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Intelligent Strategies in LNG

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Abstract

The vision for Intelligent Strategies in the oil industry is defined by the optimal integration of business processes and advanced technologies, supported by organizational alignment, to deliver a new standard for decision making. The greatest challenge we have all discovered is in effectively delivering the required change management, and therefore, greenfield opportunities deliver the easiest and the most rapid successes. The segment of the hydrocarbon supply chain where greenfield sites are prominent is in LNG.

Many aspects of LNG business processes and operations are unique. The paper will discuss the uniqueness of business processes stemming from LNG commercial models and the resulting requirement for tight interaction between Supply Chain and Operations, which is executed through the deployment of real-time data and information technologies.

Additionally, the paper will explore how intelligent strategies are especially significant in this industry due to the ownership structures. LNG is a highly fragmented industry, with different players in each segment of the value chain. The fragmentation is further complicated by different company stakes in assets as owners, operators, and suppliers and off takers of the LNG terminal assets. Intelligent strategies deliver the required world-class communication and collaboration capabilities.

Introduction

Increasing supplies of stranded natural gas reserves and favorable liquefied natural gas LNG economics have been driving forces for building many new LNG liquefaction plants and receiving terminals. Globally, the LNG market has grown by 33 percent over the last five years and more than $4 billion has been invested in that effort, according to the International Energy Agency in Paris. As favorable economics continue to drive the build-out, the deployment of intelligent strategies becomes critical to both the LNG business and as learning ground for the entire petroleum industry.

To achieve an appropriate level of granularity in describing the multiple aspects of an intelligent strategy, we will focus this paper on a rapidly growing sector of the LNG value chain that is experiencing increasing levels of complexity: the LNG Terminal.

The Imperative for Intelligence

LNG is a highly fragmented industry, with different players in each segment of the value chain. The fragmentation is further complicated by different company stakes in assets as owners, operators, and suppliers and off takers of the LNG terminal assets. The sixty terminals in operation are operated by over forty different companies. In the past, LNG terminals typically only served one commercial customer. The few terminals that occasionally allowed access to additional (third party) customers only did so in situations where the terminal operator substantially controlled the downstream markets and the third party users did not represent a competitive threat.

United States and European natural gas markets have become highly liquid, with commodity price transparency. As the LNG industry matures and LNG becomes a globally traded commodity, LNG terminals are forced to become more flexible and serve more customers. In some cases, these customers will be competitors. With greater flexibility, the industry will be able to increase profits through strategic plays, such as intercontinental arbitrage, seasonal storage, and peaking services. The move towards third-party-use terminals has required some rethinking of the business practices, supported by the effective deployment of intelligent strategies.

Business models and commercial agreements have been developed to accommodate various degrees of third party use. The degree of third party use has broad ramifications on the business processes, design approach and, ultimately, information system requirements. Business models vary from a pure third party use to a mixed third party and owner use. For the third-party-use terminals, a critical success factor of developing the intelligent strategy has been active involvement of the customers in developing the business practices for grassroots terminals and throughout the information system design and implementation.

Business process requirements become more attenuated to accommodate third party use versus single owner operator business models. Some of the business processes impacted by third-party-use agreements are:

- Ship nominations become more important due to customer's competition for berth and storage space
- Natural gas redelivery nominations are performed in accordance with downstream pipeline nominations procedures
- Marine scheduling becomes more challenging, particularly, during weather disturbances, tidal effects, or heavy channel traffic
- Terminal scheduling becomes much more important due to the requirements to comply with the terminal use agreements and ensure equitable treatment among shippers
- Energy balance and reconciliation becomes more important in order to quickly identify losses, audit balances, and monitor ship discharge
- Customer LNG composition tracking becomes more important to ensure downstream natural gas pipeline specifications can be met for various LNG cargo qualities
- Multiple shippers sharing the same terminal require a more thorough ship monitoring and demurrage analysis

The reader can quickly see the need for real-time information and integration across business processes. Most importantly, there is a need for a tight linkage between supply chain activities, ship unloading operations, and vaporization processes. Significant agility is needed to handle the difficult marine scheduling requirements at the terminals with multiple customers sharing the docks. Hence, the core of any intelligent strategy is an Integrated Terminal Operations System (ITIS).

