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## Transforming the Petroleum Supply Chain: "Fulfilling the Promise"

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# Executive Summary

For years, software vendors, consultants, process engineering firms and oil companies themselves have promised the U.S. petroleum industry significant improvements — \$0.50 per barrel and more — across the hydrocarbon supply chain. A seemingly endless stream of initiatives promised this including:

- inventory reduction
- refinery and process optimization
- improved scheduling
- asset rationalization, and
- concepts like "integrated supply chain management."

In fact, the costs to refine crude oil and distribute products have declined steadily, at roughly \$0.15–0.20 per barrel annually<sup>1</sup> over the past decade or more. The manufacturing and supply chain infrastructure — including refineries, pipelines, terminals, and other distribution assets — now handles more volume and operates more reliably than ever. And technology advances, such as more sophisticated refinery linear programs (LPs), in-line blending and advanced process controls, have helped improve capacity utilization, increase yields, minimize product giveaway and reduce logistics costs.

Despite these realized cost reductions, many oil companies remain skeptical of, or are disappointed with, their "supply chain improvement" initiatives. Why?

- 1) Benefits typically have fallen short of the promised \$0.50-plus per barrel, and there has been more hype (e.g., concepts like "real-time integration," "system-wide optimization," and "dynamic modeling," among others) than reality in the types of improvements promised.
- 2) Companies usually are not organized around supply chain improvement, which makes it more difficult to find a "process owner" with accountability for optimizing and integrating supply chain initiatives.
- 3) Many promised benefits rely increasingly on growing revenues or avoiding costs, both of which tend to be difficult to measure or substantiate.
- 4) Few of the improvements seem to create sustainable competitive advantages: either the improvements are quickly imitated, or benefits are shared (diluted) among supply chain partners (e.g., through exchanges, asset sharing or increasingly common distribution systems).
- 5) Finally, there is a perception that today's supply chain is just too complex to be integrated and optimized. That is, there are too many variables and externalities, the modeling is too data-intensive, and the tools are not sufficiently advanced to achieve the theoretical improvements.

Consequently, many downstream oil companies view "integrated supply chain" either as a buzz word with few tangible results to back it up, or as a "holy grail", too difficult to accomplish in a cost-effective way.

Still, continued efforts across the supply chain are becoming more pivotal to improving downstream economic performance. Unprecedented industry consolidation over the past several years has caused oil companies' supply chains to become more extensive, more complicated and more competitive. Product proliferation — from reformulated gasoline and low-sulfur fuels, to increasing "boutique" formulations for specific customers or geographies — has reduced fungibility and made distribution, exchanges and trades more difficult and costly. Environmental requirements have driven higher capital expenditures with little

<sup>1</sup> Energy Information Administration data on Refining & Marketing gross margin and operating costs, 1991–2001

hope of generating adequate returns. Working inventories have declined. Asset utilization has continued to increase. Capacity has become more constrained. All of these are driving greater price volatility and the potential for supply disruptions. Technology advancements have made optimizing and integrating activities across the supply chain an increasingly "must have" set of capabilities. This has resulted in the emergence of new organizational structures, processes and tools to keep pace and deliver additional efficiency improvements.

Accenture's perspective is that hydrocarbon supply chain improvement has reached a critical juncture; an "inflection point", for which there is limited improvement potential from incremental functional efficiencies. What is needed is a new set of capabilities to drive step-change transformation in supply chain performance: capabilities that overcome the skepticism, fulfill the promise, and deliver improvements of \$0.50 per barrel or more.

We believe the foundation for this step change now exists, and is built around three major elements:

- Visibility (data integration): being able to access and leverage a common, unified set of data from multiple points across the supply chain, including third parties.
- Decision Support (application integration): connecting disparate systems, models and tools to create a coherent architecture that supports cross-asset, cross-geography optimization.
- Execution Support (business integration): being able to have visibility across applications to ensure proper execution of the business processes, i.e., changing the way work is executed.

