EXCELLENT SUPPLY CHAINS IN THE OIL INDUSTRY:

ROYAL DUTCH/SHELL

by

Stefan Röthlisberger

Submitted to the Zaragoza Logistics Center in Partial Fulfillment of the Requirements for the Degree of

MASTER OF ENGINEERING IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT

at the

ZARAGOZA LOGISTICS CENTER,

A RESEARCH INSTITUTE ASSOCIATED WITH THE

UNIVERSITY OF ZARAGOZA

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ABSTRACT

The oil industry is one of the few truly global industries; besides providing a large chunk of the world's energy consumption, it also makes the feedstock for the petrochemical industry, which eventually goes into millions of products. Along its supply chain, oil passes through different legal frameworks as it moves from one country to another. Too big to be scaleable, the industry has always been segmented along its supply chain into an upstream, refining, and downstream part. This has been changing somewhat recently, due to a wave of mergers, which forced companies to focus more on their core strengths.

It is generally believed, that only today's super-majors will be able to survive as vertically integrated companies. However, little attention is paid to the threats they face, above all in the upstream environment from the sleeping giants of the industry, the National Oil Companies (NOCs). On the other end of the supply chain, retailers are moving into the gasoline market to challenge the majors which so far have exclusive franchise rights.

Shell's strategy is to invest more in the upstream and use the downstream to finance this investment. But in order to persist it will have to complement its existing strengths such as brand and knowledge with a supply chain management that leverages the full range of activities in which the company is involved.

EXECUTIVE SUMMARY

The framework for this thesis is provided by the Supply Chain 2020 project. The central goal is to establish "which are the pivotal business-processes that enable Shell's leading position in the oil industry, which make it stand out from its competitors, and which are designed to ensure the company's future success"?

Much of the modern world's accumulation of material wealth has been fuelled by cheaply available and abundant energy. A good way to get a better understanding of the oil industry, which provides a large chunk of this energy, is to take a look at the decisions oil companies face along their supply chain. Integrated oil companies, such as Shell, have not been not been operated as integrated supply chains so far. As a consequence, the industry has developed a "silo-mentality" that is supported by the incentive systems in place.

Shell is the third largest of the world's five "supermajors" with a market capitalization of roughly $175 billion. As of 2004, Shell had revenues in excess of $200 billion, employed 119'000 workers and owned some 50'000 gasoline stations all over the world. The company is organized in five main business units, Exploration and Production (EP), Gas and Power, Oil Products, Chemicals, and Other Industry Segments. In its latest strategy review from the end of 2004, Shell calls for more investment in the upstream, which it plans to finance with steady revenue flows from the downstream.

From a supply chain point of view, the upstream has indeed the greatest potential, as supply chain management has been virtually absent from a sphere that is characterized by large scale projects with few processes routines and standardization. Above all a number of technological innovations such as availability of survey data, decision making with regard to exploratory wells and the interpretation of drilling results, and the designing and building of oil platforms have led people to challenge that assumption, as geological and engineering ventures are becoming more scaleable and project management is more standardized. The opportunities for refining are more limited due to the widespread use of software suites from third-party suppliers, which are commonly available and manage the optimization decisions to be made in that part of

the supply chain. There are some opportunities in the downstream, especially in the realm of product differentiation. So far, product differentiation has been driven by regulatory developments. If the oil companies get on top of the differentiation challenge, they should be able to leverage their strong brand names and actually make money from them, as the recent success of differentiated fuels launched by ExxonMobil and Shell indicate.

However, there are more basic issues that threaten the traditional "silo"-approach to SCM. In the upstream, the integrated majors are at a competitive disadvantage compared to the National Oil Companies, both in terms of size of deposits and quality of crude oil. It is only a question of time before the NOCs will translate this potential advantage into a real one and by moving downstream, the disadvantage of the majors might not remain limited to the upstream only. On the other side of the supply chain, retailers are moving into the gasoline business, leveraging both their management experience as well as their large customer basis with increasing success. Eventually therefore, major oil companies will have to justify their existence by creating value from what they are: integrated companies that have superb knowledge and management skill to manage the vertical value chain as an integrated entity. It is only from the synergies of the integrative approach from which the majors can gain a true and sustainable competitive advantage.

The key drivers in such a move are demand management, improved communications, and the quality and timeliness of information. On the cost side, they are crude allocation, feedstock and blend component transfer between refineries, better transportation scheduling, and warehouse and distribution management. In order to make a difference, these drivers will have to be part of an all-encompassing strategy so that their sum outperforms their individual contributions. Complementary to these supply chain-specific drivers, special attention has to be given to business processes, people, and technology. If applied successfully, a number of benefits and opportunities, such as increased revenue through cross-channel coordination or optimal pricing strategies, multiple order fulfillment, improved customer experience through standardized product catalogue, better inventory management, a more optimal product mix management, improved collaboration with suppliers and design partners, proactive

monitoring of the status of shipments and intelligent exceptions management, a higher degree of planned versus unplanned activity, global work processes, a global set of planning tools, interchangeability of personnel, reduced design cycle time, reduced overall lead-times, reduction in transportation cost, manpower, fixed and working capital, and inventory levels of raw materials and finished products, can be reached. In addition, alliances will continue to play an increasingly significant role to ensure the access to supply as will the importance of brands.

Shell is very well positioned to successfully manage many of these challenges. While it is focussing its effort in the upstream by changing to an operating model that is based on regional hubs, efforts are under way to broaden the crude portfolio, shed non-strategic and underperforming assets, and focus on select profitable markets and businesses. Downstream, Shell has a strong retail position to build on with some 50'000 service stations world wide. The company is simplifying organisational structures and becoming more focussed in order to cut its cost base and become more responsive. At the same time, Shell is streamlining and developing its portfolio of products, customers and assets.

Managing such a complex global network requires implementation capabilities, which in turn depend on functioning organizational structures and highly trained employees. Shell is working to deploy the talent of its diverse workforce even more efficiently. It is aligning employees' incentives better with corporate goals and enhancing personal accountability at all levels. In order to retain the talent at hand and attract new one, Shell is actively developing its second key enabler, the Shell brand. As a consequence, Shell is pursuing a single-brand strategy, in contrast to other majors. Using explicit benchmarking, efforts are under way to standardize systems and processes and to increase throughput and asset utilization.