ITIS

Each ITIS project is unique due to differences in the business model, approach to business, and commercial agreements. There are, however, notable similarities among the LNG Terminals that cover the fundamental aspects of owning and operating a terminal. Fundamentally, ITIS includes two hierarchical levels: Business Systems (Supply Chain Management and Business Management) and Production Execution Systems (Operations Management and Asset Management). The Compliance Management System is shown separately because it spreads over the both hierarchical levels – it includes transactional activities, as well as execution activities. In order to achieve safety and high efficiency, all these systems must work in concert, i.e., their business processes and corresponding applications must have coordinated business targets, schedules and information interactions.

Through our work, we have defined five overarching, end-to-end business processes that collectively encompass all aspects of the LNG terminal business. These are business processes generally classified as:

- Supply Chain Management - this business process objective is to deliver reliable, transparent and timely information in one easy to use, role-based, secure portal to manage across the LNG supply chain
- Operations Management - the primary objective is to empower operations personnel with easy to use production information access, operating instructions, and alerts in order to execute the terminal schedule in the most efficient way
- Asset Management - the primary objective is to empower maintenance personnel with easy access to equipment information, maintenance order information, and alerts to ensure equipment's high availability and align maintenance work with the terminal schedule
- Compliance Management – this business process is designed to ensure constituency information needs and reporting requirements are met, with a focus on regulatory requirements.
- Business Management - provides the ability to achieve a balanced approach to meeting stakeholder needs and ensuring alignment of the business processes to those needs

Functions of the three latter business processes, Asset Management, Compliance Management and Business Management are fairly typical of a process plant with the exception of specific requirements to manage LNG Terminal's various contractual agreements and capital structures.

Asset Management business process begins with an approved maintenance schedule and budget that are coordinated with overall terminal schedule and budget. It ends with an executed maintenance schedule and replenished spare parts that are necessary to maintain equipment high availability.

Compliance Management is driven by a regulatory requirement or constituency issues that require planning and execution tracking; it ends with an executed plan or regulatory requirement being met. Typical activities include incident reporting, compliance planning and monitoring, and Management of Change (MOC).

Business Management process begins with an annual plan and budget and ends with reporting results relative to the plan and budget. Typical activities include business planning, financial accounting, human resources, contract administration, cost & capital accounting, and performance management and reporting.

The uniqueness of an LNG Terminal's business processes and ITIS functionality stem from unique supply chain's commercial model and tight interactions between Supply Chain and Operations. These business processes are described in more detail in the following sub-sections on Supply Chain and Operations Management, with special notes to the reader to understand that intelligent strategy for LNG requires integration across the chain.

SUPPLY CHAIN MANAGEMENT

The business process begins with an Annual "Customer LNG Receipt Schedule" and ends with meeting daily send-out commitments on a physical basis. On a financial basis the process ends with a paid invoice by the customer to LNG Terminal. The business process objectives are:

- Ensure the LNG terminal's full contribution to the customer's LNG supply chain
- Meet receipts and send-out delivery commitments with timely reporting of receipts and send-outs.
- Manage terminal services while meeting natural gas send-out specifications
- Quickly respond to schedule changes due to unplanned events
- Manage supply costs, including demurrage and losses

The primary activities included in this process are:

- Customer nominations
- Terminal scheduling
- Cargo tracking
- Energy balances

Other supply chain activities may include contract administration, mooring and piloting, and demurrage claims management.

Customer Nominations

Customer nomination is the primary supply chain customer-facing activity. This application coordinates all ship and natural gas redelivery nominations and confirmations with the customer. Based on the terms in the contract, nominations can be for the ship only, or for both ships and natural gas redeliveries. Customer nominations manage the creation of the Annual Delivery Program which are customer specific and defined in the terminal use agreements. Once the annual program is developed, typically there are rolling three month updates to the annual program. The monthly updates, once accepted, take precedence over the annual program. During the annual and monthly nomination cycles, the customers' nominations are displayed, and in some cases available ship unloading windows are also displayed.

On a daily basis, records are published to the customers that contain basis information such that the customer can nominate the next day natural gas redeliveries. For an unplanned event, such as a weather disturbance or ship delays, the customer nomination application receives and manages any customer requests to change ship arrival dates. All notifications, nominations, and confirmations are tracked for commercial purposes in the application. This application is tightly integrated with terminal scheduling. Embedded in the application are checks to ensure the customer is in compliance within their contractual limits.

