

An Integrated Approach for Accelerating and Optimizing LNG Construction and Operations

Introduction

LNG is experiencing a healthy long-term growth rate but faces resource constraints and growing competitive pressures. To maintain competitiveness and profitability, the LNG industry needs to reduce project timelines and costs. The LNG industry also needs to design assets for minimal staffing, inventory, energy efficiency and carbon footprint and improve plant flexibility to exploit spot trade opportunities. Although automation represents only 2 to 6% of project spending, its impact on operations over time is 15% to 30%. Accordingly, automation represents one of the best opportunities to improve business effectiveness of an LNG plant. But the traditional Main Automation Contractor (MAC) approach, which focuses on integrating the automation segment of the automation related aspects of the project only up to the startup phase, does not address the complexities of today's LNG projects.

A new approach called Integrated Main Automation Contractor (I-MAC) provides major improvements by addressing interactions between people, systems and processes over the complete LNG asset lifecycle. Automation providers can fill a consultative role in the early stages and conduct collaborative workshops with operations representatives to define requirements for human factors design, operational and business systems integration and lifecycle sustainability. Early involvement in projects by automation suppliers can help ensure that decisions made in the early phases support smooth, efficient startup such as through the use of dynamic simulation, alarm system design processes and plant optimization. Training operators earlier, modeling the process in parallel with construction and testing advanced process control designs in simulation mode all contribute to reducing time to market and reducing project risk.

Challenges despite steady growth

The global LNG industry has seen dramatic growth since the late 1990s. According to British Petroleum, global LNG trade increased from 113 million tons per annum (MMTPA) in 2000 to 154.0 MMTPA in 2006. The same source expects LNG trade to reach 225.0 MMTPA by 2010 and 524 MMTPA by 2030. Today a combined liquefaction capacity of 207.01 MMTPA is provided by 31 terminals in 17 countries supplying LNG to 59 regasification terminals with a combined capacity of 402.15 MMTPA in 19 countries. But the growth in LNG capacity has helped to drive a dramatic increase in capital expenditures and operating costs that is threatening the health of the industry.

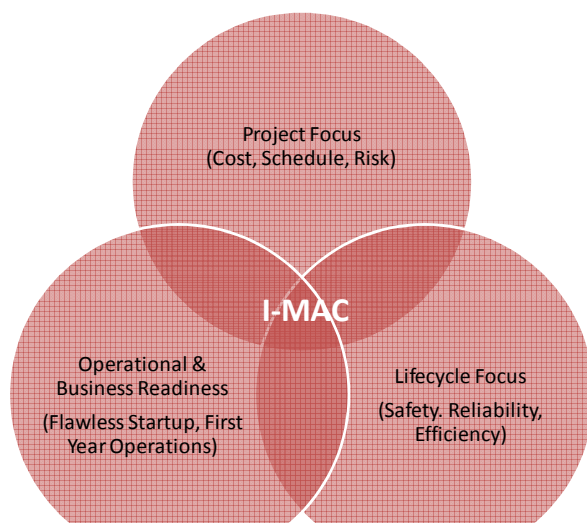
Project capital costs doubled between 2005 and 2008 and plant operations costs doubled between 2004 and 2008 while the oil prices that LNG contracts are typically tied to are close to 2004-2005 levels. As a result, pressures are as high for new projects to be brought on line as quickly and cost-efficiently as possible and accelerated through the ramp up phase to full earning capacity. The industry is also striving to preserve its enviable safety and security record despite increasing risks and complexity of operations.

For most of its history, the LNG trade has had a very conservative approach to business development and operations. This is primarily due to multi-decade take-or-pay contracts that were and are still needed to guarantee the relatively high capital costs as compared to conventional oil and gas plays. Twenty year contracts were signed for up to 95% of the working capacity of the LNG liquefaction plant, leaving little opportunity for lucrative spot trade.

But developments in the past decade have made the trade in LNG more flexible and introduced more competition into the market. An increasing number of LNG terminals can blend or spike the imported LNG to desired heating value (HHV) so that LNG from multiple sources can be imported. Many countries that have sufficient existing natural gas sources are building LNG terminals for energy security. These are not base-load plants and serve to increase the amount of spot trade in LNG. Many new gas reserves are smaller than the 10 TCF proved reserves typical of earlier large scale base-load plants. LNG Liquefaction solutions are being developed that can monetize stranded reserves down to even 0.1 TCF by using such solutions as Floating LNG Plants or LNG FPSO.

