

THE VALUE OF DIGITAL ASSISTANCE

Samuli Bergman, NAPCON, Finland, explains how machine learning can aid operators of oil refineries and petrochemical facilities.

achine learning has the capacity to be a very efficient tool for oil refinery and petrochemical facility operators, where the requirements of end products can change at short notice, and the quality of feedstock can vary widely. Because information is constantly gathered from different stages of the process, there are millions of process values – historical and ongoing – that can be compiled into a machine learning model that predicts process behaviour and provides accurate operation suggestions to operators.

0

An oil refinery operates constantly, and though the process is highly-automised, there are many process variables for operators to supervise at the different process steps. This task is particularly challenging, as product quality requirements can vary with short intervals, which in turn requires a lot of changed process parameters.

A human operator is simply not able to carefully watch every monitor and follow all important process variables simultaneously, which means that digital assistance makes it possible to operate a process with increased efficiency. To address this problem, Neste Engineering Solutions began to develop an AI-based solution built on a machine learning model that demonstrates what happens chemically and physically inside reactors, pipes and columns. The model also covers the automation's effects on the factory.

Making changes

At all chemical processing plants, huge amounts of data are constantly collected regarding flow, temperature, pressure, and other process variables. In addition, there are large amounts of historical data that has been collected over a long period that can be used to teach the machine learning model what a well-functioning process should look like.

The core of machine learning is that the more material that is fed into the system, the more the AI learns about how the factory behaves under different circumstances. When fully trained, the digital assistant can predict how the process will behave during certain hours, for example. Operators can also consult the digital assistant if help with the settings is required. The next development step could be a verbal interface such as Siri, Google Assistant or Alexa, but the fully-developed system is yet to be completed.

Within chemical processes, there are both slowly changing phenomena (such as when the process equipment wears and gets dirty on the inside or when the catalysts in the reactor slowly fade) and fast events (such as when new batches of



Figure 1. The Advisor and/or Phenomena Indicator create dynamic models of an oil refinery process or a petrochemicals unit to optimise process conditions, meet production objectives, or detect malfunctions.

feedstock are fed into the process, which must be changed accordingly). Process units must adapt to these changes, and it is here that a digital assistant could shine, as it can be used to calculate how the process could be optimised, and instruct operators as to how to reach the goal.

Prolonged service intervals

Because a digital assistant carries out the calculations continuously, the machine learning model is constantly changing and evolving. The advice applies mainly to factors such as temperature and pressure, and the idea is that the operator implements the advice by changing the set points in the process control system.

Of course, it is the operator's normal job to handle these factors, but by using the digital assistant's advice, the measures can be scheduled more precisely in difficult situations. It is also more likely that the setting values are correct, as the AI model can sort out enormous amounts of data in a fraction of a second, and apply this wisdom to aid the operator.

Al can also be used to extend the lifetime of the process equipment, which can result in prolonged service intervals and smoother running processes. If, for example, the wrong temperature or pressure is used, the components of the plant wear faster, but for a digital assistant, it is not difficult to always find the optimal value at different stages of the process. This could mean that a production shutdown for service can be postponed, which in turn corresponds to better earnings.

The digital advisor's situation-specific optimisation also helps to reach the true limits of a plant, whether there is a need to reduce carbon emissions, optimise utilities, or maximise certain yields.

Inside information

Neste is the one of world's largest producers of renewable diesel, but the company also has a subdivision, Neste Engineering Solutions, which implements Neste's innovations on an industrial-scale; carries out major industrial investment projects; and helps its customers in the process industry to continuously develop their production and to optimise their processes. One of Neste Engineering's units,

NAPCON, specialises in the development of solutions to help companies in the process industry to streamline their processes.

Many of NAPCON's solutions are tried and tested at Neste's refinery in Porvoo, Finland, but the company also sells its expertise to third parties that want to have better control over their processes. The digital assistant, NAPCON Advisor, and the soft sensor,



Figure 2. A digital operator assistant predicts the dynamic behaviour of process variables; creates what-if scenarios to allow operators to test various operative scenarios; and suggests what changes should be made in order to meet operation objectives.

WORKSHOP

Workshop to identify the right fit

OFFLINE MODELS

Offline implementation to check the feasibility of the ML model Working offline solves the deviations of the data without disturbing production

TRANSITION TO ONLINE

Implementation of the verified offline models to the production site

NAPCON ADVISOR IN PRODUCTION

Onsite application with OPC UA Information Models allows for real time advice Smart Refinery in action!

Figure 3. Seamless cooperation between process and operation experts and machine learning specialists is the key to success in an implementation project for a digital operator assistant. A typical project starts with a workshop where the potential and benefits of a digital operator assistant are identified.

NAPCON Phenomena Indicator, are the latest additions to the company's product portfolio. Both are based on machine learning and AI. These products are an example of how data analysts and machine learning experts have entered the oil refining and petrochemical industry, which until recently has made slow progress when it comes to AI and machine learning.

The products work in real time and use the same data, but from the operator's perspective they are two completely different products. Where Advisor predicts how the process will behave up to six hours ahead, Phenomena Indicator usually predicts just one variable, mostly for which there is no hard or correct information that can be measured in traditional terms.

Complex problems require complex solutions

A typical example of the need for a soft sensor is when a product must meet a particular quality requirement, but can only do so with expensive additives. If more additives are used than are needed, it is just a waste of money. However, with traditional measuring methods it is difficult to continuously estimate certain phenomena during the process because of the many factors affecting the production line. One factor is that the crude oil may come from

different batches. As such, the recipe for a certain product can vary hugely at short notice, which is why a phenomena indicator using the same data as the digital assistant is needed.

The term 'soft sensor' is nothing new in the process industry, but until recently, it has not been based on machine learning. The big difference is that the machine learning model makes it possible to estimate much more complicated things than before. Therefore, an AI-driven soft sensor enables the continuous adjustment of the process so that the product meets the specification, but does not overdo it. Ecologically, this is also the soundest solution because the process uses just the amount of energy needed and no more. Additionally, it is also possible to use cheaper raw materials, as operators have better control over the process.

With a digital advisor and an Al-driven soft sensor rendering the forecasting of what will happen within a few hours possible – as well as the analysis of what happens in

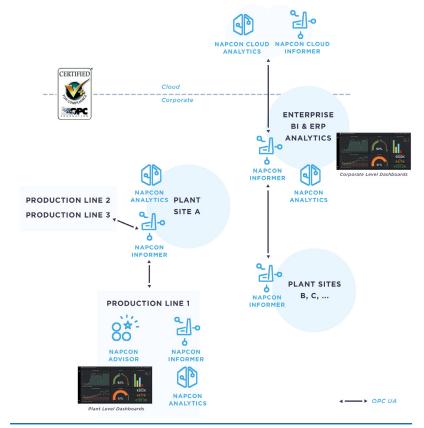


Figure 4. Digital operator assistants are a means to increase situational awareness. There are other important data analytics applications, such as dashboards and other visualisations, that can be implemented on various levels – production line, site and enterprise.

the process under different conditions — oil refineries can make big strides. As huge amounts of data are collected every day at a chemical processing plant, man power is unable to keep up with this volume of information, but a digital assistant can continuously suggest effective means of optimisation.

The value of digital assistance

Many of the experienced operators in the process industry will soon retire and be substituted with younger operators that lack the same experience but who are born into the digital world. This means that a digital assistant can secure competence and support new operators. With the help of a digital assistant, which constantly analyses the process and makes forecasts based on the readings, it is significantly easier for inexperienced operators to run a plant under varying circumstances.