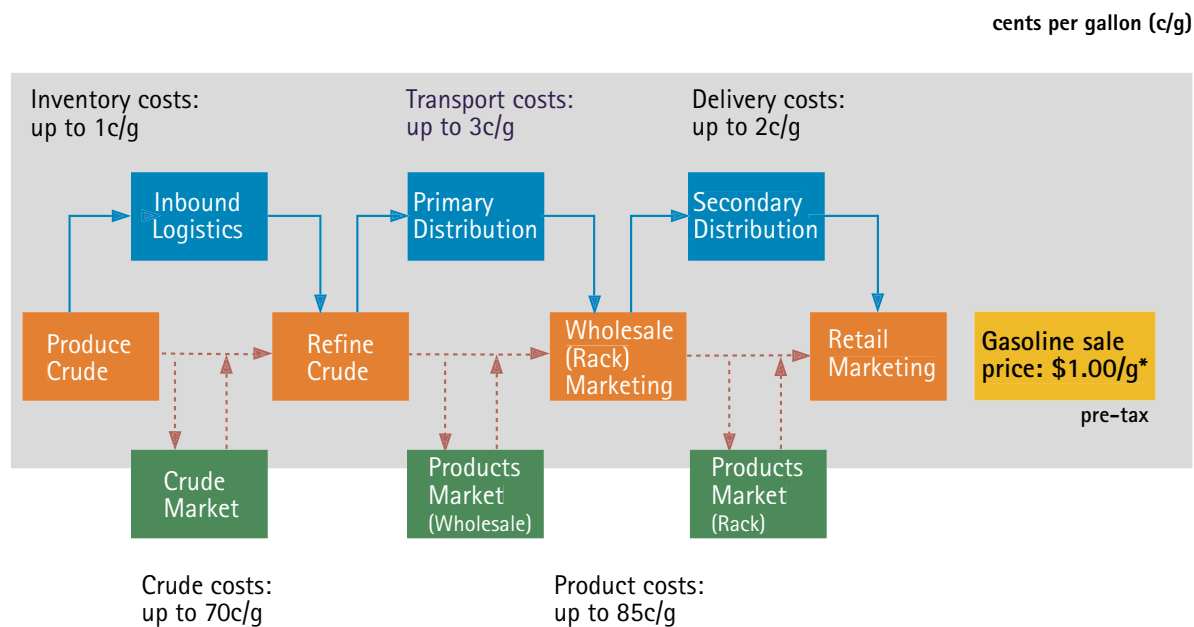
The good news is that none of the pieces in this foundation are new – but now technology infrastructures are capable of handling the massive amounts of data, increasingly real-time, at a reasonable cost. The analytical and decision support tools are now sufficiently sophisticated to leverage this data in ever-decreasing cycle times. Also, companies are more prepared – with common back office systems, trading and scheduling systems, measurements, and communication protocols – to make supply chain management a "core process" for enhancing downstream profitability.

The bad news is that the technology advancements have been necessary, but are not wholly sufficient, to meet the challenges of the evolving supply chain. Companies will need to develop new capabilities that cross traditionally separate functions (e.g., crude supply, refinery planning, trading, risk/exposure management, logistics and distribution, pricing, product supply, marketing, and sales) to take advantage of the emerging analytical and optimization tools. This will require changes in processes, organizations, skills, and metrics to simultaneously drive yield and margin maximization while delivering the right products to the right customers in the right locations at the right price. Those companies that do not make these changes and build these capabilities will continue to be disappointed with and skeptical of supply chain improvement, or will make limited progress. Only those companies with a strategic focus on transforming the hydrocarbon supply chain will enjoy dramatic levels of improvement.

# The promise of the supply chain

The hydrocarbon supply chain is broadly defined to include crude purchasing, inbound logistics, refining, product sourcing, distribution and delivery. Given that it represents the bulk of a typical downstream company's operating costs, it has long been a target of cost improvement initiatives. As illustrated in Figure 1, many of the direct costs are driven by crude and product purchases. However, logistics and distribution costs comprise tens of millions (and for larger companies, hundreds of millions) of dollars annually.

Figure 1 - Supply Chain Costs to Sell Gasoline in the United States



\* Rough estimate based on 2001 U.S. market conditions

Source: Energy Information Administration; Muse, Stancil & Co.; Accenture analysis

Consequently, software vendors, consulting and process engineering firms, and oil companies themselves have proposed a seemingly endless stream of initiatives in an effort to reduce these costs. Promised improvements are of \$0.50 per barrel and more. At around 1.2 cents per gallon, this level of improvement may seem small in terms of overall supply chain costs. However, it can be a material impact compared to the historically narrow margins in the business. These initiatives have ranged from traditional approaches (such as inventory reduction, improved scheduling, and asset rationalization) to increasingly advanced efforts in refinery-process optimization and advanced process controls. More recently, this has also included concepts like "integrated supply chain management."