LIST OF FIGURES

ACKNOWLEDGMENTS

The author wishes to express sincere appreciation to Professor Prashant Yadav for his assistance in the preparation of this manuscript. In addition, special thanks to Larry Lapide whose familiarity with the needs and ideas of such an undertaking was very helpful. Finally, I would like to give special thanks to Fidel Santos; as a student at the MIT's Centre for Transportation and Logistics' partner program and researching the same industry as part of the SC2020 project, Fidel was of invaluable help throughout the project. Not only has his year-long industry experience greatly helped with the technical quality of some of the chapters, but he has also been a fine comrade in supporting, advising, and guiding me through the non-technical challenges that inevitably arise during any such project.

ABBREVIATIONS

API	American Petroleum Institute
APS	Advanced Planning System
CEFIC	European Chemical Industry Coucil
CDU	Crude Distillation Unit
EP	Exploration & Production
IEA	International Energy Agency
KOC	Kuwait Oil Company
LPG	Liquefied Petroleum Gas
MIT	Massachusetts Institute of Technology
MP	Mathematical Programming
NOC	National Oil Company
NIOC	National Iranian Oil Company
OPEC	Organization of the Petroleum Exporting Countries
PDVSA	Petróleos de Venezuela S.A.
PEMEX	Petróleos Mexicanos
PIDX	Petroleum Industry Data Exchange
PSA	Production Sharing Agreement
SC2020	Supply Chain 2020 Research Project
SCM	Supply Chain Management
XML	Extensible Markup Language
ZLC	Zaragoza Logistics Centre

1

INTRODUCTION

This thesis is part of MIT's research project Supply Chain 2020, which is a multi-year research effort, designed "to identify and analyze the factors that are critical to the success of future supply chains".[1] The research project was initiated by the MIT-Zaragoza International Logistics Program, a partnership between MIT and the Government of Aragon, Spain, with the goal of creating a world-class logistics platform in Zaragoza that offers education, research, and interaction with the PLAZA logistics hub. The insight gained from the research should then be used to serve as a guideline for companies to prepare for the future.

The two superordinate research questions reflect this twofold motivation: "what will excellent supply chains look like in 2020?", and "what should companies do to prepare for 2020?" In order to be of practical value to the potential users of the research results, SC2020 attempts to develop a Supply Chain Model; once created, the purpose of this model is to allow a simulation of the supply chain's behaviour in different scenarios. The project thus really pursues two separate research goals, which only come together towards the end of the project: one is to develop the model, which is done by analyzing and understanding how today's excellent supply chains work. The other part of the project is to identify the macro factors that influence the business world and develop different scenarios, which supply chains of the year 2020 might face.

This thesis is part of the former, i.e. to research an excellent supply chain in an important industry as it stands today. In order to create a generic supply chain model for the future, more than a dozen of the world's most important industries are analyzed. A broad definition of the term supply chain serves to understand the competitive positioning, the business strategies, and the operating models that are critical in maintaining a competitive edge.

My motivation for taking a closer look at the oil industry in general and Royal Dutch/Shell[2] in particular were twofold: on the one hand, I have had a longstanding professional interest in the industry, although more from a policy-oriented viewpoint than a technical one. On the other hand, the oil industry is not only one of the world's

biggest industries, but it also serves as a basis for the proper functioning of just about every other industry. Due to this specific characteristic of the oil industry and the fact that it is a finite natural resource that will eventually run out, oil will continue to play an important and often controversial role in public discourse for years to come. Shell, finally, is one of only five companies that form the league of today's super majors and while it is not the company anymore that it used to be when it was founded some hundred years ago, it is the oldest one to look back on a continuous history as a legal entity.[3]

1.1. Research Question

The guiding question has therefore intentionally been formulated broadly; or, in other words, the use of the term "supply chain" is a very broad one for the purpose of this paper. For the danger would have been that other important aspects, which are not directly considered to fall under supply chain management, but which might be important enablers thereof, are neglected, rather than the supply chain aspects taking a back seat. While supply chain and supply chain management is unmistakably at the forefront of the research interest, the broad definition of what supply chain comprises should help ensure that no important aspect evades our attention.

There are some definitional problems with what is meant by the oil industry. Given its size, I will exclude gas altogether and only mention the petrochemical leg of the supply chain in the industry overview, however not when taking a closer look at Shell. With regard to the timeline, this thesis only covers developments up to the present, with the main emphasis being on the current situation. While any results of this thesis is intended to serve to goal of determining what an excellent supply chain in the year 2020 will look like, any forward-looking speculation, such as trends and future developments, be it with regard to the industry or the company, is not part of this thesis.

1.2. Methodology

A number of factors predetermine the methodology used in this thesis. First and foremost, it is determined by the time available during a nine-month master program. The narrow time-frame is additionally restricted by deadlines from the SC2020 project. Furthermore, as far as hard copies are concerned, we are constrained by what is available

at the library of the Zaragoza Logistics Centre (ZLC), as there is virtually no English literature available in Zaragoza's public libraries.

There can, however, be no doubt as to the most severe shortcoming with regard to the methodology. The SC2020 project not only tries to understand how future supply chains operate from a scholarly perspective, but by so doing it hopes to add real value to firms, which might not dispose of the time needed to reflect on the long-term consequences of changes in supply chain management. The idea is to provide a strategic framework both to researchers and to companies that can be used by everyone involved in supply chain management as a tool to better understand, challenge, and improve his own work. From the very beginning, the SC2020 project has therefore been set up with the explicit goal of getting as much interaction with, and recourse from, private businesses as possible. The network of companies won over to participate in SC2020 has subsequently been organized in an American and a European body, the Industry Advisory Council (USA) and the European Advisory Council, which together combine a large number of the world's most successful companies.[4]

Unfortunately, no oil industry experts are on the committees and so far, we have been unsuccessful in our attempts to get the collaboration of an expert. This weighs all the heavier, as the oil industry is known to be close-lipped, which is still a rather euphemistic way of putting it; this trait of the people working in the industry goes some way in explaining why we were unable to find someone willing to talk to us; what it also means is that the internet is not the informational panacea it usually is. At this stage, it has to be accepted that the readily available material is sparse and leaves much to be desired.

