EXECUTIVE SUMMARY

Current advances in information systems technologies make possible the integration of decision-making for the functions of the upstream petroleum supply chain: exploration, trading, transportation, and refining. This integration can lead to savings for the industry through more stable profit margins. Some estimates suggest an average margin gain of fifty cents per barrel (Lewin, 2003). Integration of upstream supply chains can also control price swings. Nonetheless, barriers exist to this integration. Here, I analyze these barriers and suggest means for overcoming them.

This summary starts with an industry overview and proceeds to discuss the structure and logistics of the upstream functions of the petroleum supply chain. Study of the four upstream functions reveals that they use disparate systems and mathematical models for decision making. Thus, barriers in upstream integration is caused by communications disconnect between the four upstream functions.
To understand the development of the silos that exists in the upstream supply chain, a case study of one of the major players in the global oil industry was undertaken to gain an organizational perspective and to explore opportunities for information exchange between the four functions of the upstream petroleum supply chain. In addition to the case study, a discussion with industry experts such as software providers, logistics providers and consultants to the energy sector reveals substantial room for integrating the upstream functions. This summary concludes by advocating the need for a transition to holistic, system-wide thinking as the best way to achieve integration in the upstream supply chain.

**INDUSTRY OVERVIEW**

The oil industry operates in an environment that combines large capital investments and operating cash flows with volatile prices and margins. Price volatility places financial risk on oil companies. In order to manage and mitigate this risk, supply chain integration is needed to mitigate price swings through the implementation of processes that ensure up-to-date information about changes in the industry. This will enable needed quick response to changes in the external environment such as price spikes, government regulations, natural disasters, and production declines. The ability to be responsive to these factors and optimize upstream operations is necessary for achieving profitability and survival.

**INTEGRATION LAGS IN THE UPSTREAM PETROLEUM SUPPLY CHAIN**

The petroleum supply chain consists of upstream and downstream activities. Upstream activities include exploration, trading, transportation and refining, while the downstream
activities include the distribution and marketing of all products from the refined crude. The business units that comprise the upstream supply chain are such that timeliness and accuracy of information received directly affects their performance. Upstream supply chain integration has lagged behind downstream integration. There are four reasons for this. First, the upstream’s complex structure and logistics. Second, each unit uses different information support systems, which are not always compatible. Third, significant “siloing,” or compartmentalization, exists between the different functions of the upstream supply chain. Fourth, there is a resistance to change within oil companies themselves, signalling the need for a transformation into holistic, system-wide thinking.

UPSTREAM STRUCTURE AND LOGISTICS

Upstream profit optimization is achieved within business units rather than across the entire organization. The structure of the petroleum upstream supply chain relies on six independent operations: exploration, demand planning, price modelling, crude oil trading, transportation planning and refining. Each of these operations has its own costs and risks, which can be controlled by accurate and timely information. Oil exploration requires a high investment cost. Crude oil trading is where oil’s price volatility leads to financial risk for companies, indicating the need for up-to-date information. Transportation costs vary depending on the situation, with 62% of oil (100 million tons per day) being transported using maritime transportation, and the rest by pipelines, railways or trucks. The complex nature of the refining process, which produces varying proportions of gasoline, diesel and other by-products depending on the chemical composition of the oil, leads to the need for information support systems. For example, it is necessary to
communicate possible delays of crude oil shipments to the refinery managers to reduce
the risk of costly downtimes. Thus, information exchange between functions directly
affects the viability of the industry.

INFORMATION SUPPORT SYSTEMS

Decision makers in upstream oil production rely on mathematical models such as LP
(linear programming), stochastic and heuristic models, and simulation and trading
software. These models are used to determine yield ratios of individual products derived
per barrel from raw crude and the volume of crude available for purchase. They are also
used to evaluate crude, model price, forecast demand, schedule cargoes, and blend
streams to give products. These mathematical models provide estimates of the yield and
quality of the finished product. LP models are useful in refineries as well as crude oil
trading and transportation. Stochastic models are appropriate when data evolve over time
and decisions need to be made before the entire data stream is available. Heuristic
methods for decision-making include general random search approaches, such as
simulations and genetic algorithms. Process simulation models help to evaluate the
effectiveness of policies such as predicting the performance of configuration changes.
Trading and tracking software are used by the transportation and trading sectors of the
supply chain. In general, each of these models uses different software packages. Oil
companies are faced with the challenge of integrating these systems.
SILOING BETWEEN THE FUNCTIONS OF THE UPSTREAM SUPPLY CHAIN

