



Expanding the Application and Benefits of Modularization in LNG Facilities to Include Automation and Digitalization

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01 Industry Trend of Modularization

In the rapidly evolving landscape of LNG investments, companies are compelled to accelerate the design and construction of LNG facilities to align with the dynamic nature of LNG demand and achieve positive Free Cash Flow (FCF) promptly. One transformative strategy that has emerged is the adoption of modularization among technology providers and engineering firms which is significantly reducing project timelines compared to historical benchmarks. Although equipment, piping, and rotating machinery have benefitted from standardization and modular design, there remains a reliance on traditional methodologies for certain project packages, highlighting an opportunity for the next generation of modularization.

02 Need for Application to Automation

A significant bottleneck in LNG project timelines is the control and automation system, particularly during the commissioning phase. With advancements in technology, there is a compelling case to develop standardized automation designs that will align with a modular approach and will simplify the project critical-path. This strategy leverages established industry methodologies such as Copy-Exact and Design-One-Build-Many and recent advances in IT. A considerable proportion of global LNG facilities have relied on a limited number of liquefaction designs, thereby creating efficiencies in engineering investment and implementation.

However, one of the historical challenges of modularization focus has been the relatively small project cost of automation and controls packages compared to the full project scope, which includes gas pre-treatment, liquefaction, storage, and utility units. By embracing modularization and standardization in automation and control systems, we can expand pre-engineering efforts, ultimately enhancing project deliverables.

03 Advantages of A New Approach

Modularizing automation not only accelerates engineering completion but also enables automation suppliers to integrate best practices and optimization strategies that have traditionally been applied post-startup. Modern implementations—such as automating the cooldown process of cryogenic heat exchangers during plant startups and optimizing control systems to account for diurnal temperature variations—serve as practical examples of this initiative.

Historically, advanced process control systems have been overlay solutions added after commissioning to the LNG asset. Rather than following this sequential approach, embedding optimal engineering practices into modular automation designs from the project's outset can yield immediate operational efficiency and capacity optimization from Day 1.

Moreover, the commissioning phase can be accelerated by the automation of smart field device configuration and testing. By incorporating automatic testing algorithms within control systems, we can realize an “auto commissioning” process that minimizes the need for manual oversight and cumbersome record-keeping. This shift not only enhances efficiency but also allows businesses to expedite their readiness for LNG production, transforming the commissioning landscape and ultimately accelerating the return on investment.

04 Expansion into Digitalization

Now that we have considered the base automation layers for LNG liquefaction we can look further at additional digitalization that can benefit from a modular approach. It is quite common for most LNG liquefaction facilities today to have an Operator Training Simulator. These training simulators typically leverage a dynamic simulation model of the facility integrated to a simulation of the control system to create the training environment. Much of this can be standardized. As we consider leveraging a model of the process used by the engineering firm, we then can layer a model of the standardized modular automation package on this. With this high-fidelity model of the plant, one of the final elements for the training environment is to incorporate training scenarios. These are typically very similar scenarios across the industry. These scenarios need not be re-engineered for every project. Using this methodology, it is quite practical to see how a standard Operator Training Simulator can be derived for each major process license then tuned slightly for each different site installation.

As a bonus, project critical-path can be further reduced by early delivery of the Training Simulator such that it can be used to test the process automation and emergency shutdown systems. Typically over 200 defects are corrected “off critical-path” as well as earlier implementation of the tuning of control loops and development of operating procedures and sequences, all positively influencing the project schedule.

05 Driving Adoption

Approximately ten years ago we saw a step change in technology and process automation project execution methodology. We were able to transform how we executed projects with the development of technologies like automation I/O channels that are software re-characterizable, negating the need for last-



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minute wiring changes, virtualization of servers, and cloud engineering platforms that enabled us to deploy the best engineering knowhow from anywhere in the world. We also saw the cost of automation projects decrease and the quality often improved.

It is now time for yet another step change in how we automate our LNG facilities. Leveraging the ability for smart instruments to communicate with the control system and technologies like HART to diagnose field instrument failures we can commission dozens of loops within minutes. We can reduce engineering time in the field and minimize exposure to HSE related elements. We can now leverage the power of high-speed networks to reduce one-to-one hardware redundancy. Now we can leverage any spare controller or I/O capacity across the network to improve redundancy to be higher than the previous one-to-one philosophies. We can improve our Operator Training Simulators by connecting the models to live DCS data during operation and leverage machine learning for levels of accuracy and robustness not previously enjoyed. The technology for all these paradigm shifts already exists. It is up to us as thought leaders in the industry to drive adoption of these new methods to maximize capital efficiency, minimize worker exposure, shorten time to first LNG, and deliver more robust operating systems.