Given the limitations of the "traditional" sources and the unintentional imbalance of written sources and oral testimonies, the internet will be a major pillar of this thesis, despite the restrictions mentioned earlier. The most important benefit thereof is the access to the MIT network of libraries, which with its vast amount of journals, thesis and articles, makes up for some of the shortcomings of the library on site. Additionally, the worldwide web provides a vast array of reports and analysis from various proveniences, such as market research institutions, investment banks, or consultancies.

1.3. Thesis Overview

The structure of this thesis follows largely the one suggested by the SC2020 management to students participating in the project. Chapter two is the literature overview. Chapter three takes a look at the oil industry as a whole. The most common financial indices and industry-specific metrics serve to get a quick grasp of the industry. Some paragraphs are then devoted to policy and regulatory issues, which afflict both the upstream and the downstream of the business, although in quite different ways. From there we turn to take a look at the supply chain and the issues that each of the different segments of it face.

The introductory part of chapter four gives an overview of the company itself, its history, size, geographic reach, products, activities and financials. These insights are then used to get a better understanding of the company's strengths and weaknesses and to establish its competitive positioning. From there we move on to take a look at the competitive landscape and where Shell faces its major threats.

The first subchapter looks at the upstream; due to the peculiarities of the industry, Shell faces an unlikely threat from the so-called producer nations. The times when countries with rich oil deposits were merely bystander as the big Western oil companies moved to exploit their national riches are long gone and producer nations are increasingly leveraging their position, both by passing laws that make access to their oil resources more difficult for foreigners as well as by becoming themselves active in the industry by means of their national oil companies (NOCs).

Another trend that adds to the complexity of operations lies at the other end of the supply chain. In the developed nations, which are the main consumers of petroleum products, customers become increasingly demanding and law makers account for this by passing an unprecedented number of regulations, most notably environmental, by which oil companies must abide.

The same trend towards more environmentally-friendly energy has given rise to a number of alternative energy sources, which potentially pose a danger to the very existence of oil companies. Alternative energy providers, however, are by no means the only new players entering the market. Over the last decade a number of small and highly specialized companies have entered the market and made some inroads, harnessing their

expertise by concentrating on a very small segment. Finally, there is the "traditional" competition of the other majors.

Chapter five analyzes where Shell's numbers (see chapter four) come from. In so doing, we will disentangle Shell's supply chain network and examine the operating model. Breaking down the organizational structure should not only make possible a deeper understanding of Shell's success, but also of missed opportunities when contrasting the findings with the organizational structure of the supply chain. To facilitate and structure the task, the supply chain is divided into three segments: the supply-side business processes, the "inside" business processes, and the customer-side business processes.

The final chapter is a forgone conclusion with regard to the research question, as it establishes the business processes that make Shell stand out from its competitors. In addition, the second part of the chapter relates those processes to the framework within which supply chain operations take place: the business strategy and the operational objectives. The emphasis lies with synergies among the different elements of the framework, and how those synergies are harnessed by Shell. At last, a paragraph is devoted to the so-called enablers, i.e. the factors that make the business processes possible all possible in the first place.

2

LITERATURE OVERVIEW

A good start to almost any thesis that deals with the oil industry is Yergin's classic *The Prize: The Epic Quest for Oil, Money, & Power*. Although it does not deal with the technical aspect, it gives an excellent overview of the history of the industry. Yergin portrays the story of oil as intimately intertwined with the rise of a market-oriented economic system in large parts of the world over the past two centuries and as it fuels modern economies, it is also closely linked to global politics. Yergin argues that the history of oil is one of astonishing innovation, both with regard to the workings of the industry as well as with developing new markets. Both Royal Dutch and Shell had their own company biographer, Gerretson and Henriques which are still the standard today, although they were written half a century ago. The two books are *History of the Royal Dutch* and *Marcus Samuel: First Viscount Bearsted and Founder of the "Shell Transport and Trading Company"*. Both books depict the evolution of the respective companies with much attention to detail and a lesser emphasis on the environment in which this evolution took place.

To get an overview of the current situation of the industry, there are a number of homepages that are helpful. OPEC and IEA are probably the best ones to get a quick grasp of the dimension of worldwide oil. They provide numbers on reserves, production and refining capacity, output, and consumption on a worldwide and on a country level as well as by product group where applicable. It is far easier to get good numbers on the US, first and foremost from the Department of Energy, which provides the same indices as OPEC and the IEA, but on a more detailed level, including regions as well. The homepage of the American Petroleum Institute offers a number of simple and colourful schemes to explain the basic operations of the industry, but it has to be born in mind that they are an interest group, representing the industry.

A good overview of the key players in the industry is given by Standard & Poor's *Industry Survey Oil and Gas*. It discusses the most important recent trends, such as the recent wave of mergers in the industry, and gives a fine overview of how the industry operates by means of the supply chain segments. To my best knowledge, there is no

article that covers supply chain-specific aspects of the overall industry. However, there is a wealth of material on aspects of the industry that are supply chain related.

Of the individual parts of the supply chain, refining is clearly the best document one. However, the majority of articles only deal with the US situation, which is not representative of worldwide refining. A very good article entitled "New Forces at Work in Refining: Industry Views of Critical Business and Operations Trends" has been published recently by Rand, the Santa Monica-based Research Institute. The report looks at what are the success factors in today's refining. Although the findings are restricted to the US, some of the conclusions clearly have a broader significance. The main challenges on which future success hinges as identified by the report are: Increasing regulatory restrictions, and less integration of refining with the upstream and downstream part within firms. As a result, refineries are beginning to operate more as stand-alone, market-oriented businesses. The National Petroleum Council publishes material on refining on a regular basis. One of the most helpful journals was the *Newsletter of Mathematical Programming in Industry and Commerce*, published by a small group of mathematicians with a background in the oil industry.

Although not quite up to date, a number of articles had been published by the *McKinsey Quarterly* around the time of the merger frenzy in the industry in the mid-90s. David Ernst and Andrew M.J. Steinhubl published to articles entitled "Alliances in Upstream Oil and Gas" and "Petroleum: After the Megamergers", respectively, in the *McKinsey Quarterly* 1999, no 2. In it, they argue that thanks to better functioning markets, oil will become more of a regular industry, where competitors have to position themselves strategically either as integrated majors or as highly focused specialists. In addition, Deutsche Bank makes a lot of material on the industry accessible, which include analysis they did at their investment bank for clients from the oil industry on a wide range of industry aspects.