Up to now, a conservative approach has also dominated the construction of an LNG plant and its processes and automation systems. EPC (Engineering, Procurement and Construction) contractors have shifted some of the risk and complexity to automation vendors. The MAC method was designed to provide a single point of responsibility for all automation related aspects of a project, including the integration of automation with plant equipment and management systems, up to the startup phase. However, the MAC was designed to simplify only one dimension of the asset construction and does not address the majority of the LNG asset lifecycle. It should be noted that the LNG asset has three distinct phases in its life: the construction project phase which may take 2 to 5 years; the asset readiness phase, beginning at plant startup and persisting until the asset reaches operational and business readiness at sustained working capacity, which can take 2 years; and the operating lifecycle which can be from 25 to 50 years or longer.

I-MAC is the improved method for achieving sustained benefits across all three phases of an LNG asset life. The “I” in I-MAC indicates integration with the LNG company’s overall business objectives of the new LNG asset, including people, products and processes. I-MAC addresses not only the short-term objectives of the capital project phase, but also the operational and business readiness that is required for startup.



The I-MAC approach focuses on the business objectives of the LNG company through automation at the process, operational and business layers of the plant. An integrated approach to reliability management is also important. Integrated people means having an integrated project team consisting of the client, the PMC/EPC(s), MAC, and other

Figure 1: The three phases of holistic automation regime - I-MAC

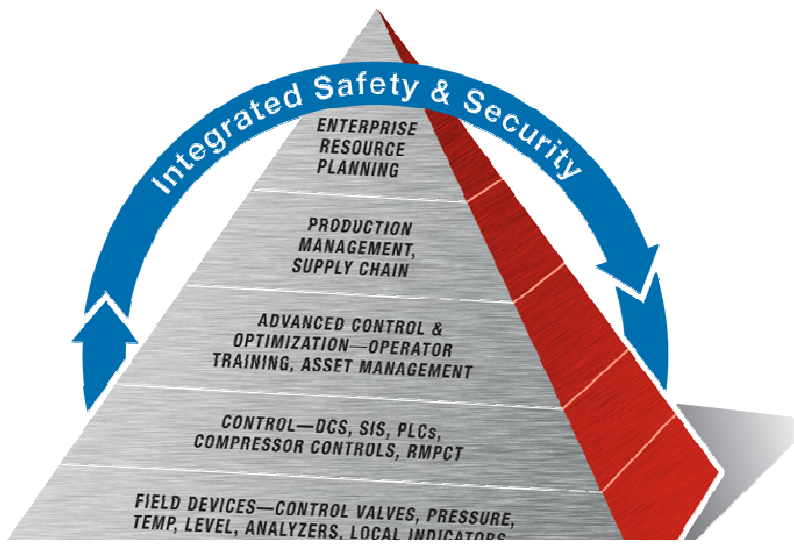


Figure 2: One improvement of I-MAC over MAC is the inclusion of the additional scope of Operator Training Simulator, Advanced Control, Asset Management and Production Management all wrapped with automated safety and security systems

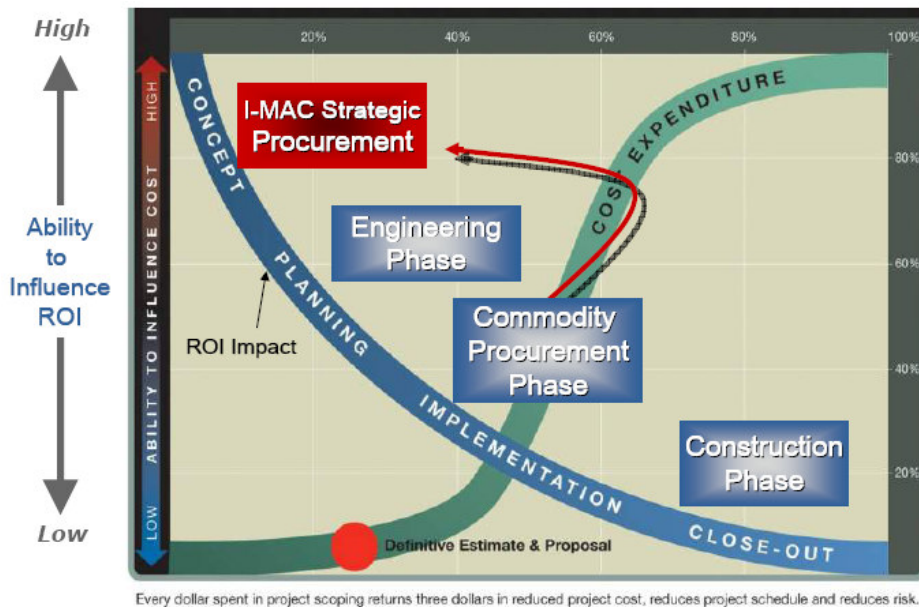
parties involved in the project. It also means integrating the expertise of partners such as IBM, SAP, and large equipment or process providers. Integrated products means an integrated approach from process automation systems to enterprise systems and IT, all of which must be wrapped in a secure environment. The I-MAC philosophy also

includes automating and managing work processes. I-MAC delivers a holistic approach to the entire life of plant assets in addition to managing costs and reducing risk during project execution.