## Sustained progress in operating efficiencies

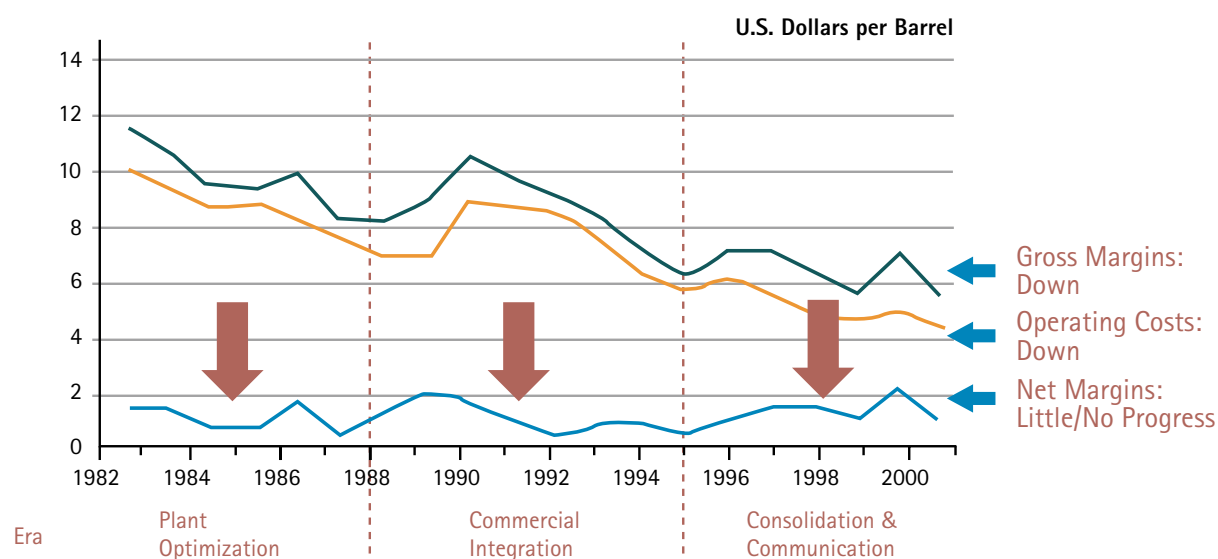
In fact, the industry has made significant progress improving the efficiency of refining crude and marketing products. The U.S. Energy Information Administration (EIA) reports that downstream operating costs decreased from about \$10 per barrel in 1982 to about \$4 per barrel in 2001<sup>2</sup> (constant year 2000 dollars). This represents a 60 percent cost reduction (Figure 2), or an average of \$0.15-0.20 per barrel annual improvement in operating expense.

Indeed, in just the past 10 years, the downstream industry:

- Added about \$28 billion in revenues
- Increased heavy crude runs by 75% to reduce feedstock costs by \$2 billion/year
- Reduced crude and product inventories by about \$6 billion
- Increased refinery utilization from 85 percent to 93 percent
- Almost doubled the average throughput per retail station<sup>3</sup>

How did the industry achieve these efficiencies? Engineers and scientists in this industry introduced new processes, catalysts and equipment to upgrade increasingly heavy and sour crudes into valuable gasoline and distillate products. In addition to these processing advances, important information technology advances have occurred. For instance, in the early 1980s, linear programming and modeling advances provided more powerful economic assessment and plant optimization tools. From the late 1980s through the mid-1990s, we saw advances in distributed controls, in-line blending, maintenance management, logistics management, and enterprise resource planning (ERP) implementations, as well as a renewed focus on performance management. In the late 1990s, consolidation had a big impact on efficiencies, as did electronic-based communications and transactions.

Figure 2 - U.S. Downstream Petroleum Margins and Costs, 1982-2002



Source: Energy Information Administration

<sup>2</sup> Energy Information Administration, data on Financial Reporting System (FRS) companies 1982-2001

<sup>3</sup> Energy Information Administration; Oil & Gas Journal; National Association of Convenience Stores

Despite these realized cost reductions and performance improvements, Figure 2 also highlights the apparent lack of progress the industry has been able to make in boosting profitability (net margins), particularly considering the capital investments made to achieve these improvements. The industry has certainly become more efficient over the past 20 years, but the benefits have essentially been competed away and passed on to the customer. This is a great story if you are a consumer or politician, but a disappointing story for the investors in this business.