For Shell, the best report was by PFC Energy, a market research firm, called *Shell: Strategy and Performance Profile*, which summarizes publicly available information on the company. The most detailed information, however, is provided by Shell itself, above all in its *Annual Report*, the *Investor Strategy Presentation*, as well as the information on its homepage.

3

BIG OIL OVERVIEW AND SUPPLY CHAIN

> *"The oil industry commonly is viewed by the public as a monolithic entity. The public policy discourse concerning "the oils" tends to reinforce this view. In reality, refining should not be viewed as a unified "industry" or "system" but rather as an amalgamation of diverse firms and operations acting independently in a market that is highly segmented."*[5]

Most of the accumulation of material wealth that the world has recently witnessed is based on the relatively cheap availability of abundant energy. Total world consumption of energy has skyrocketed in the past century and oil consumption has grown both as a consequence of this general trend as well as at the cost of other energy sources.

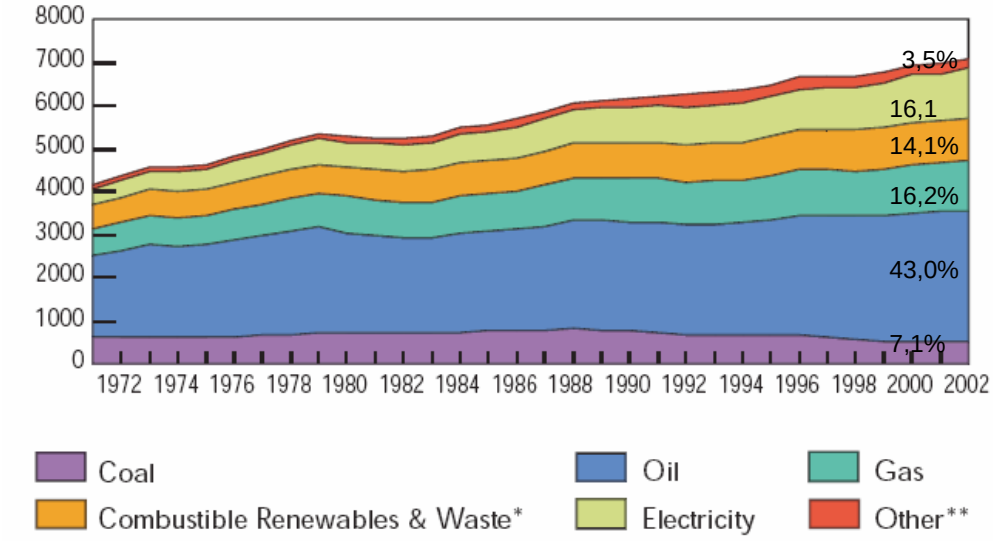


Figure 3.0 Evolution of World Total Final Consumption by Fuel (IEA, 2004)

The term "Big Oil" has thus a solid foundation, although energy is by no means the only way oil is used. Everything related to oil seems to be of extraordinary dimension: the fortunes of oilmen such as Rockefeller or Getty, the magnitude of environmental damage when a tanker leaks, or the profits of the major oil companies. The reason is simply that oil is so important to our modern way of life. Today, the oil industry produces almost 1000 bn barrels of oil and employs virtually millions of people.[6] And

the oil companies, whose primary objective is to move the oil from its natural sites of occurrence to where it is used, have continued to grow along with the rates of oil consumption, as have their profits. In 2003 the top five major oil companies, ExxonMobil, BP, Shell, Total, and ChevronTexaco had combined revenues of some $986bn and net income of $65bn in 2003.[7] All of them are in the top twenty of fortune's "Global 500".[8]

3.1. Evolution of Modern Day "Big Oil"

What is even more surprising is that the majority of them can be found in some form or another among the largest companies a hundred years ago. The modern oil industry goes back directly to Rockefeller and Standard Oil. The history of most contemporary oil firms can only be understood in light of Rockefeller's empire and the Supreme Court's decision to split it up and divide it into separate entities, as announced by Chief Justice Edward White in May 1911. The successor companies were Standard Oil of New Jersey, Standard Oil of New York, Standard Oil (California), Standard Oil of Ohio, Standard Oil of Indiana, as well as Continental Oil and Atlantic. The first five eventually became in the same order: Exxon, Mobil, Chevron, the American arm of BP, and Amoco, of which the first and the latter two merged again in 1999 and 1998, respectively, to become ExxonMobil and BP Amoco; finally, in 2003 BP Amoco changed its name to BP.

Although not successor companies to Standard Oil, the origins of Shell and Royal Dutch are best understood in light of those same developments. In the late 19th century, Rockefeller and Standard Oil had a firm grip on the oil industry. Around the same time the second major oil deposits were discovered in the Caucasus, for which the French banker family Rothschild and the Swedish entrepreneur family Nobel had obtained the production rights from the Russian Tsar. In trying to find a way around Standard Oil into the world market, the Rothschilds were looking to sell their oil in the rapidly growing markets in the East. They realized that in order to be successful, they would need to take on Standard Oil in all markets simultaneously; so that Rockefeller could not wage a price war by cross-subsidizing it with price rises in other markets. To carry out such an ambitious scheme, they would need to move swiftly, secretively, and

above all, they needed allies. Soon they turned to Marcus Samuel who had quickly expanded the shell trading business he inherited from his father into a fast-growing and profitable trading-house. Samuel thus had the experience and connections in Asia that were needed to carry out large-scale logistics' operations.

Consequently, he acquired the exclusive rights to sell Rothschild kerosene east of Suez. Transporting the oil through the newly opened Suez Canal would cut down travel time to Asia and allow pricing the oil competitively. Samuel set out to build storage sites in major ports, and acquire cars to transport the oil to inland depots, where it could be broken down for local wholesale and retail. In the process of planning the venture, Samuel exhibited great entrepreneurial talent; among other things, he invented the oil tanker to meet the safety requirements of the Suez Canal Company. The Economist reported as follows on the innovation:

> *"If simplicity is an element of success, the scheme certainly seems full of promise. For instead of sending out cargoes of oil in cases costly to make, expensive to handle, easy to be damaged, and always prone to leak, the promoters intend to ship the commodity in tank-steamers via the Suez Canal, and to discharge it wherever the demand is greatest into reservoirs, from which it can be readily supplied to consumers."*[9]

By the mid-1880s Samuel's tankers accounted for about 90% of all trade going through the Suez Canal. The success of his joint undertaking with the Rothschild family was such that Standard Oil agreed to sign a deal in 1895, which granted Russian oil a 25% share of world export sales.