Siloing is the segmenting and segregation of information and decision-making between the different functions of a supply chain. Supply-chain management which achieves functional integration requires improved coordination and synchronization among multiple autonomous entities. The refinery production plan is needed by other business units such as crude oil trading and transportation planning for making strategic decisions. Hence, the quality and timeliness of information shared is critical to the decision-making process. Siloing can be avoided through more effective communication. Currently, companies communicate through telephone calls, letters, faxes, telex, electronic data interchange (EDI), and the Internet, with the Internet taking on a much more prominent role in recent years as firms create more effective and open transmission protocols. Given that silos exist within the upstream petroleum supply chain, how can oil companies share the required information necessary to achieve the right refinery production plan for crude oil procurement? Present business support systems do not have the capability to capture the information from various functions that make up the upstream section and represent it in a structured manner that would aid unified decision-making. Thus, it is difficult for managers to assemble all the data required for an optimal refinery production plan. There is a need for a new paradigm for the integration of processes and functions using decision support systems that are capable of gathering dispersed information. These are required for the effective flow of information in order to make effective planning for crude oil procurement in refineries.
Software providers to the energy sector believe that the barriers to integration of information systems can be overcome if executives in the oil industry commit to an information technology investment that will fully automate processes, streamline operations and improve the integrity of financial reports. While advances have been made in information systems such as the trading and tracking software, their weaknesses are that they are dependent on human input and decision-making (crude oil traders). One ripe area of integration is for software producers to collaborate in providing smooth interaction between their products. Barriers to this approach include limited interoperability between systems, lack of enterprise-wide visibility and territorial concerns by software vendors.

CASE STUDY

A review of the techniques used by one of the major players in the global oil industry reveals the areas in which upstream supply chain integration can be improved. The company uses mathematical modelling to find the most economical crude oil to fill requirements and make decisions. It uses price modelling to ensure that refineries produce and set the appropriate price. It shares information about current demand, which is pulled into LP models to assess crude oil grades. It runs demand models with updated price files to focus on appropriate feedstocks. It also uses LP models to interface between systems in trading and refinery optimization. In its refinery planning, it uses standard sets of procedures and LP models. Its transportation planners share information on shipments, and its marketers set prices by including information from the rest of the supply chain.
An analysis of the information flow in this company suggests that substantial room for improvement exists. A reduction in siloing could increase profit margins for this company. For example, profit margins could be maximized by using real-time information obtained from refinery optimization and price models. Suggestions are made for the maximization of business process transparency.

NEED FOR TRANSITION TO HOLISTIC, SYSTEM-WIDE THINKING

While oil industry executives see the value of upstream integration, they are unsure as to the process by which change can be implemented. An energy consultant believes that executives are only receptive to “process changes and system changes,” but not to “transformational change.” This type of change would require a multi-year program and is a pre-requisite for integration. The executive must also be capable of aligning both strategic and tactical objectives, and be flexible in applying different models as problems change.

Once executives have bought in, they need to communicate the benefits of the change process to all involved, and to ensure that all silos are removed. In order for effective decision-making to take place, the employees must be able to access data promptly and share information across business units. The transition to a more holistic supply chain view will need a paradigmatic change (Jonathan Byrnes, 2006) and a modification of the incentives and metrics used to measure the success of supply chains. This change can be achieved through linking an explicit set of performance goals with financial objectives.
CONCLUSION

Integrating business units can improve processes and help oil companies maximize the value of existing and future IT investments. This is because an integrated supply chain structure ensures timely information exchange, which in turn enables global supply chain changes to be addressed in minutes, so that as the market changes, responding to the changes are done efficiently. The ultimate gain is in reducing the variability in the price of end products and maximizing profits for oil companies. Taking this step toward process improvement using timely information exchange, reduced siloing, and system-wide thinking can help forward-thinking companies achieve competitive advantage through efficiency improvement.