## Skepticism of additional supply chain improvements

It should not be surprising, then, that many oil companies are disappointed with their "supply chain improvement" initiatives, or that they remain skeptical that any meaningful benefits can be achieved. There are five major reasons behind this skepticism.

- **Hype vs. reality:** Downstream companies have faced a barrage of ideas to deliver the promised \$0.50-plus per barrel improvements, which raises expectations so that even \$0.15–0.20 per barrel is viewed as falling short. In addition, many "leading" supply chain concepts have been adapted from batch-based or discrete packaged goods industries (e.g., microprocessors, retail, automotive) and do not easily translate to the continuous, process-based hydrocarbon supply chain. Yet the explosion of companies in the supply chain management sector has driven an ever-expanding set of ideas (e.g., just-in-time inventory, demand-driven manufacturing) that do not apply directly to the downstream industry.
  - **Lack of visibility across supply chain:** Companies usually are not organized around supply chain improvement, which makes it more difficult to find a "process owner" with accountability for optimizing and integrating supply chain initiatives. In fact, conflicts and misaligned priorities between refining, crude and product supply, trading, logistics, and marketing can result in sub-optimal outcomes (e.g., excess inventories, complicated transfer price mechanisms, volume/supply "push" vs. total margin, excess trading to balance refining outputs with marketing demands).
  - **Inability to measure impact:** Many promised benefits rely increasingly on growing revenues or avoiding costs, both of which tend to be difficult to measure or substantiate. Efforts to "baseline" performance can be time consuming, and benefits can be overshadowed by market changes, supply disruptions, competitive moves, turnarounds, and other planned and unplanned events. Also, many companies still focus on headcount reductions as evidence of benefit—when it may require more or higher-skilled resources to properly analyze and execute supply chain improvements.
  - **Advantages difficult to sustain:** Supply chain improvements are often pitched as something that provides "first mover advantage." Many companies find, however, that few of the improvements seem to create sustainable competitive advantages: either the improvements are quickly imitated, or benefits are shared (diluted) among supply chain partners (e.g., through exchanges, asset sharing or increasingly common distribution systems). Ironically, many of the efforts companies have made to "simplify" the supply chain (such as increased product fungibility, more standard contracts, more extensive exchanges, and supply through third-party terminals), have contributed to the higher volumes, lower margins, and lack of differentiation.
  - **Hydrocarbon supply chain too complex:** Finally, there is a perception that today's supply chain is just too complex to be integrated and optimized. That is, there are too many variables and externalities, the modeling is too data-intensive, data required to optimize is not available (e.g., competitor prices and inventory positions), and the tools are not sufficiently advanced to achieve the theoretical improvements.
- Consequently, many downstream oil companies view "integrated supply chain" either as a buzz word with few tangible results, or as a holy grail, too difficult to accomplish in a cost-effective way.