Terminal Scheduling

A critical activity, terminal scheduling integrates customer nomination with operations to produce a feasible schedule that meets the customer needs. Terminal scheduling determines schedule feasibility, analyzes various alternatives, and develops the best feasible terminal schedule. Once the schedule is developed, key parameters are passed from the schedule to the

Operations Execution and Ship Unloading applications for execution.

The terminal schedulers collect schedule baseline information from various information sources to establish the current state of the terminal operations. The most current ship and gas redelivery nominations are imported into the application and analyzed to ensure feasibility of ship unloading, storage, and redelivery capability. The scheduling application also is used to evaluate the impact of terminal services unavailability, weather disturbances, or ship delays.

Cargo Tracking
Cargo tracking coordinates and tracks LNG cargoes from the time of the annual LNG Receipt schedule until the ship's cargo is discharged and the ship is sailing. The activity ensures compliance with the terminal use agreement terms with respect to ship nominations, scheduling, and discharge. Cargo tracking is used to manage ship departure notices throughout the voyage, capture cargo information, manage channel transits from the sea buoy to the dock, collect cargo unloading information, and ship positions throughout channel transit. Cargo tracking collects all information associated with a cargo life cycle, such as nominations, notifications, cargo quality, and ship discharge events and performance.

Energy Balance
The energy balance application provides reconciled, auditable information for the purposes of managing inventory and custody transfers and identifies sources of unreported losses and meter errors. Energy balance receives information from all the flow meters, tank inventory levels, and ship discharge reports to develop reconciled gross heating value energy balances. The energy balance performs the following functions:

- Provides capability for near real time monitoring of terminal inventory of volume, mass and calorific basis
- Develops reconciled energy balances based on redundant measurements for various energy envelopes including ship to LNG tank, LNG tank to vaporizer, vaporizer to custody meters and cavern gas withdrawals/(injections)
- Reviews balance inquiries and make adjustments as necessary to historical balances
- Identifies faulty meters and real sources of losses
- Performs various ad hoc analysis such as ship discharges, process performance, and tank compositions

The energy balance manages prior period adjustments for the purposes of custody transfers. It forms the basis of daily inventory positions and tank compositions, sendout custody transfers, fuel usage monitoring and ship discharge validations.

OPERATIONS MANAGEMENT
Operations Management begins with an approved terminal schedule and ends with an executed daily schedule. The business process objectives are:

- Meet receipts and send-out delivery commitments and timely unloading of ships
- Provide safe, flexible operations to comply with terminal schedule
- Ensure high level of operational readiness and efficiency
- Communicate terminal status and condition
- Control operating costs

The primary activities included in Operations Management are:

- Operations execution
- Sample records management
- Ship unloading
- Production performance

Operations Execution
This activity provides operations personnel with visibility into critical information to empower the operations. It complements process control capabilities by automating and expanding the traditional logbook functions.

The operations manager receives the daily terminal schedule and create daily targets and operating orders. Operators receive daily operating targets and operating orders from the logbook. As work is progressed, the operators update the order status and enter comments into the logbook.

Operations personnel also have visibility into technical information, such as equipment drawings, process & instrumentation drawings, control system conditions and alerts, and operating and maintenance procedures. Operations management has access to the logbook from remote locations to assess current operations and maintenance status and issues.
Typical functions of the activity are:

- Translate schedule into daily operating targets and orders
- Approve operating and ship unloading orders
- Execute operating orders
- Update operating order status
- Monitor equipment, sendout and compliance alerts
- Enter logbook comments required during operating orders execution
- Update work order status and inspection prior to placing in equipment in service
- Enter remote readings and observations
- Monitor inspection rounds and routine tasks

Operations Execution assists in managing the scheduled operating tasks performed by operations personnel. The activity complements process control systems by providing necessary tools to communicate the tasks to the operators and log execution results to ensure timely actions and to collect information for operations performance analysis.

Sample Records Management
Sample Records Management provides the capability to electronically manage records of manually collected samples. The scope of this activity typically includes gas sample records from the unloaded ships and environmental sample records (air and water).

Sample Records Management functions include:

- Manage sample retention storage as specified in terminal use agreements
- Record sample retention requests and issue samples as specified in terminal use agreements
- Monitor sample container retention aging
- Return sample containers to use after storage
- Record environmental sample quality results
- Historize sample records

Sample Records Management is specific to LNG Terminals due to special conditions stated in Terminal Use Agreements (TUA) for the gas samples handling and dispute resolution. The activity also helps effectively managing sample containers and third-party labs.

