when unforeseen conditions occur. Yet outages cost the industry significant losses and impact global supply balances.

Currently, assets are typically monitored and inspected on a set schedule based on limited performance information compared with historical data. This leads to operations being at risk from unintended events. Wells and equipment need to be ranked and prioritized based on business outcome to make the impact of decisions visible. This includes single metrics like volumes, revenue, costs, and cash flow, and more complex metrics for safety and sustainability.

A modern offshore production platform can have more than 80,000 data tags capable of streaming real-time data, including temperature, pressure, and well conditions.[12] Data flows out from well sites, pipelines, equipment, and distributed control systems, but insight might be challenged by outdated legacy systems. Cognitive predictive maintenance, much like prescriptive maintenance, uses computer programs to harness the flood of unstructured and external data, such as weather and benchmarking performance data. It then relies on this information to predict asset failure and maintenance needs and create recommendations that can help stop operational challenges from becoming full-on failures.

Physics-based AI software company Tachyus, for example, has developed a platform for geoscientists and reservoir engineers to more quickly interpret data collected from sensors and monitors in the oilfield. The platform collects and integrates data from seismic activity, drilling logs, completion designs, production data, and maintenance records. Physical modeling and machine learning help the platform predict mechanical equipment failure and recommend operational improvements.[13]

Another example, eLynx Technologies launched predictive-analytics-as-a-service (PAaaS), a suite of predictive maintenance software products that forecast oilfield problems—everything from when equipment is about to break to downhole events such as liquid loading—before they happen. The plunger lift predictive maintenance product saved one producer USD 710 per month per well; for a 500-well field that translates into USD 4.2 million in annual savings.[14]

Action guide

How AI can pump new life into oilfields

1. Leverage AI for geoscience

To better understand reservoir characteristics and production potential, engage AI to: visualize the probability of assumed properties; predict missing properties; improve production prediction accuracy; enhance emulsion production prediction accuracy; and reduce the time needed to interpret seismic image interpretation.

2. Model the production facility

Create multiple scenarios to determine optimal conditions. Understand the potential “chokes” that could affect overall throughput, and predict probability and impact based on real-time condition monitoring. Learn from previous and similar situations to inform possible actions to mitigate production shortfalls.

3. Construct an early warning environment

Use machine learning and constant sweeping of sensor data to detect patterns that can help predict, prepare for, or prevent failures. This includes predictive drilling analytics, and monitoring electric submersible pumps or surface equipment. Beyond the producing facility, analytics can be used to detect oil and gas leakage or understand how weather conditions could impact scheduled operations.

Notes and sources

1 Shiklo, Boris. "Make data the new oil: IIoT-enabled predictive maintenance for oil and gas." *Connected World*. February 2019. https://connectedworld.com/make-data-the-new-oil-iiot-enabled-predictive-maintenance-for-the-oil-and-gas-industry/

2 Rystad Energy. "AI could fix costly downtime." October 18, 2019. https://www.rystadenergy.com/newsevents/news/press-releases/ai-could-fix-costly-downtime/

3 Christopher, Elena, Glenn Finch, and Cathy Reese. "Artificial intelligence: The killer app for data." IBM Institute for Business Value. February 2019. https://www.ibm.com/downloads/cas/WQX3QOYR

4 McKinsey & Company. "An analytical approach to maximizing reservoir production." September 2017. https://www.mckinsey.com/industries/oil-and-gas/our-insights/an-analytical-approach-to-maximizing-reservoir-production

5 Ibid.

6 Seto, Carolyn. "Open innovation investments in the upstream: A new model for subsurface technology development?" IHS Markit. July 2019. https://ihsmarkit.com/research-analysis/open-innovation-investments-in-the-upstream-technology.html

7 "A better world: Pegasus-Excalibur." Repsol. 2019. https://www.repsol.com/en/energy-and-innovation/a-better-world/pegasus-excalibur/index.cshtml

8 Dale, Bjørn-Erik and Vidar Uglane. "Artificial intelligence in oil and production." *Geo ExPro Magazine*. August 2018. https://www.geoexpro.com/articles/2018/08/artificial-intelligence-in-oil-gas-production

9 The Oil & Gas Technology Centre. 2019. https://www.theogtc.com/projects/live-projects/intelligent-plant-well-intelligence/

10 "Spartan Controls becomes exclusive representative of Ambyint in Western Canada." Spartan Controls. January 2018. https://www.spartancontrols.com/news/2018/jan/spartan-controls-becomes-exclusive-representative-of-ambyint/

11 "PTTEP partnering with Solution Seeker in their drive for Digital Transformation." Solution Seeker. September 2019. https://www.solutionseeker.no/journal/2019/09/pttep-and-solution-seeker

12 Sanghavi, Sundeep. "Why the time is right for cognitive predictive maintenance in oil, gas." Hart Energy. October 2017. https://www.hartenergy.com/opinions/why-time-right-cognitive-predictive-maintenance-oil-gas-122588#p=full

13 Luck, Marissa. "Houston AI startup headed for hiring spree after raising funds." *Houston Chronicle.* May 2019. https://www.houstonchronicle.com/business/article/Houston-AI-startup-headed-for-hiring-spree-after-13914523.php

14 "eLynx Transforming Oil and Gas with Groundbreaking Predictive Analytics." eLynx Technologies. September 2018. https://www.elynxtech.com/press-release/elynx-transforming-oil-and-gas-with-groundbreaking-predictive-analytics

15 Womack, David, Richard Cave, Mike Foden and Matthew Stent. "Exploring the power of cognitive IoT." IBM. October 2016. https://www.ibm.com/industries/geos/chemicalspetroleum/assets/IBM_Whitepaper_Exploring_the_power_of_cognitive_IoT.pdf

About Expert Insights

Expert Insights represent the opinions of thought leaders on newsworthy business and related technology topics. They are based upon conversations with leading subject matter experts from around the globe. For more information, contact the IBM Institute for Business Value at iibv@us.ibm.com.

IBM Corporation
New Orchard Road
Armonk, NY 10504
Produced in the United States of America
February 2020

35030335USEN-00