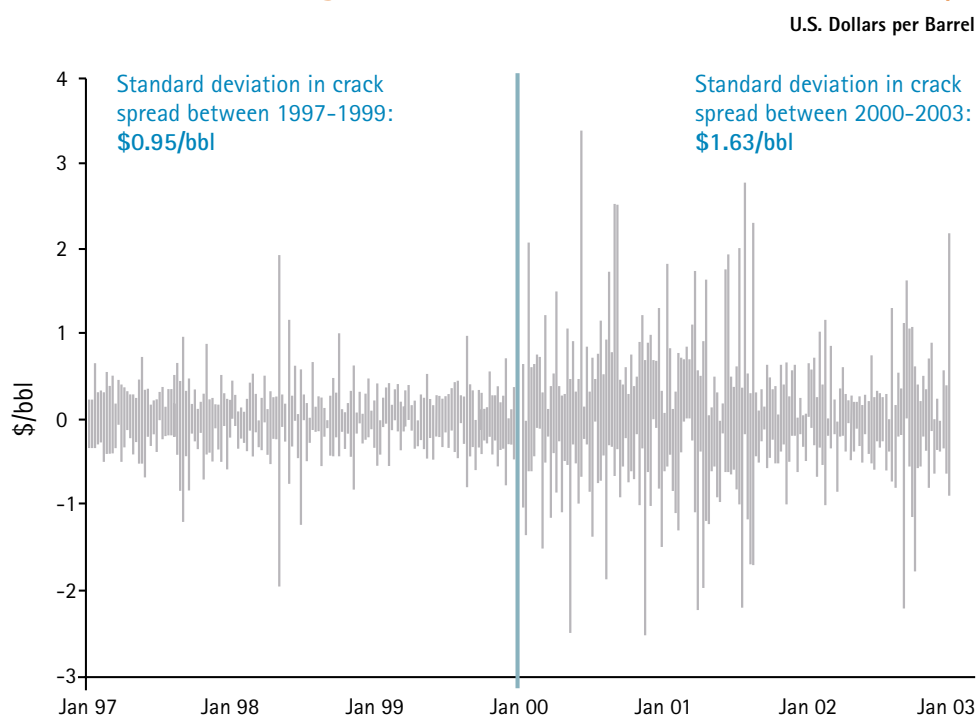


## Focus on supply chain integration and optimization

Despite the skepticism, we believe a focus on the "next generation" of supply chain improvement is needed. There is no doubt that continuing to squeeze costs out of today's supply chain is more challenging than ever. The consolidations of the late 1990s were focused on scale efficiencies, but have created expansive refining, supply and distribution networks. Additional efforts to reduce inventories could tax an already strained system, particularly with the proliferation of new products from regulatory, geographic, and even customer-driven, "boutique" blends. Increased reliance on imported crude oil and finished products poses new problems in shipping, storage, and planning. Tighter supply/demand balances – due in large part to the Sports Utility Vehicle (SUV) craze, inventory reductions, restrained capital investments and refinery closures – have allowed refiners and distributors to achieve higher utilization rates, but have also made the market vulnerable to small disruptions in supply and demand.

One outcome of this complexity is increased price and margin volatility. Figure 3 illustrates how crack spread volatility has almost doubled in the past three years (compared to the prior three years), and can change by as much as \$3.00 per barrel on a given day

Figure 3 – Daily Change in U.S. Gulf Coast 3-2-1 Crack Spread\*



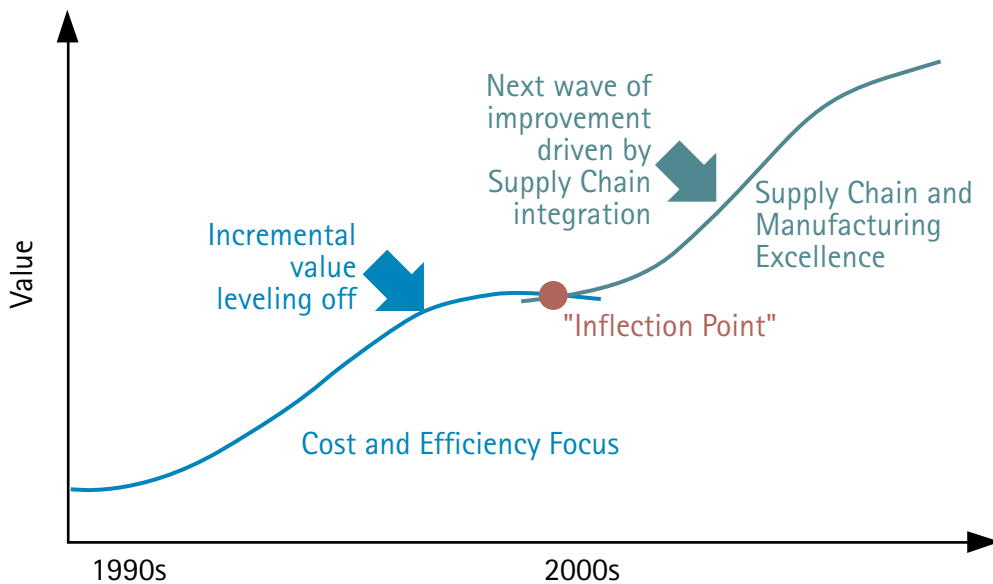
\* U.S. Gulf Coast Spot (3 \* ULR + 2 \* No. 2 + No. 6)/6 - WTI

Source: Energy Information Administration; Accenture analysis

In this complicated environment, companies must develop new capabilities to manage the supply chain in an integrated fashion (from crude supply through refining, distribution and retail). They must more dynamically adjust their positions to capture highest value and highest margins throughout the system. The leading companies will be those that can consistently purchase the most economical feedstocks, adjust operations to respond to changing market conditions, and excel at the myriad of buy/make/sell/exchange decisions across their entire networks.