Around the same time, Royal Dutch was opening up the world's third major producing province in Sumatra. The company was established in 1890 and began producing in 1892. This posed a direct challenge to Samuel, who was acutely afflicted by the most basic problem of the industry: the quest for balance among the different parts of the business. Any investment in one part of the business means new investments in other parts to protect their viability. Samuel had built up a huge marketing system which was wholly dependent on Rothschild's Russian oil for supply. The growing volume from the Dutch East Indies with shorter routes and lower freight rates threatened Samuel's very ability to remain competitive in the Far East. Royal Dutch had become a dangerous competitor to Samuel for distribution in Asia.

Samuel tried subsequently to buy out Royal Dutch as a way to get his own production site in Asia and thus protect his investments. But it was not until a decade later that the deal eventually took place, and this time around it was Royal Dutch who dictated the terms. Although Samuel consolidated his business into the Shell Transport and Trading Company in 1897, his ad-hoc managerial style was not appropriate for managing such a large venture on a day-to-day basis. Henri Deterding, who in 1900 became the new head of Royal Dutch and who would dominate world oil until Second World War, was much more adept. In 1901 he convinced a cash-strapped Samuel to sign an agreement to combine forces, which the Rothschild joined shortly after; in 1907, they merged officially to become Royal Dutch/Shell the first true global rival to Standard Oil.[10]

BP, alias former Anglo-Iranian, alias former Anglo-Persian, came into being in 1909 on the basis of a petroleum concession by the Persian Shah. In 1914, the British Government took a majority stake in the company to protect its oil supplies during the First World War. That share was subsequently reduced to next to nothing over the next seven decades. Texaco, which was founded in 1906, was one of the leading "independents", which emerged after the discovery of oil in Texas and opened a domestic front against standard oil. These six companies (Exxon, Mobile, Shell, BP, Chevron, Texaco), together with Gulf Oil (which was acquired by Chevron in 1984) constituted what came to be known the as the seven sisters.

The only one of today's major that was not part of the seven sisters[11] is Total, the French oil company. Founded in 1924, it was designed as a hybrid between a "free market and a state monopoly". Its role was explicitly defined by a parliamentary commission to "curtail the Anglo-Saxon oil trusts, to build a domestic refining industry, to bring order to the market and to develop the French share of Mesopotamian oil".[12] To ensure that the Compagnie Française des Pétroles, as the company was called back then, would adhere to those principles, the French government acquired a 25% share. It changed its name in 1954 to Total, the same year Anglo-Iranian changed its name to BP. It changed its name two more times over the course of its history, first when acquiring its Belgian rival PetroFina in 1999 and again after its merger with French rival Elf Aquitaine in 2000. It was finally changed back to Total in 2003.[13]

3.2. Supply Chain Overall

The major oil companies are sometimes called vertically integrated oil companies, because they cover the whole value chain. Traditionally, the oil value chain is divided into three parts: the upstream component, which is focused on producing or purchasing crude and getting it to the refinery. The refining process is itself considered a separate component, both for its complexity as well as because it is the linchpin where the crude from various production sites comes together and from where the refined products diverge on their way to the end consumer. The downstream part of the business, finally, is focused on moving the refined products from the refineries to terminals and on to the wholesalers or retail outlets such as gas stations.

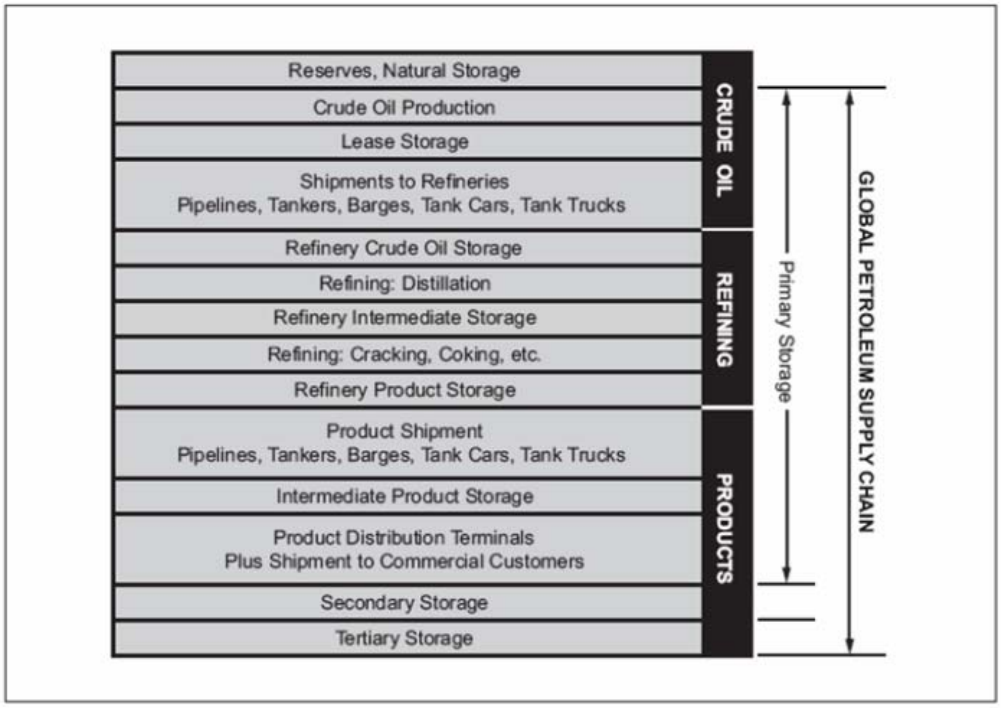


Figure 3.1.a Global Petroleum Supply Chain (National Petroleum Council 2004)

It is important to note that there is not just one type of crude oil, but that every deposit of crude oil has its own chemical characteristics. Crude oil is basically a cocktail of hydrocarbons, but also has varying concentrations of other components such as sulphur. This is especially important in refining, which splits up the different crude oils and then reblends the individual components to make the products the market wants, a cocktail

with lower variability. The molecules which enter the refinery in crude are the same molecules which leave it in the products. The conversion flexibility of refining is, however, not unlimited and comes at a price. The combination of different crude inflows should therefore be optimized together with the refinery set up.

