



Chevron Corporation, based in San Ramon, Calif., is one of the world's leading integrated energy companies.

All photos courtesy of Chevron.

Operations research at Chevron

From solving conventional problems to solving common problems unconventionally, Chevron applies data science across the enterprise.

**By Shira Hetz and
Margery H. Connor**

In a company as large and complex as Chevron, the opportunities to apply data science, operations research and decision analysis techniques to business challenges are numerous and create significant value. Chevron Corporation, based in San Ramon, Calif., is one of the world's leading integrated energy companies, which means it participates in every aspect of the oil and gas business. This includes exploration, production and transportation of oil and gas; the refining, marketing and distribution of transportation fuels and lubricants; and the manufacture and sale of petrochemicals and additives.

From reservoir models to simulate the flow of fluids using seismic data, to managing flow of oil from the well to the retail pump, to forecasting resources for the success of major capital projects, Chevron's experienced analytics professionals consistently generate valuable business insights for the business to make data-driven decisions.

All About the Roundtable

Its size and scale are just part of Chevron's strength. As an employer, Chevron boasts a very strong culture described in "The Chevron Way" [1], which emphasizes a core set of values and strategies that include investing in people to develop and empower a highly competent workforce. In fact, *Forbes* magazine ranked Chevron as the sixth happiest company to work for in 2018, outranking its oil and gas competitors by a large margin. This is partly because Chevron hires for a career at the company and not for a specific role. The company carefully manages employees' careers to develop the breadth and depth of knowledge in various areas of the business while aligning development opportunities with employee's interests and career aspirations.

"At Chevron, we firmly believe that by fostering diversity and inclusion, we foster our success," says S. Shariq Yosufzai, vice president of Global Diversity for Chevron. "Diversity and inclusion helps our employees achieve their full potential, leading to greater innovation and higher performance. By aligning and inspiring the workforce, building strong relationships with business partners and deliberately developing organization capability, we deliver results that positively impact the bottom line."

In 2015, Chevron was awarded the INFORMS Prize for effectively and repeatedly applying the principles of advanced analytics and operations research/management sciences in pioneering, varied, novel and lasting ways.

This article provides readers with insight into Chevron as a company focused on its employees and their contribution to the fields of operations research, data science and decision analysis.

Operations Research

Chevron has a long history of applying operations research. Early efforts included the use of linear programming for refinery planning in the early 1970s. Refinery planning is the process of



By the numbers, Chevron is a huge international company with operations around the globe.

The Roundtable consists of the institutional members of INFORMS with member company representatives typically the overall leader of O.R. activity. The Roundtable is composed of about 50 organizations that have demonstrated leadership in the application of O.R. and advanced analytics. The Roundtable culture is peer-to-peer, encouraging networking and sharing lessons learned among members.

The Roundtable meets three times a year. Roundtable goals are to improve member organizations' OR/MS practice, help Roundtable representatives grow professionally and help the OR/MS profession to thrive. Further information is available at <http://roundtable.informs.org>.

The Roundtable also has an advisory responsibility to INFORMS leadership. According to its bylaws, "The Roundtable shall regularly share with INFORMS leadership and advise the INFORMS Board on its views, its suggested initiatives and its implementation plans on the important problems and opportunities facing operations research and the management sciences as a profession and on the ways in which INFORMS can deal proactively with those problems and opportunities." The Roundtable Board meets with the INFORMS Board each spring to discuss topics of mutual concern.

This series of articles aims to share with the INFORMS membership at large some information and insights into how O.R. is carried on in practice today

optimizing the process of converting crude oil into gasoline, jet and diesel fuels, as well as lubricants and specialty products such as additives. Chevron produces but also purchases crude oil; acquiring crude at a competitive price is very valuable. The ability to process almost two million barrels of crude oil per day means an improvement of one cent per barrel is worth millions of dollars annually.

As the operations research competency progressed through the next decades, it evolved into distributive recursion-based linear programming as a foundation for an in-house software tool called Petro. Petro has been used by Chevron in decision-making for more than 30 years and has generated approximate \$10 billion in value. Mike Wirth, Chevron's chief executive officer, has noted that it's an excellent example of how operations research and analytics contribute to the competitive success of the company.

Petro considers a long list of dynamic variables and helps analysts advise crude traders on optimal bids for respective market conditions. Analysts trained on the tool work in the refineries and next to traders in each of Chevron's trading hubs in Houston, London and Singapore. Petro processes 400 to 500 variables associated with crude oil characterization, along with thousands of refinery-capability variables, to arrive at the most valuable operations parameters within a few seconds. In addition, Petro analysts advise refinery operations and product traders on the most economic mix of products to produce, buy or sell.

Petro scenarios results are also used in discussions with the Environmental Protection Agency and the California Air Resources Board to analyze different fuel

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Chevron workers in Duri Field in Sumatra, Indonesia.

While Chevron
has been
applying analytics
to
various parts
of its
business for decades,
the company
has recently emphasized
the need to
scale up data science
across the
enterprise
in a
systematic way.

blends being considered for future regulation. The collaboration with external agencies is central to Chevron's goal of supporting the community and environment through scientific and technological discoveries.

Chevron also employs operations research techniques for the optimization of chemical plants to increase productivity and the optimization of schedules for large crude carrier vessels.

Data Science

"Advanced analytics and operations research are critical to helping us stand out from the competition and deliver significant advantages," states Bill Braun, chief information officer of Chevron.