The Value of Early Involvement

LNG asset owners have the greatest ability to influence project costs in the early stages of the project, even though most project costs accrue during the latter phases. Automation philosophies have a large contribution to the smooth efficient startup and enable lowest cost of ownership of the operational life of the facility. Decisions made early on in

projects around automation technology selection such as the use of dynamic simulation, alarm system design processes, production management systems and plant optimization all have major impact on the ongoing operation of the facility. I-MAC providers fill a consultative role in the early stages of a project and conduct collaborative workshops with operations



The Ability to Influence ROI of a Project is Much Greater in the Early Stages

representatives to define requirements for human factors design, operational and business system integration and full life sustainability.

Early involvement is also crucial to the success of the systems that support the Reliability or Maintenance Department. Look for an I-MAC provider with strong credentials in FEED (Front End Engineering and Design) and consulting capability. Projects built in a virtual silo are likely to not meet requirements in many areas and struggle during commission and handover. The I-MAC approach enables the various stakeholders to influence the plant design, resulting in smoother and faster startup and handover to operations.

Although the MAC or I-MAC provider takes responsibility for all design, engineering and construction activities for automation, the team is tightly integrated with the overall EPC team, often sharing the same or compatible computerized tools. Choosing automation providers with substantial prior experience in LNG and strong project execution capability will accelerate and stabilize the capital project compared to other choices.

Achieving Operational Readiness

I-MAC introduces a broader view and delivery of operational readiness and its delivery than previous techniques. Operational readiness is the state when a new LNG plant is operating for an extended period at its desired production rate, within designed operating costs. The engineering, sourcing and construction of the physical asset have been completed and all tests made to verify compliance with the capital project scope.

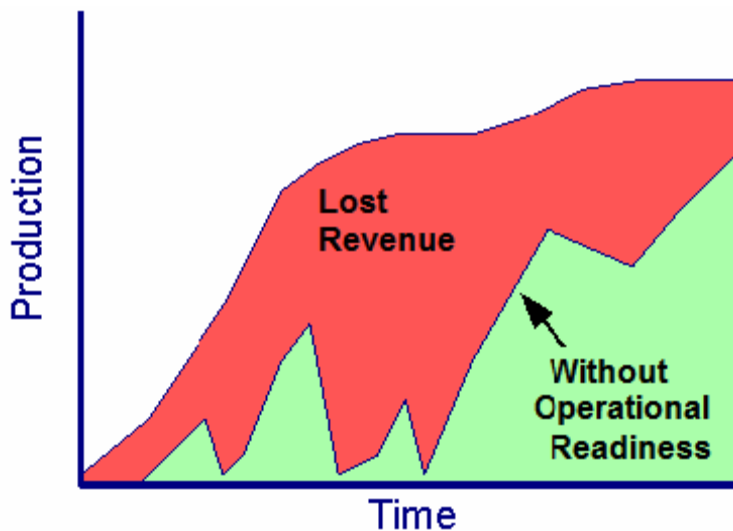


Figure 3: Any delay in operational readiness results in significant lost revenue

Operational readiness also includes readiness of the operations personnel – the people assets – as well as the plant and physical assets. The cost of financing a multi-billion dollar LNG plant makes every day of delay very expensive. Any delays in achieving operational readiness can be incredibly expensive.

Startup is the first time that all the new systems in an LNG asset are operated together. Validating that all systems work together

correctly from the process automation layer to the operational and business automation layers prior to startup is a core component of I-MAC.