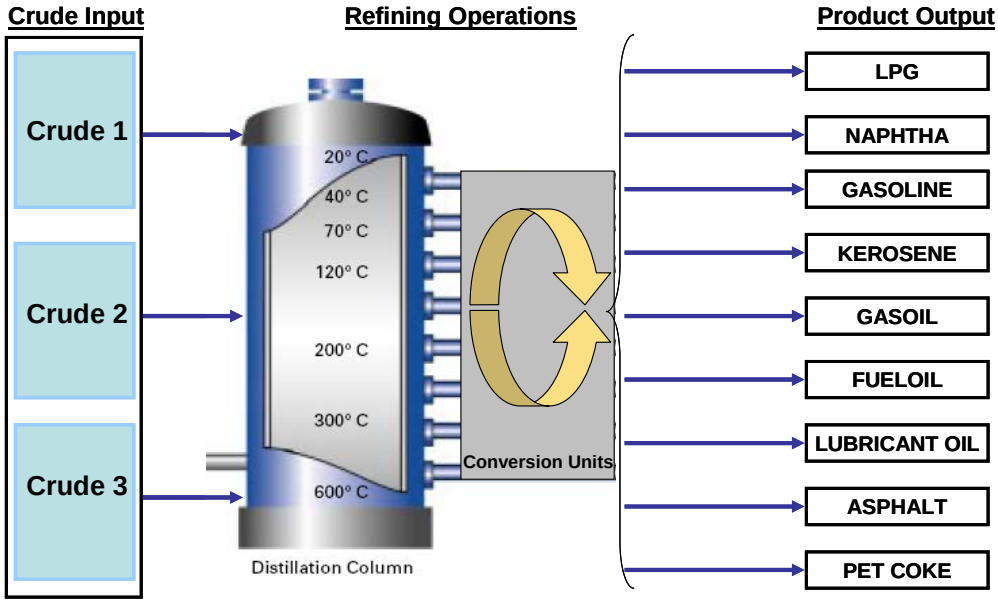


Figure 3.1.b Refinery Decisions (Modified from Original Work by Fidel Santos, 2004)

Integrated oil companies complement their own production and refined products through trading. After refining a variety of different products is available, which are treated separately due to their diverse properties and customers. The basic distinction is between fuels and feedstock for chemical products.

Combined, there are a vast array of decisions an integrated oil company has to take. The most important ones concern the crude intake, the refinery set up, and the product distribution. The greater the variety of crude intake, the easier get the processing decisions in order to obtain the desired product mix. But there are a number of additional decisions that have to be taken into account in acquiring crude supply. "Make vs. buy" is one of them, essentially it is a decision of how much a company wants to invest in EP versus buying it on the market. The success of EP in discovering new sources is not straight forward and bears a high financial risk. On the other hand, owning part of the crude makes supplies and therefore planning more reliable. If the oil

is acquired on the market, a company has to decide whether it wants to do so in the sport market incurring some uncertainty regarding the price, or whether it wants to enter a long-term contract, thus limiting flexibility. In addition, transportation decisions have to be made to move the oil from the production site to the refinery.

The refining process is tremendously complex and there is an almost infinite number of ways to decompose the crude and rejoin the molecules to obtain the final products.

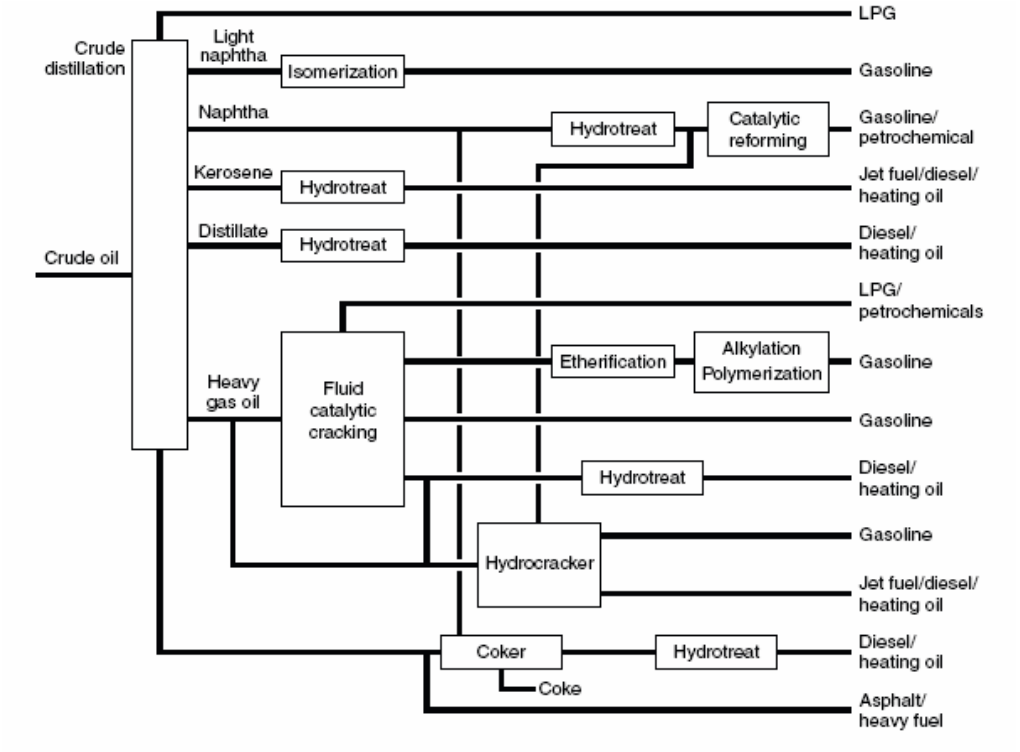


Figure 3.1.c Refining Operations (RAND, 2003)

Without going into the details, it is enough to say that the optimization of the decision making process is assisted by MP software. In the downstream, decisions have to be made as to which markets the company wants to compete in, the distribution network it is going to rely on to move the product to the customer, and the customer demand it thinks it will face over the time horizon under consideration.