While Chevron has been applying analytics to various parts of its business for decades, the company has recently emphasized the need to scale up data science across the enterprise in a systematic way. In addition to solving traditional petrotechnical challenges based on physical models, Chevron is now combining the knowledge of engineers with that of experts in data science who provide insights with advanced computing tools such as machine learning algorithms.

"Data scientists are solving real and complex challenges that directly impact the company's operational and financial performance," says Justin Lo, data science team lead in Chevron's Modeling & Analytics Center of Excellence. "We have generated over \$100 million of quantifiable value using data science in the last three years and are building up data science organizational capability to drive capital efficiencies across the company." Business managers are charged with ensuring that data scientists are working on the highest priority items and that the project solutions are being deployed and adopted by business end users to

drive performance – which gives them a stake in the outcome.

In addition, data science is being applied beyond engineering and physical models. For example, Chevron data scientists are working to unravel the mystery of the unconventional reservoir for Chevron. Unconventionals, also known as tight oil, or oil that is found in low-permeability rock, poses a unique set of challenges. By applying machine learning to its proprietary database of petrophysical, completions and production attributes and implementing the completions design into its workflows to efficiently and cost-effectively develop economic and high performing wells, Chevron has significantly improved

performance in this important asset delivering value even at low oil prices.

From solving conventional problems for the unconventional reservoir to solving common problems unconventionally, Chevron has also applied data science to operational challenges in its deep-water assets. The Loop Current in the Gulf of Mexico influences many industries that operate in the gulf.

Data scientists at Chevron are working on a long-range model to predict the position of the Loop Current and the eddies it spawns to ensure activities such as platform installation and drilling operations are scheduled to avoid these features. If successful, the model could also provide benefits to marine transportation routing, the fishing industry, naval operations planning and regional assessment of intense hurricane risk.

Other data science initiatives underway include work in procurement and supply chain, audit and finance, drilling and completions and facilities engineering. These activities are closely governed to ensure they will directly impact the bottom line and improve the ability to protect people and the environment.

Decision Analysis

As with O.R. and data science, Chevron has a long history of leveraging decision analysis to make strategic decisions and there is great depth of knowledge in this methodology. It is also a core requirement for all major capital projects. The decision analysis tools include stakeholder analysis, project scope framing, decision criteria and incorporating uncertainties. All Chevron managers are trained on how to use and interpret these analytical products.

Decision analysis was adopted at Chevron in 1991, and within a year, more than 1,500

individuals had participated in multi-day courses. Today, decisions analysts work across Chevron with more than 200 employees dedicated to using the practice. Chevron's commitment to decision analysis is exemplified in the use of a proprietary decision tree software, Simultaneous Decision Analysis, which is used by upwards of 1,300 employees. The decision analysis career ladder is a well-defined track intended to provide challenging opportunities, growth and increased responsibility for each practitioner in every role. Professional development is fostered through education programs, mentorship, internal conferences and external activities. Annual internal conferences attract more than 100 attendees from across Chevron.

The commitment to decision analysis starts the first day: All college graduates in scientific and engineering career fields participate in a development program that includes three days of classroom instruction in decision analysis. More than 500 employees participate in the course annually, ensuring all Chevron's earth scientists, engineers and technologists are familiar with decision analysis and the associated tools from the very start of their career.

Chevron was formally recognized in 2015 by the Society of Decision Professionals for exemplary organizational decision quality with the inaugural Raiffa-Howard Award at the Decision Analysis 50th Anniversary Gala. The Award's Board of Examiners noted that, "Chevron culture is infused with decision quality. Decision-makers ... understand decision analysis and expect evidence in their decision recommendations." Chevron was also awarded the INFORMS Decision Analysis Practice Award in 2010.

Growing Organizational Capabilities

The demand for advanced analytics at Chevron continues to grow rapidly, and it is met by a balance of new college graduates and experienced external hires. The professionals working in this space have degrees in engineering, operations research, math, computer science, statistics and other related fields. Many have advanced degrees.

Information technology leadership established a central Modeling and Analytics Center of Excellence (COE) in Chevron's Information Technology Company (ITC) to build a team with standardized training, technology and terminology. They do internal consulting to solve some of Chevron's toughest challenges, from reducing well development costs to asset reliability. There are currently 15 data scientists in the COE and another 20 in the business.

To spark interest and to identify employees with advanced analytics skills and passion who might be

good candidates for data science roles, ITC hosts internal data science competitions. Two competitions are being planned for 2018. In addition, a data science development program matches prospective data scientists with a mentor to work on a targeted data science project.

The COE and ITC culture is dynamic and team oriented. Data scientists can focus on one area of Chevron's business or work in different areas of the business. They collaborate to solve challenges by sharing ideas and leveraging each other's experiences. The Modeling and Analytics Community of Practice (CoP) has more than 1,000 members and hosts monthly technical talks, as well as a two-day forum focused on knowledge transfer.

What is Next?

Chevron has a long history of leveraging data and technology. Today, efforts to accelerate the adoption of emerging technologies are well underway. These include increased automation, the Industrial Internet of Things, augmented reality, blockchain, leveraging the cloud and harnessing the power of data science. With new solutions and insights, some of which were discussed in this article, the Chevron workforce continues to consistently elevate and evolve the company's ability to power progress around the world. Chevron generates huge amounts of data, and opportunities to solve real business problems is endless. This is the perfect place for job satisfaction. Every employee is offered challenging work assignments, receives leadership and peer recognition and has a direct impact to influence capital gains for the company. **ORMS**

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