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SPECIAL REPORT ARTICLE January 2021

Artificial intelligence in the Canadian oil patch

BY ALICIA QUESNEL AND MIKE HENRY

The Canadian oil and gas industry has experienced unprecedented challenges in recent years. The US shale gas and tight oil boom, and increased production from the Organization of the Petroleum Exporting Countries (OPEC), have resulted in an oversupply of oil and gas on world markets. Simultaneously, alternative energy sources gaining prevalence and cost competitiveness, and the fall in energy demand due to the coronavirus (COVID-19) pandemic, have restricted global demand for oil and gas.

These forces have combined to put significant downward pressure on oil and gas prices around the world. The factors affecting both the demand and the supply side are exacerbated in Canada, which faces structural difficulties in transporting its commodities to refining and consumption centres in the US.

Many have referenced these challenges when forecasting the long-term decline of the Canadian energy industry. Despite these issues, the Canadian energy industry continues to hold an important place in global energy production. Canada's oil and gas is produced under the strictest environmental management regime in the world. As global demand for these fuels is expected to continue to increase for the next 20 years and beyond, it makes good sense for that demand to be satisfied with the safest, most responsibly developed resources.

Canadian energy companies have undergone an unprecedented evolution in the past 10 years. Industry players have had to bring down the cost of production substantially to stay competitive and have instituted strict governance to ensure environmental responsibility. These efforts have been geared toward providing energy that is cleaner and safer, while remaining cost competitive with the rest of the world.

Artificial intelligence (AI), and the associated technology of machine learning (ML), is helping to achieve the goal of making energy production cleaner, safer and more cost effective in Canada. At a critical turning point in the future of the industry, new applications of AI and ML may be the breakthrough that Canadian energy companies have been waiting for.

The precise definition of AI has been heavily contested in academic and legal circles. This analysis relies on the definition offered by Jacob Turner in his book 'Robot Rules, Regulating Artificial Intelligence'.

Turner defined AI as "the ability of a non-natural entity to make choices by an evaluative process". This definition gets to the heart of AI's process and abilities, and includes such concepts as neural nets (the ability to simulate human thought through a network of decision-making nodes) and ML (the iterative process of testing and refining hypotheses by processing large quantities of data). As ML is covered in this definition of AI, this article refers to true ML applications as applications of AI as a whole.

AI technology is being applied in not-for-profit innovation centres like the Alberta Machine Intelligence Institute (AMII), and in major corporations like Canadian Natural Resources. AMII has recently advised Imperial Oil on a range of AI projects aimed at reducing environmental impacts, improving worker safety and increasing production efficiency. Canadian Natural Resources has announced its desire to implement an AI-based strategy to optimise production and the flow of resources across multiple facilities, a challenge that has only recently become possible to address with AI's increased processing abilities.

AI-powered predictive maintenance

A common criticism of both the upstream and midstream oil and gas industries is the risk posed to our environment by spills and leaks. Though rare in Canada compared with the volume of oil and gas produced and transported on a daily basis, spills can be devastating for the environment in which they occur. Predictive maintenance can prevent spills and similar breakdowns by detecting equipment that is at risk of failure, allowing a company to repair or replace the equipment before that happens. AI can help to automate that identification process, improving its accuracy and reliability.

AI allows energy companies to make sense of the previously insurmountable quantity of data now becoming available to them. By coupling AI with the increased data collection allowed by more sophisticated and plentiful sensors, producers can begin to understand the data points that might indicate imminent failure of a piece of equipment. With enough data and lead time, these companies will be able to replace equipment that is on the verge of failure, preventing a possible spill and saving a great deal of time and money in the resulting cleanup process. AI can also be used to better plan for equipment replacement. If equipment is only replaced when it shows signs of pending malfunction, a great deal of unnecessary labour and materials can be saved and diverted to more productive uses.

Optimised worker safety

There are many jobs in the energy production industry that put human workers in potentially unsafe situations. AI can either take over those unsafe jobs or help monitor those workers more effectively. Major Canadian producer Suncor Energy announced in 2018 that it would expand its fleet of massive autonomous vehicles in the Alberta oil sands after years of successful testing.

Improvements in health sensor technology have allowed energy companies to more closely monitor their employees in the field. Companies can now absorb and track all of the data generated by these sensors and use AI to detect any irregularities that may indicate an employee in distress. As each employee's vital health patterns will be different, AI can track the patterns of a specific individual's health data and more accurately predict when they require medical intervention.

Similarly, AI can be used to review security footage on a worksite to detect and alert the company to examples of unsafe behaviour. Given the quantity of footage amassed by security cameras on large-scale work sites, it would be impossible for humans to observe and report on every unsafe incident the cameras capture. AI allows all of this data to be processed automatically and delivered to management in a format that allows them to easily understand where health and safety risks can be reduced.

From identifying a lack of sufficient personal protective equipment, to smoking in unsanctioned areas, the potential applications of this technology on the worksite are numerous. The most significant barrier to applying AI in this way is that it must be 'trained' on a large database, containing thousands of examples of such unsafe behaviour. Generating this initial database represents a significant upfront investment, but it is an investment that only needs to be made once at the outset of the AI application development process.

Digital twin technology

In every industry, AI evangelists promise that their technology will save money. Due to the volume of data generated in the upstream and midstream energy industries, this promise may be especially applicable. One exciting AI application that may bring about these promised cost savings is digital twin technology, currently used in the aerospace industry and holding significant promise for applications in energy production.

Design problems are inherent in major oil and gas construction projects because of their engineering complexity. Only when the project is being physically constructed do design flaws become apparent, when engineers can observe their design in three dimensions. This leads to expensive mid-project redesign, which can account for up to 30 percent of the cost of major construction projects, and result in blown budgets and costly delays.

VizworX, an Alberta company spun out of two research labs at the University of Calgary, has developed an application of digital twin technology that uses augmented reality to allow engineers and designers to walk through a 3D-rendered model of their design using virtual reality goggles. This helps the engineers understand the flow of products through a facility and make critical design changes prior to the beginning of construction.

Digital twin technology also allows reservoir engineers to create a digital model of an oil or gas reservoir, which can be updated in real time with information from a series of sensors collecting operational data. Engineers can digitally test various production stimulation techniques on the digital twin and observe the production gains and potential adverse consequences that may result. The difficulty of understanding the makeup of a reservoir

located far beneath the Earth's surface can be alleviated by combining advanced sensors with AI to make sense of the ocean of reported data.

AI will not bring back the $140 barrel of oil seen in 2008, but the applications of this rapidly evolving technology hold promise for the struggling Canadian energy industry. Canadian research organisations such as AMII are making great strides in identifying potential applications of AI and working with national and international energy companies to encourage AI adoption. The future 'booms' in the classic boom and bust cycle of oil and gas may be less pronounced in the future as advanced economies turn to more sustainable sources of power, but AI holds the potential to help Canadian energy companies stay competitive in global markets by producing the world's safest, most environmentally responsible fossil fuels. ■