Ship Unloading
The objective of the activity is to enable proper management of ship unloading operations by automating the operating tasks and user-system interactions. This activity is critical for LNG Terminals since it generates custody transfer data and actual unloading time log that are used by Supply Chain to calculate customer storage positions and demurrage charges are collected and generated by this activity. Ship unloading is an important integration point with the Supply Chain activities. Integration is achieved in both directions: 1) From Supply Chain to Operations - through terminal scheduling, which coordinates ship unloading operations with vaporization operations and passes the unloading targets to operations, and 2) From Operations to Supply Chain – through reporting of actual ship unloading results.

The Ship Unloading functions are:

- Translate daily schedule into daily unloading targets and orders
- Generate Ship Unloading Report
- Generate Ship Unloading Time Log Report
- Capture key ship unloading timestamps and events

Ship Unloading provides necessary tools for managing the scheduled ship unloading tasks performed by operations personnel. The activity complements Process Control Systems by communicating the tasks to the operators and reporting execution results to Supply Chain activities.

Production Performance
This activity provides operations personnel and process engineers with information required to monitor production performance so that they can diagnose and fix process problems in a timely fashion.

The main functions are:

- Analyze process performance and calculate process efficiency
- Identify root causes of process under-performance or equipment failures

- Set thresholds for process alerts
- Modify operational procedures and process conditions as necessary

All the above functions use real-time production data stored in the Plant Historian, which is considered typically as a part of the activity. Production Performance Management monitors production processes and provides operations personnel with analytical data leading to further performance improvements.

As stated earlier, the design of the underlying systems that support an intelligent strategy are only designed after the business processes are well defined with the critical input of the owners and operators. This drastically reduces the change management issues that are normally associated with the "retrofit" of existing operations, and allows for the realization of significant results.

Results

Throughout the paper we have shared the various business objectives of the business processes that an intelligent strategy supports. The results of those successfully deployed intelligent strategies in this space include:

- Integration of all functions across the business
- Construction of robust business processes
- Greater agility in decisions
- Lowest possible capital and operating costs
- Higher performance
- Maximized operational flexibility

Naturally, embedding intelligence into an LNG terminal design impacts the direct terminal plant investment capital costs. Direct plant investment cost for an LNG terminal range from $500 million to $1 billion per BCF per Day of send-out capacity for a United States Gulf Coast terminal.

Factors affecting direct plant capital investment are:

- Plant size economies
- Process configuration and automation
- Location
- Advanced technologies (such as sensors, wireless infrastructure, visualization tools, and collaboration tools)

These design considerations can dramatically affect direct invested capital. The added cost of an intelligent infrastructure, including hardware and software, can range from 1.5% to 3%.

The benefits, however, are realized in a potential 15-30% reduction of terminal operating expenses. The expense categories that are most significantly impacted are staffing costs and maintenance costs.

Typical plant and overhead staffing costs is about $10 million per year, which is includes operator, maintenance, plant administration, and corporate overhead. Case studies have shown a 20-30% employee/contractor productivity benefits with the integration of business processes, information systems and advanced technologies.

The benefits to maintenance costs, however, have fallen across a wider range depending on the key performance indicator in question. Response time for addressing maintenance issues, for example, ranges from 25- 80% reduction. Completion or turnaround time on maintenance issues has shown reductions ranging from 15-30%, and spare parts inventory has shown reductions ranging from 20-50%.

Integrating the nominations,terminal scheduling, and ship unloading buisness processes results in a 10 percent reduction in ship demurrage by better scheduling arrivals. For a typical terminal reveiving 130 ships per year (1BCF), the savings in demurrage are about $2 miilion per year.

Fuel and losses are reduced by 0.1 to 0.3 percent, for a 1 BCF terminal, this represents an annual savings of $2 to 6 million per year.

Conclusions

The complexity of today's modern terminal operations and the speed to which this segment of the LNG value chain is growing, essentially demand the deployment of intelligent strategies. Fortunately, greenfield sites allow for the proper design of business processes from the outset with the appropriate level of involvement of the multiple stakeholders in the process. This drastically effects the successful adoption of new ways of operating so that intelligent models can become the accepted norm. As the number of new sophisticated terminals increase, the examples of successful case studies in intelligent strategies will increase, and hopefully provide wider acceptance across the entire petroleum industry.