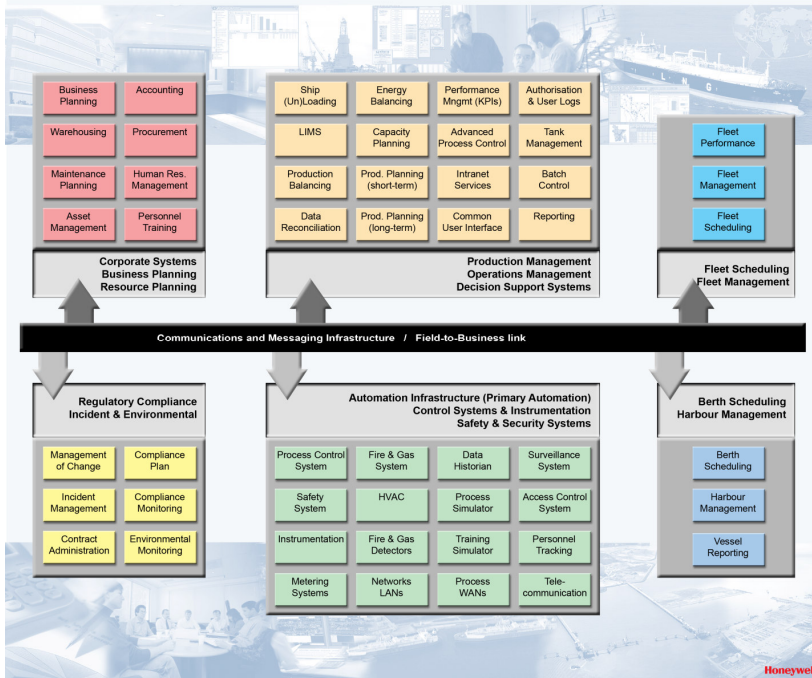


Figure 4: Operational Readiness in an LNG plant is not complete unless all these systems are in-place, integrated and effective training delivered to users.

Training, or people readiness, is perhaps the most important aspect of the success of operational readiness. Only when properly trained, can LNG plant operators run the plant to optimum efficiency levels. Keeping operators well trained to handle infrequent process upsets is critical. An Operator Training Simulator (OTS) enables operators to continually develop skills to handle process upsets in a safe simulated environment. Startup and operating procedures can be developed and validated using the OTS along with the process control system design in order to reduce startup time. Simulators can be used during testing phases to aid in pre-commissioning automation systems. Advanced Process Control (APC) can also be step tested on simulators.

APC, already used in most oil refineries and large gas plants, is also gaining popularity in LNG. Analogous to an autopilot, APC typically removes the reactive actions required by a process operator to allow more time to be spent on optimizing production. For example, massive cryogenic and ambient air-cooled heat exchangers operate at differing capacities in the cool of night versus the heat of the afternoon sun. This is only one of many opportunities that can be automatically exploited by APC to increase throughput and decrease energy consumption and emissions.

Layered Safety and Security

Safety needs to be approached from a plant-wide perspective, incorporating layers of safety, such as a secure process design, Abnormal Situation Management and physical security. The safety system should be operationally integrated with the control system to align the LNG plant's goals for safety and reliability with a proven solution that combines process safety data, system diagnostics, and critical control strategies.

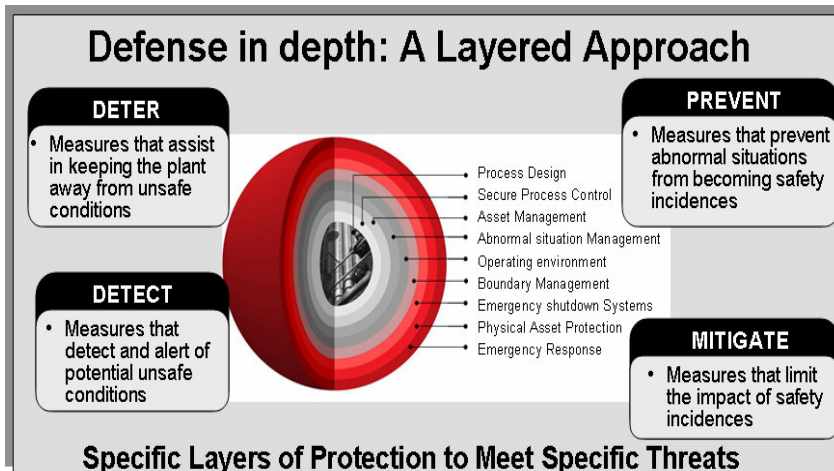


Figure 5: Layered approach to security

Additionally, the I-MAC vendor provides a tightly integrated suite of robust applications for physical protection, providing significant lifecycle cost of ownership benefits based on a common automation and security systems model. With such design and implementation, security technology can equal that at sensitive military, governmental and private facilities around the world. Ideally the security and control consoles should use the same solution platform and the same alarming and access structures as the process control system to optimize sharing information throughout the LNG facility.

Sustaining Performance Throughout the Plant Lifecycle

The LNG enterprise is expected to operate for many decades at the original working capacity of the plant. Typically most LNG capacity is sold on 20 year contracts and most contracts are renewed for a further 20 years. Accordingly it is important to keep the plant operating reliably, with Reliability Centered Maintenance (RCM) being the current best practice. Automation vendors can deliver solutions that monitor the condition of large equipment and Digital I/O solutions can monitor the condition of automation equipment.

