Cost overruns and schedule delays continue to plague many LNG projects worldwide. This, coupled with the approximately US$200 billion worth of projects in pre-final investment decision (FID) across the globe – all of which are vying to meet LNG demand growth – is putting increased pressure on project stakeholders to reduce the total cost of ownership (TCO) of facilities in order to remain competitive.

In recent years, digital transformation has emerged as a powerful lever for helping engineering, procurement and construction (EPC) contractors and operators achieve both incremental and quantum improvements in the development and performance of LNG facilities and associated assets. However, harnessing digitalisation to its fullest potential requires careful upfront planning, ideally in the form of a ‘digital roadmap’ to identify long-term opportunities, and to ensure cost-effective implementation from the earliest stages of development. It also requires a well laid out cyber defence strategy, as the risks of hacking no longer stop with unauthorised access to data, but now extend into potential manipulation and interruption of critical assets. This article offers a view of what the future holds for digitalisation in LNG. It also provides a tangible example where digital adoption is making a positive impact on a facility currently in operation.

Digital transformation barriers
According to data from McKinsey and Accenture, the oil and gas industry will spend approximately US$80 billion over the next two years on operational efficiency that, if invested in digital technologies, could lower operational expenses by 25%, and result in a sustained profitability increase of 11%. Despite these benefits, organisations across oil and gas have been slow to embrace digital transformation for several reasons, many of which are valid, including the following.

Digitalisation: A RUNNING START

John Nixon and Hermano Ferreira, Siemens, USA, discuss the benefits of digitalising LNG projects at the earliest possible stage.
Cost of downtime
In continuous process plants, such as LNG facilities, a single failure or plant trip can result in millions of dollars in production losses. Therefore, any solution that has the potential to impact a process or its safety negatively must be well-proven before being utilised. Throughout history, the industry has taken a highly conservative approach when adopting new technologies, even ones that are designed to prevent unplanned downtime, such as the case with digital.

A recent study that looked at US refineries over a three-year period found that an outage or shutdown occurred, on average, every 1.2 days, with mechanical breakdowns and power disruptions cited as the most common causes. This is a trend that the LNG industry does not want to inherit. Digital technologies that enable capabilities, such as condition monitoring and preventative maintenance, can go a long way in helping them achieve that.

Cybersecurity and data privacy
In a recent survey of oil and gas executives conducted by Siemens and the Ponemon Institute, more than 60% of respondents said that their organisation’s industrial control systems protection and security were inadequate. More than two-thirds said they had experienced at least one cybersecurity attack in the last year. Given this reality, it is no surprise that operators have been reluctant to connect their critical assets to cloud-based platforms. They have also been cautious to share performance data with partners, even when data has no operational significance or relation to intellectual property. This lack of collaboration and connectivity has inevitably slowed the pace of digital transformation.

Limited human capital
Human capital has been another barrier to digital adoption. Capturing the full range of benefits from digitalisation requires a unique combination of in-depth oil and gas domain knowledge and expertise related to data science and software development. Both are required to generate measurable value from digital solutions. The domain knowledge is most commonly found in highly experienced industry personnel, who are retiring at a high rate, while the advanced analytics knowledge resides with the younger generation of data scientists, who are in limited supply across all industries.

During a recent conference organised by Siemens in London with small and medium sized oil and gas customers, the attendees discussed how the sector, with its aging workforce and legacy of conservatism, must become more digitalised to attract new talent. To achieve this, companies must commit to a cultural change, which means asking those in the ‘twilight’ of their careers to take on not only new technologies, but also new ways of working in order to attract young skilled professionals who are electing to enter more digitally advanced industries or those that are perceived as ‘cleaner’ and more sustainable.

Harnessing digitalisation
Despite the hurdles that companies face, it has become clear that the benefits of digital transformation greatly outweigh the perceived risks. To this end, the LNG industry can benefit from embracing a holistic digital strategy to improve the development and delivery of projects and optimise the long-term performance of facilities once they are in operation.

Critical digital tools and strategies that have been deployed across the industry and are now considered proven, include the following.

Enterprise product lifecycle management solutions
An enterprise product lifecycle management (PLM) system drives product and process innovation by providing decision-makers with the right information needed to make decisions that result in better outcomes. A single source of facility and process knowledge empowers global teams and suppliers to collaborate and can be especially useful in LNG projects, which are immensely complex and require extensive coordination from multiple parties. On these projects, delays can often arise due to late-stage field changes. Tenders are handed out, but during execution, what comes up deviates from tender requirements. The deployment of an enterprise PLM solution can significantly reduce the risk of errors and omissions by integrating and aligning the triad of requirement, tender and execution.

Siemens’ enterprise PLM solution, Teamcenter®, for example, is used for everything from coordinating complex change across disciplines, to executing a simple design review, to directing a response to quality issues. In this way, stakeholders have access to data, people and processes, allowing them to optimise product change management processes.