Indeed, given the efforts and improvements to date, we believe the industry has reached an "inflection point". This means the industry must now find new ways to move beyond incremental reductions in "siloed" functions. Successful companies will build capabilities, leverage technology, and achieve a level of integration, collaboration, and optimization that will drive the next wave of improvement (Figure 4).

Figure 4 - Moving Beyond the Inflection Point



# Moving beyond the inflection point

These so-called new capabilities have been around for some time; the "new" part is making them real. If the ultimate vision for a company is complete supply chain integration, then that implies the need to adjust product deliveries, inventories, sourcing, refinery operating conditions and crude purchases as margins fluctuate throughout the supply chain. Recognizing the unique characteristics of the hydrocarbon supply chain, we are a few years from real-time, end-to-end optimization, where one push of a button in a central control room sends out automated signals across the entire network to optimize the system. However, companies are able to make important strides in that direction.

Capability building will take place in four broad areas:

- 1) Supply Chain Optimization
- 2) Production Optimization
- 3) Product Placement and Sourcing
- 4) Operations Excellence

The optimization capabilities focus primarily on margin and price, while the operations excellence capabilities focus on cost and inventory.

Supply Chain Optimization focuses on maximizing margins on crude and feedstock purchases, including the ability to consistently keep operations at the constraints of the refining and logistics assets. The critical capabilities in this category are crude valuation and crude blending. Crude and feedstock valuations must incorporate the constraints on the assets at the time the crude will be run. Processes must be robust enough to respond to the volatile crude markets. Blending capabilities are required to ensure that the crudes are run consistent with the plan and schedule. This must also ensure that crude mixtures are adjusted as needed to optimize throughputs, inventories and operating costs. The enablers for these capabilities are accurate data (inventories, compositions, schedules, constraints), robust analytical tools and cross-functional processes (especially across trading, scheduling, logistics, planning and operations).

Production Optimization focuses on maximizing the refinery profitability by adjusting product qualities and quantities to best meet market conditions and to minimize quality giveaway. The critical capabilities are executing to plan and schedule (especially as those plans and schedules are adjusted to respond to market conditions) and product blending to minimize giveaway and maximize the value of the product portfolio. The enablers are similar to those of supply optimization: accurate operating and market data; robust decision support tools; and the ability to execute to plan and schedule.

Product Placement and Sourcing maximizes margins by optimizing the hundreds of buy/make/sell/exchange decisions throughout the network. The same capability requirements apply: data, decision support tools and process execution. The data requirements in this area can be daunting, due to the number of transactions and the number of decisions that must be made.

- First, data are required on prices, inventories, storage capacity and transport capacity, delivery costs, contract specifics, sourcing options, sourcing prices and product availability.
- Second, all the data must be accurate and available in time to make the decisions.
- Third, the decision support tools need to be able to analyze all of this data and generate economically optimal plans and schedules.
- Fourth, the emphasis moves from pushing volume through the system to maximizing total net margins.
- The last requirement is a business process structure that can execute the solution. One important challenge is to ensure proper behavior at the local level—seeing to it that decisions to sub-optimize one area of responsibility are taken in the context of optimizing the broader network.