The automation vendor can provide long term support agreements to keep instrumentation and control systems at peak working order. Recent advances extend the automation maintenance regime to remote calibration of control loops and APC via “scouts”. For the LNG plant, it is critical to reverse the typical degradation of production capacity, efficiency and reliability that typically occurs in the mid-life of the plant. Automation providers can provide solutions in mid-life that can step up performance, sometimes to better than new.

Maximizing business opportunity

The increasing number and size of LNG trains, storage tanks and carrier vessels, have made traditional approaches to managing logistics scheduling obsolete. Although software models may be used to predict voyages and future LNG inventory, these tool-like models are not integrated and require manual workflows to communicate schedules

and activities. Personal spreadsheets, still frequently used to coordinate multibillion dollar LNG enterprises, are prone to error and miscommunication.

Solving the complex LNG logistics problem requires producers to master the entire production chain from the gas wells to the final sales terminal. This means having a transparent overview of gas pipelines, liquefaction, intermediate storage, ship scheduling, berth scheduling and harbor management. The challenge is to constantly and accurately match the delivery contracts with the LNG production, the available storage capacity, the harbor constraints and ongoing production rates, including by-products and the shipping logistics. Any disconnects will result in significant financial losses or penalties due to loss of capacity/throughput, non-timely delivery, ship idle time (demurrage), and so on.

LNG delivery commitments are normally defined in terms of an Annual Delivery Plan (ADP). The ADP globally matches the expected LNG output with the long-term contracts in place and any possible spot cargoes. In order to plan effectively, the production planning, ship scheduling, and berth scheduling functions all need to communicate with each other in essentially real time (see Fig. 6).

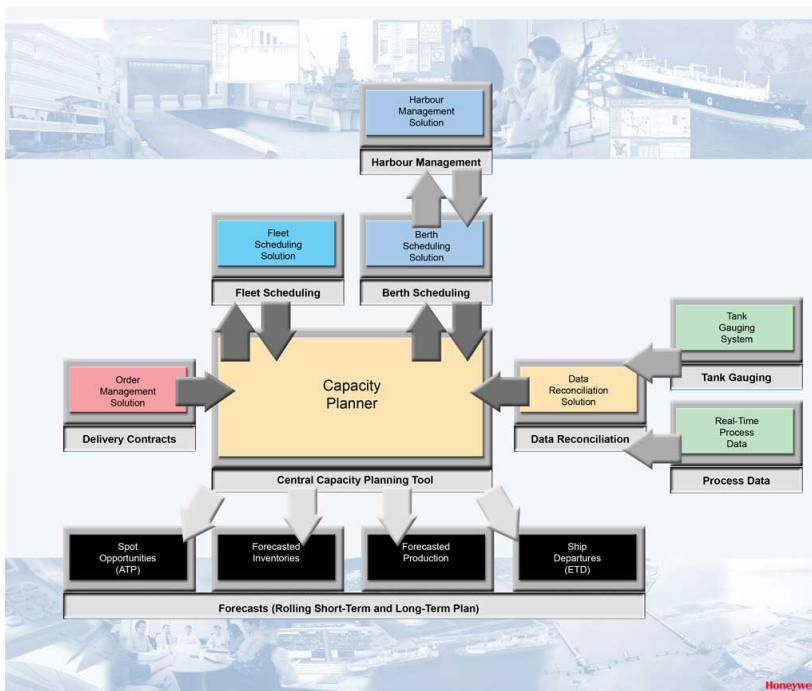


Figure 6: Multiple software models of the LNG supply chain need to be electronically integrated from day 1.

The I-MAC approach delivers common interfaces across product and business enterprises, reducing engineering and design work and enabling a higher level of collaboration. Tight integration of point solutions around a central inventory management database can deliver effective supply chain management for a liquefaction facility. This approach can cope with the breadth of the supply chain problem, even when the large numbers of trains and tankers are involved.

Conclusion

The LNG industry must continue to develop new practices to manage increasing competition with other fuel sources, competition within the LNG industry and pricing volatility. Automation can provide significant economic and holistic benefits across the entire LNG plant lifecycle. I-MAC builds on the MAC concept of providing the EPC and end user with one stop responsibility for automation scope. I-MAC goes on to include operational and business readiness solutions as well as integrated security and safety systems. Early involvement strategies enable I-MAC to improve capital project success and reduce project costs. Full LNG plant lifecycle maintenance services and solutions prevent deterioration of LNG plant and subsystems.