3.3. Upstream – Exploration & Production

The dominant part of the supply chain has traditionally been the upstream. It is generally agreed that the oil and gas industry is supply driven, because, as an old saying in the industry goes, "it's where the money is". This trend continues today, which is demonstrated both by the devastating reaction of the markets to Shell's repeated adjustment of its reserves last year as well as by the capital expenditure of the five majors in 2003: more than 70% of their total capital expenditure, some $41bn, was invested into exploration in 2003. The upstream part of the business accounts only for roughly 30% of revenues for the integrated majors, but for 60% of their profits.[14] Nevertheless, it is the NOCs, which dominate the upstream part of the industry. The five top companies, Saudi Aramco, the National Iranian Oil Company (NIOC), Petróleos Mexicanos (PEMEX), and Iraq NOC, produce together roughly a third of world supply.[15] Because they are not publicly traded companies, it is almost impossible to estimate total revenues and earnings in the upstream part of the industry.[16]

To some degree, the dependence of the downstream on the upstream is due to the fact that for most part of their history, oil companies have not found it difficult to find customers for their products. Refineries were thus essentially built to run at maximum capacity, being pushed by supply to process the maximum amount of crude oil. At the same time, accurate demand forecasts has until recently been deemed impossible due to the long lead times of the industry. Even today it takes several weeks for the crude to get from the oil field to the refinery, where it usually spends several days; the refined products then take another three to four weeks to reach the regional terminals, from where they go on to retail outlets and the end customer.

In addition to these problems, the industry has also difficulties to maintain a steady supply. That is because the upstream is a capital-intensive, high-risk business and – even worse from a business point of view – for a large part highly political;[17] and because of its project-like nature it is next to impossible to commoditize.

Finally, the business has for the most part its history been so profitable, that no need was perceived to make the downstream more accountable and thus responsive, as any losses sustained in that segment of the value chain could easily be offset by the upstream. This has changed somewhat in the more recent past, as technology has made

exploration a more predictable business, and supply therefore has come to depend more on price than a good nose.

If therefore upstream operating cash flows are not fully reinvested, as an estimate by research firm John S. Herold suggests, then this says more about the difficult prospects of the whole industry than about some shift in the relative importance of different segments within the supply chain.[18] With most of the world's known reserves in its mature stage, the industry is forced to turn to expensive or high-risk production sites.

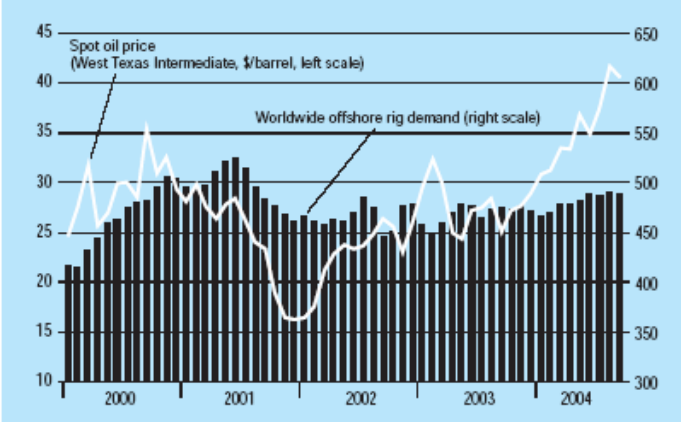


Figure 3.2 Rig Demand vs. Oil Prices (ODS-Petrodata 2004)

3.4. Refining – "A Barrel of Oil"

While it is fair to say that without its use as an energy source, oil would never have obtained the predominant position as a resource it enjoys today, oil is, of course, much more than just energy which we use for transportation, heating, or power generation. In fact,

> *"oil is so embedded in our daily doings that we hardly stop to comprehend its pervasive significance. It is oil that makes possible where we live, how we live, how we commute to work, how we travel – even where we conduct our courtships. It is the lifeblood of suburban communities. Oil (and natural gas) are the essential components in the fertilizer on which world agriculture depends; oil makes it possible to transport food to the totally non-self-sufficient mega cities of the world. Oil also provides the plastics and chemicals that are the bricks and mortar of contemporary civilization, a civilization that would collapse if the world's oil wells suddenly dried up."*[19]

Although they account for only a fraction of a barrel of oil, the petrochemical products are the ones people come in contact with most often and many are surprised to learn

that they are made from oil. Naphtha, a refining product, provides the feedstock for the petrochemical industries further downstream, which then produce plastics, polymers and synthetic fibres from it.

There are virtually thousands of products made from oil this way, from aspirin to artificial hearts, from cameras to PCs from diapers to clothing, from hang gliders to surfboards, from eyeglass frames to soft contact lenses, from fertilizers to insecticides, from furniture to garbage bags, from lipstick to toothpaste, from paint to shampoo, or from hair dryers to credit cards. Another important product of the refining process are the lubricant oils, which are used as lubricants and for insulation purposes. Asphalt is used in roads and impermeabilization among others; and pet coke, yet another refined product, is further processed in the cement and steel industries.

Product	Gallons per Barrel
Gasoline	19.4
Distillate Fuel Oil (Includes both home heating oil and diesel fuel)	9.7
Kerosene-Type Jet Fuel	4.3
Coke	2.0
Residual Fuel Oil (Heavy oils used as fuels in industry, marine transportation, and for electric power generation)	1.9
Liquefied Refinery Gases	1.9
Still Gas	1.8
Asphalt and Road Oil	1.4
Petrochemical Feedstocks	1.1
Lubricants	0.5
Kerosene	0.2
Other	0.4

Figures are based on average yields for U.S. refineries in 2000. One barrel contains 42 gallons of crude oil. The total volume of products made is 2.6 gallons greater than the original 42 gallons of crude oil. This represents "processing gain."

Figure 3.3 "A Barrel of Crude Oil" (API, 2002)

The refining industry, which is the point of origin for all these products, is a mature industry with a well-established infrastructure and technology base. It employs a complex array of chemical and physical processing facilities and processes such as separation, cracking, combination, reformulation, treating. Refining is and traditionally has been a very sophisticated industry. It was the first industry to use MP to optimize operations. And it uses MP today – as one of the few industries that use MP as a matter of routine – to decide on the number of shiploads of crude oil that should be bought from production oil fields over a three-month planning horizon or to determine the optimal product mix given yields, transportation costs, and the prices achievable for the finished products. And every refinery is a unique combination of types, size, number,

and flow sequences depending on crude oil input quality, output product and quality, and constraints such as environmental, safety, or economic.