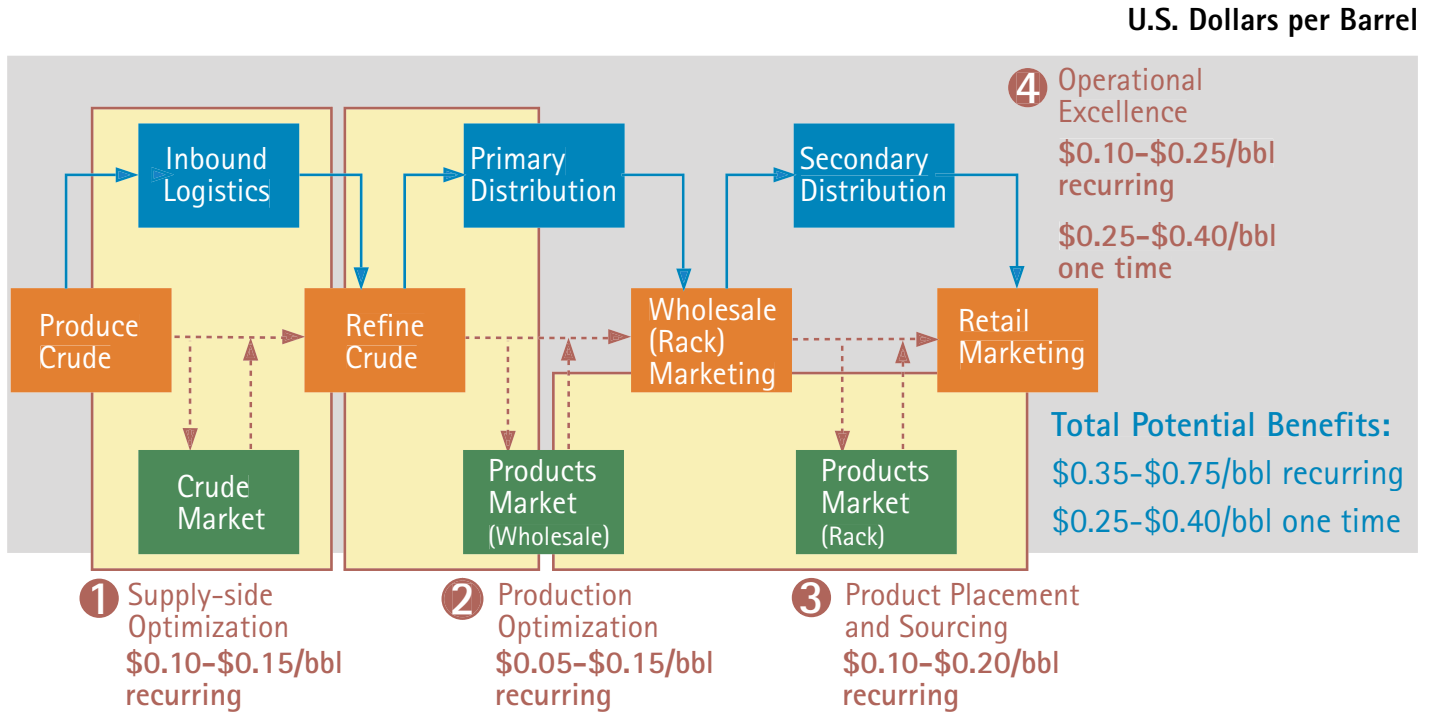
Operations Excellence is all about efficiency, driving out costs, reducing inventory, and minimizing variability in the system. The critical capabilities here are: translation of schedules to operational orders; execution monitoring; effective scheduling and inventory management to eliminate self-inflicted variability; and performance management capabilities to continue to improve business processes. Total alignment of objectives and incentives to ensure well-orchestrated pursuit of opportunities also is critical.

## Value – the new promise

The value of achieving this vision can be more than \$0.50 per barrel, split almost evenly across the four opportunity areas (Figure 5). For a small- to mid-size downstream company – in the 500 thousand barrels per day to one million barrels per day range – this could amount to benefits well in excess of \$100 million pre-tax. For the largest players – one to two million barrels per day – the impact could approach \$500 million pre-tax.

Although this looks mysteriously like the previous promises made to the industry, interviews with downstream executives and diagnostic efforts corroborate both the size of the opportunity and what should be done to capture it. We believe that the opportunities are generated not only by executing better in the four process areas, but also by executing across the process areas. For example, better product placement will result in benefits in the refinery and crude acquisition pieces of the business. We have not rigorously quantified this cross-process integration value, but empirical data suggests that increasing the visibility of the implications of changes in one functional area, and incorporating those impacts into an enterprise-wide view of the operation, would likely help achieve the higher end of each range of value.

# Figure 5 – Value of Supply Chain Integration



Source: Accenture and Aspentech analysis

Although the sheer magnitude of the benefits—driven by the multiplicative effect of the large volumes each company's supply chain must manage — is compelling, the more meaningful discussions are those that focus less on the absolute value of the opportunity and more on where to start the pursuit. Each company's starting point will be different. Each company's value proposition will be different based on the complexity of their system, the sophistication of their current tools and processes, and their willingness to adopt supply chain management as an improvement opportunity area.

# The technology enablers

Among the biggest historical constraints in making progress against this vision have been the limitations of information technology. Much of the technology that supports this industry was developed to solve problems within a somewhat narrowly defined scope. Developing the capabilities of the vision require much more robust solutions. Communication, consistency, completeness and speed cannot be delivered in a point-solution or environment, nor will they be delivered by any single end-to-end "integrated solution." What is needed is a cost-effective architecture that meets the needs of the business.

In the past, the cost and complexity to pull together the necessary pieces and make them fit the business processes has been difficult to justify relative to the benefit that could be achieved (measured). We see a big change coming in this value proposition, for three reasons.