Asset process management
Asset process management (APM) solutions that utilise advanced analytics, artificial intelligence (AI) and machine learning are increasingly proving their worth in oil and gas operations, including LNG facilities. By applying AI to real-time and historical data, operators can identify signs of anomalous machine behaviour. This equipment health analysis provides the basis to conduct condition monitoring and prescriptive maintenance, leading to reduced downtime and increased revenue. A salient example of this is discussed later in this article.

Use of digital twins
The ‘digital twin’ is a concept that has garnered significant attention in oil and gas in recent years, but there remains a great deal of confusion about what a digital twin is, and how it can be harnessed to add value to LNG operations. Many throughout the industry believe that a digital twin is an advanced 3D engineering model. However, a true intelligent digital twin is much more than
that. It is a dynamic, cross-domain digital model that mirrors the operation of a physical asset or process as it moves throughout its lifecycle. The digital twin evolves to reflect changes in its physical counterpart, creating a closed-loop of feedback in a single-source-of-truth environment.

Developing a digital twin as a standard project deliverable is significantly less costly than it is to retrofit it to an existing facility or process. Therefore, it is important that stakeholders engage with their EPC contractors at the earliest possible phases of the project lifecycle to ensure that the delivery of the digital twin, as specified, is a contract deliverable.

Low-code development
It is no secret that in the oil and gas industry, there is a significant need for improvements in the way software is developed and delivered. Mobility and the demand for a corporation to ensure its data is portable and secure is growing exponentially every year. Companies across the supply chain are experiencing an increase in demand for application development. However, the skills and talent needed to meet that demand are in short supply.

To address this, companies across the energy sector are increasingly turning to low-code rapid application development. In simple terms, low-code development refers to a platform that allows programmers to create application software through graphical user interfaces and configuration, instead of traditional computer programming.

Siemens, for example, recently announced the availability of Mendix™ for the development of applications in its open internet of things (IoT) platform, MindSphere. Mendix is a low-code application development solution and enables users, regardless of technology background, to use low-code development to change the way they approach and solve business problems. With the technology, domain engineers and plant operations staff – in addition to professional developers – companies can build advanced IoT solutions without the need for coding, thereby furthering the reach and impact of digitalisation.

Cybersecurity protections and security analytics
Despite all of the benefits that digital transformation can provide to LNG facility operation, connecting critical equipment, such as compressor trains, to cloud-based platforms means that operators must be ready to respond to an evolving security landscape in which cyber threats are the norm. To this end, cybersecurity protections must be integrated into the design of digital solutions, rather than bolted on top and used as a proverbial ‘airbag’ or ‘seatbelt’.

In recent years, cybersecurity standards have grown in response to the increasing frequency and sophistication of cyber threats. This includes safeguards, such as ISA/IEC 62443, along with ISO 27001 and 27002, which are the world’s first data security standards. Additionally, new protections against advanced, persistent threats use AI to monitor networks for changes that can signal a possible intrusion.

Digital case study: condition monitoring of compressor trains
The value to be gained through the digital transformation of LNG facilities is no longer hypothetical, as there are now many salient examples where it has generated quantifiable benefits for operators.

In Europe, for example, Siemens partnered with the operator of an all-electric (E-LNG) facility to implement a digital solution that enabled monitoring and long-term forecasting of the various components of an electric compression train, including the motors, transformer, converter, harmonic filter, cooling system and compressors (Figure 1). One area that attracted particular attention from plant operators was the vibration behaviour of the stator winding overhang. Vibration anomalies in the winding overhang can lead to insulation failure and damage to the motor, which increases the likelihood of an unplanned production shutdown. To protect against this, Siemens installed a customised data acquisition system on the variable speed motors, which are fed by frequency converters.

By continuously monitoring variables, such as speed and load, the system can detect if the condition of the winding overhang has left its normal state and alert operators so that they can take the necessary steps to alleviate the issue and keep the motors running.

Additionally, the system enables operators to build a basis of vibration levels against which possible deviations during long-time operation can be detected. This is achieved by clustering data based on different operational parameters. Doing so makes it possible to build trend data for specific operational states of the motor, which allows for the adoption of a condition-based maintenance approach. The operator can analyse records and results for mitigation and risk-reducing actions during operations. The operator can also schedule inspections and make intelligent decisions about whether to shift the system’s operating point. In this way, shutdowns can be evaluated well beforehand, and maintenance can be scheduled in such a way that reduces costs and minimises unplanned downtime.

By averting trips and resulting forced outages via early detection of potential faults and preventive remediation, compressor availability can increase as much as 3%, equating to approximately 11 days per year.

Conclusion
Digital is increasingly emerging as a competitive driver of LNG projects, helping EPC contractors and operators achieve both incremental and quantum improvements in the development and performance of their facilities. However, to capture the full range of benefits that digitalisation has to offer, careful upfront planning is required to identify long-term opportunities.

Projects can, therefore, benefit by engaging with solutions providers and original equipment manufacturers (OEMs) in the earliest possible phases of the development process. Doing so ensures that maximum value is derived by digitally capturing asset knowledge from the very outset of the project. At times, the concept is referred to as being ‘born digital’ and is ultimately key to creating a framework where digital transformation and associated cybersecurity measures are leveraged to their greatest extent.

References

Reprinted from September 2019