Zied M. Ouertani, ABB, Germany, discusses the digitalisation of the onshore hydrocarbon chain.

A DIGITAL REVOLUTION

Figure 1. Digitally-enabled control rooms facilitate better decisions during operations.

A fourth industrial revolution is underway and, unless players across the onshore hydrocarbon chain embrace the Industrial Internet of Things (IIoT), they risk delivering disappointing shareholder returns in the short-term. They could even put their firms in serious jeopardy as they are leapfrogged by those who use digitalisation to generate quicker and better insights to drive competitive advantage.

Digitalisation is about transforming businesses by collecting timely data and using modern technologies, such as Big Data analytics, to improve products, processes and decision-making in ways that increase efficiency, profitability and customer value while minimising risk. In the oil, gas and chemicals (OGC) industry, this involves measuring devices, sensors and actuators embedded in items – such as wellheads, pipelines and tanks – that exchange real time information to take action autonomously or under the guidance of well-informed operators.

Better connected oilfields, pipelines, terminals, refineries and chemical plants give companies the potential to significantly improve their performance, efficiency, safety and security. Cost-effective digital products and services help provide better monitoring, more collaborative operations and remote management to drive greater productivity at reduced costs and risk.

Eventually boundaries between individual rigs, pipelines, terminals and factories will no longer exist. Instead, they will be interconnected across multiple sites

or even geographical regions, scaling production up or down as best suits the current market conditions.

Today, integration from wellhead to pipeline to terminal to plant is limited to a few large players. Each segment operates as its own silo – otherwise known as 'islands of automation.' Within each segment there are additional islands inside and across sites. Digitalisation offers companies the chance to not only optimise each of these islands but also the entire island chain. Cloud-level computing is the big facilitator as it is much easier to integrate within the cloud, where computing, storage and connectivity resources are plentiful and cheap as opposed to more traditional wired approaches.

The digital wellhead

The digitial wellhead is perhaps the least developed area but it has strong potential. In North America alone there are 2 million wellheads and operators are interested in decreasing the time their staff spend travelling between them to perform maintenance checks. Digitalisation makes it possible to accomplish most of these checks from a distance. It also ensures any action taken is the best choice due to analytics and cloud computing, which help operators more accurately diagnose the situation and apply the most optimal solution based on the available data.

However, not all operations are currently suitable for cloud-enabled optimisation. Data-driven applications like plunger lift and gas lift applications, for example, are good candidates. Real time applications such as keeping temperature, pressures, flow and levels, however, are better handled in the onsite remote terminal unit (RTU). Until there is 100% reliable and instantaneous cloud-connectivity it is too dangerous to always employ digital methods.

The digital pipeline

In contrast to their wellhead counterparts, pipeline operators use digitalisation more extensively. Examples include advanced measurement devices such as data-intensive pipeline inspection gauges (PIGs) and electric flow metering. Yet, there is still scope to optimise operations further through better aggregation and analysis of the data they currently collect to generate new insights.

The growth in unconventional energy, e.g. natural gas and LPG, creates further issues, as it needs to be transported from well sites to refineries, processors and storage facilities. Pipeline companies need to expand capabilities, or adapt ageing infrastructure to track and optimise greater flows of an increasingly complex array of product to and from a variety of new locations. Done properly, digitalisation can help firms use their pipeline data to improve routes to market and react quicker to fluctuating prices and changing volumes.

Case study: Australia

Queensland Curtis LNG (QGC) is the world's first project to turn coal bed methane (CBM) into LNG, producing up to 8.5 million tpy. Through ABB's complete integration of telecommunications, automation and electrification infrastructure, engineering, applications and services, QGC needs fewer than four people to oversee a vast and complex operation via a single operator interface: ABB Ability™ System 800xA. In Chinchilla, a 24 hour control room allows operators to monitor and regulate the operations of wells, processing facilities and a 540 km pipeline consisting of over 6000 wells spread over 3500 km^2. Information is also shared with the Brisbane centre, which oversees operations in Gladstone where QGC's two train liquefaction plants are situated.

The project was delivered with reduced engineering and design cycle times, as well as improved engineering data management and a shorter procurement cycle. There is also a lower cost of ownership along with more efficient process and system availability as compared with other similarly complex operations.

The digital terminal

Digitalisation delivers value to tank and terminal operators in many ways. The most obvious of these is in its ability to cut costs and grow revenues more easily from the same infrastructure by using automation instead of relying on manual labour. Getting trucks in and out of terminals quicker, for example, means more product is processed, while improved order accuracy enables companies to keep more profits from the extra throughput generated.

Getting orders by email or fax is time-consuming and introduces potential for mistakes. By processing orders digitally instead, key information is inputted quickly and accurately into a firm's enterprise resource planning system. Likewise, a digitalised approach to site access means trucks, rail wagons and barges go in and out quickly – yet securely – as permission to enter is granted through card readers and scanners. And once the vehicles are within the site, digitalisation accelerates the activities needed to perform the loading and unloading of products. It can automatically verify orders, generate documentation and monitor volume changes.

Inventories can also be more evenly balanced because digitalisation helps operators better calculate the difference between expected and actual yields to calculate product gains and losses. This is done through a real time record of all terminal operations, used to calculate the theoretical product quantities and produce timely product reconciliations. Additionally, product and additive recipe calculations can be automated, which also improves speed and safety while minimising human error.