- 1) The pieces of the technology platform are being put in place. The technology can achieve integration on three levels, all at a reasonable cost. On one level, technology must provide visibility. On another level, data about the enterprise (e.g., inventories, costs, compositions, prices, constraints, plans, schedules, performance data) have to be generated, collected and organized in such a way that it all can be accessed in a timely, consistent manner. A third level requires innovations in data storage, communication, architecture, analytical techniques and the standardization created by ERP systems to provide cost-effective solutions.
- 2) Robust decision support tools are needed. To move from simply "feasible" to "economically optimized" solutions to business problems, the decision support tools must be able to collect and process tremendous amounts of enterprise data in a timely fashion. These tools must work in an integrated way, using consistent data sets, sharing inputs and outputs, and being highly synchronized to provide an accurate and optimized real-time picture of the supply chain. Technology advancements in the form of increased computing speed and sophistication will provide the capabilities at a reasonable cost.

- 3) Technology must deliver the information needed to run the enterprise in such a way that it can be easily used. The most elegant solutions will be of no value if the results cannot be understood by the user and presented in a way that supports the particular business process. Visibility into the enterprise has to be complete; and the recommendations of the decision support tools have to be delivered in such a way that the people executing the business processes can utilize them fully. Recent technology advancements in this area include role-based Web portals, workflow, event notification, communication, and performance management.

Although companies may continue to be skeptical of making additional expenditures on technology for promised improvements, technology has indeed evolved to the point that it supports the vision for more dynamic supply chain integration at reasonable cost. With the magnitude of benefits conservatively exceeding \$100 million annually in most cases, and one-time benefits (that can be used to self-fund these initiatives) typically in excess of \$25 million, return on investment for technology and related initiatives becomes somewhat academic. The key point is that technology alone will not create the value, but it is arguably the most critical enabler of performance improvements that move beyond the inflection point.

## The people and process enablers

Of course, as technology continues to advance over the next few years it will no longer be the limiting factor in capturing the promised benefits. Indeed, some would argue technology is not the limiting factor today. Delivering these technology advancements will not be easy, but the impressive track record of the downstream industry in developing innovative technologies provides us with much confidence. As we "crack the code" on the technology front, the focus will shift to people and processes to deliver the value. The key is having the people and processes to effectively leverage the technology.

Companies that take advantage of the new technology will look different from the companies of today. Business processes will be executed differently, with much more emphasis on standardization, responsiveness to business conditions and performance feedback. To truly optimize the supply chain, functional silos will have to be broken down, spans of control will change, and there will be more sharing of responsibilities and need for new or better-aligned metrics, as margins in one area of the business may be sacrificed to maximize margins of the whole.

As with any industry, business process and organization change will be difficult across the hydrocarbon supply chain, because of required changes in behavior and long-standing practices. It is no secret that the downstream industry has generally been more effective in implementing new technol-

ogy than in orchestrating behavioral change to use it effectively. Refineries and other functions within the business have been generally autonomous. This makes standardization, adoption of collaborative practices, introduction of new activities to do more central planning, coordination of the supply chain across functions, and demand-driven planning difficult even for companies that have operated small or mid-size networks. Companies who have undergone mergers, acquisitions and consolidations typically find it even more difficult to overcome "heritage" behaviors. How many of these companies have captured the full potential of the combined companies? And how many of the essential cultural and people changes have been carried out to their fullest business potential?

## The courage to start the journey

Fulfilling the promise of significant supply chain improvement requires moving beyond skepticism. It requires creating new capabilities — technology, process and organization/behavior — that enable the coordination, integration and collaboration needed for broader, more real-time optimization. Advances in technology infrastructure, analytical tools, and data management are creating new opportunities to move beyond the "inflection point."

Leaders in this industry will embrace supply chain and manufacturing excellence as a strategic initiative. It is becoming less a choice and more a necessity to being competitive. Companies will differentiate themselves on their asset base, but even more so on their ability to execute their business processes better than the competition. Exactly how to capture those benefits will be unique for each company, because of different starting points and business models.

But the promised value almost certainly exists. Starting the journey is the critical first step — simultaneously taking on the needed technology, organization/behavior, and process changes. While each step must be driven by the business value it will create, ultimately, deploying capabilities faster than the competition, and reaping the benefits before they are competed away, will achieve success and find the promise of supply chain improvement fulfilled.

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