Case study: Spain

Compañía Logística de Hidrocarburos (CLH) is a leader in storage, transport and distribution of petroleum products in Spain and is one of the largest private companies in its sector at an international level. The company is currently transforming all 40 of its terminals into entirely unmanned enterprises through the use of ABB's terminal management system. Digitalised site access via truck RFID verification and driver magnetic card scanning means that a process that used to take up

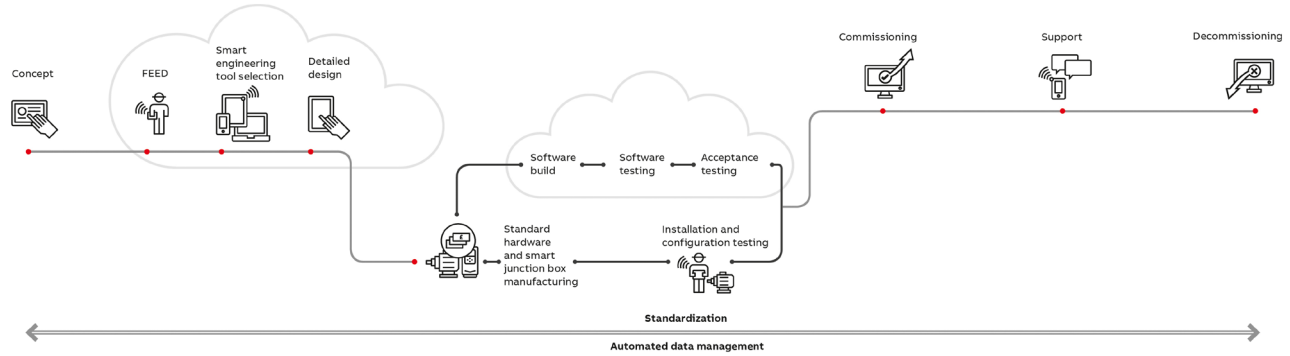

Figure 2. Successful project execution in a digital age leverages cloud-engineering, digital marshalling and automated data management.

Figure 3. Following digitalised site access, trucks proceed to their assigned loading area for automatic filling of the order they have come to receive (©CLH).

Figure 4. Sadara mixed feed cracker at dawn (source: Sadara Chemical Co.).

to 60 minutes can now be done in less than half the time. Trucks proceed to their designated loading area for automatic filling with the product matching the order they have come to get. Automating bill of lading generation, and communication with the relevant tax authorities to authorise the product movement, has also accelerated the process by approximately 10 minutes. A handful of operators at an offsite location uses integrated CCTV to monitor terminal activity remotely. Where required, they can interact with drivers through voice over internet protocol (VoIP) enabled by its integration in ABB Ability System 800xA.

The digital plant

Downstream petroleum and chemical players are even more mature in using digital technologies to enhance performance. However, even here, there is much more that can be achieved. For example, considering that significant capacity is coming online in areas such as ethylene cracking, project execution can be streamlined through digitalisation to cut cost, schedule and risk. At the other end of the spectrum, digitalisation can also be used to improve the performance of ageing assets and extend facility lifetimes.

The two case studies presented next cover both extremes.

Building and operating the largest petrochemical complex built in a single phase

Sadara represents a unique alliance between Saudi Aramco and The Dow Chemical Company who came together through shared values and a dedicated vision to develop and serve the Middle East market with chemical products that had never before been produced in the region.

The project scale was huge. In a short time-frame, 26 plants needed to be built as part of this US$20 billion project, and 15 different EPCs (engineering, procurement and commissioning) were involved from different countries. Once operational in 2017, the mega-site needed to operate efficiently from start-up and for the decades to come.

There are 70 operator consoles, across five control rooms, operating 18 distributed control systems, and a single operator is able to take on a range of complex, interlinked tasks that are central to the efficient operation of the facility.

By deploying a range of digital tools such as cloud engineering, digital marshalling and automated data management, ABB as the main automation contractor brought Sadara online with reduced CAPEX and lower engineering costs. The site also benefits from improved economies of scale.

High fidelity simulation systems were used extensively early on in the project to test applications and to train operators even before start-up and commissioning. Now that Sadara is up and running, these 'digital twin' capabilities are being used to simulate scenarios so that operators can pick the best process control option by knowing – ahead of time – which action will maximise the desired outcome.

The site's scalable design allows it to meet future needs and integrate new technologies in a digital environment.

Digitalising control system migration projects

Trinseo is a large global chemical materials solutions provider and a manufacturer of plastics, latex binders, and synthetic rubber. Because of its history, it had a large installed base of legacy systems, which faced challenges related to ongoing support. It was necessary to migrate 100 000 input/output devices integrated within production management and business processes and systems, without impacting Trinseo's key performance indicators.

ABB partnered with Trinseo to create CAFÉ software which automates the process of creating a digital twin that provides the functional specifications for new and migration projects along with simulations later on. It uses a procedural automation-based control philosophy to turn functional specifications into control applications in the ABB Ability System 800xA. It builds a reverse-engineered functional specification from the object-based legacy code. The software can be used to maintain code and provide updated design documents throughout the lifecycle of a plant.

The software has accelerated Trinseo's use of simulation for testing, training and plant life cycle change management purposes. Instead of taking months to build a model, it can now be achieved in minutes. These models enable the company to find leaks, test alarm limits and tank material balances, check the directionality of all control loops, along with many other benefits.

This digital solution helps eliminate a significant amount of customisation and effort (particularly in the form of repetitive, low value tasks) that had previously been required, already resulting in significant CAPEX reductions. The savings are likely to become even greater when Trinseo starts using standard, repeatable templates more widely. In fact, the company estimates that it will achieve over a 50% reduction in total life cycle cost of ownership for its application software, as well as the training and change management benefits.

Conclusion

The digital revolution is already transforming the OGC sector by helping companies to cut costs, improve productivity and minimise risks across the onshore hydrocarbon value chain.