Above we have seen that the oil industry is a supply driven industry. Adjusting refining capacities to fluctuations in supply can be done in two ways. Physical capacity can be changed by building new or dismantling existing refineries, which is a long and capital intensive process. A medium-sized refinery has an average life-time of thirty years and costs some $1bn to be built.[20] The second possibility is to make the converting process more flexible, i.e. to have greater leeway to produce the demanded products from the given crude oil. A lot of effort has gone into achieving this. Modern refineries can process a broad range of different crude oils with a high flexibility in terms of the composition of the refined products although there are still economic limits to flexibility due to set up costs that will persists for a long time to come. It is generally agreed that the refining industry is a mature one and major technology breakthroughs are not to be expected in the near future.[21]

Long-term cyclicality of capacity usage is thus a fact of life of the industry. According to a survey by Oil & Gas Journal, worldwide refinery capacity was at 82.1 million b/d in 2003. Refining capacity had been essentially flat since 1999.[22] The recovery of returns in refining in recent years is probably more due to the recent surge in oil prices and higher utilization rate after a long period of underinvestment during the depressed oil price periods of the 80's and 90's than to changes in the fundamental ways the plants or the industry works.

Operations within firms also have become more autonomous. Traditional malpractices such as transfer pricing and other mechanisms, which in effect was the equivalent to subsidies, have largely disappeared with more and more refineries being managed as stand-alone business units. Independent refineries now often process crude purchased on the open market and work hard to increase their options of where to sell their products. In addition to distributing their products through networks of dedicated brand-name gas stations, refineries now also sell directly to wholesale markets or to large third-party retailers, such as large discount clubs or convenience store chains. The profit-orientation and the stronger profile of refineries have led to a prolonged wave of restructuring and consolidation to boost profits and improve their upstream crude oil

reserve and production portfolios. As a consequence of the consolidation trend in recent years the number of refineries has decreased to around 700 and ownership is more concentrated.[23]

The two main challenges refiners face is the significant shift of world crude oil supply toward lower-quality grades, which in oil-speak means heavier oil with higher sulphur content; and the ever-growing body of regulations, above all the green laws, which increase both the overall demand for low sulphur oil as well as the number of products. These so-called boutique fuel specifications add cost and complexity to refinery operations and distribution channels because of greater complexity and rigidity of the supply chain. A more chronic problem is the small size of inventories of refined products on hand at any point in time relative to demand because of their physical qualities and the unwillingness of producers to keep large stocks on hand. This makes prices and supplies downstream more prone to disruptions in refinery operations.

3.5. Downstream – Retail & Marketing

The major oil companies control only about a third of worldwide marketing sales. The rest is handled by a complex network that consists of a wide array of different players. All of these segments of downstream sales channels are fed and supported by a range of firms engaged in engineering, construction, technology development and supply, and consulting and services provision. These enterprises range in size from large, diversified multinationals to specialized consulting firms. It is also worth mentioning that with the pipeline, the oil industry disposes of a unique means of transportation.[24]

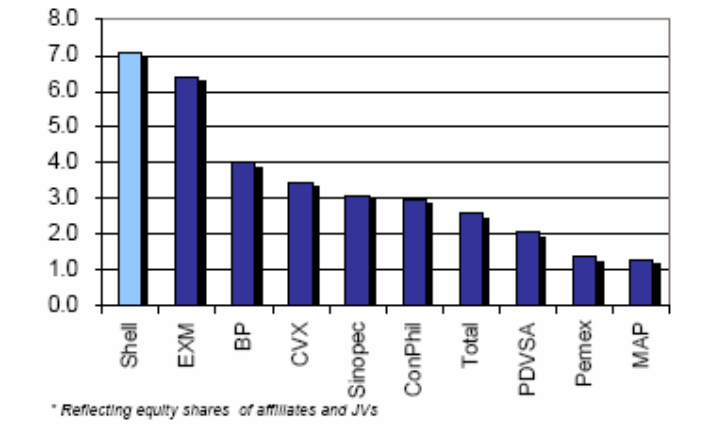


Figure 3.4 World Marketing Sales in mmb/d (PFC Energy, 2004)

A number of characteristics can be established for the sales channels according to product groups. Gasoline is marketed through retail outlets, with the direct involvement of the customer. The oil industry is one with the fewest stock outs, with sophisticated instruments – such as the use of POS data – having been in place in the industry for decades. Retail still has an exclusive franchise system so far and most outlets are still owned by the integrated oil companies. But due to consolidation among the majors, changing customer preferences and the expertise of existing retailers, hypermarkets, grocery stores and independents have made some inroads into the business in recent years.

Wholesalers for the petrochemical industry offer a wider range of products from naphtha to petroleum products. While some act merely as brokers, others take on the role of a principal or even own various stages of the manufacturing process. Kerosene and fuel oil, which are used as marine fuels and for aviation, are also sold through wholesalers, some of which are also in the petrochemical market and others which are highly specialized.[25] Fuel wholesalers are strongest in Japan and South Korea, two countries with high per capita consumption rates that are fully dependent on imports. As a consequence, Japanese Mitsubishi and South Korean Samsung are two of the biggest wholesalers.

Fuel oil for power generation is usually handled separately, as the customers are as a rule very large commercial and industrial entities, or even governments. The same holds true for asphalt and pet coke, which have customers from different industries. In the US, another customer group are the privately-owned petroleum bulk stations and terminals, which are run by independent operators. Finally, some of the crude gets sold already further upstream to independent refineries such as Valero.

3.6. Challenges and Trends

In practice, oil companies have lagged in supply chain integration. Companies have been broken into multiple fiefdoms, acquiring products from each other at transfer prices, which are often highly artificial, and operating as local profit centres. There are, however, good historical reasons for these developments. The oil companies are so big that technology was not historically scaleable enough to allow for enterprise

optimization. A lot of effort is now going into technological solutions to integrate the different parts of the companies to give them more flexibility. The better use of information technology is making the industry more responsive.

Leading software providers for the industry are AspenTech, I2, Manugistics and more recently the petroleum suite of SAP. State-of-the-art retail demand planning solutions examine the inventory position and sales of service station and use advanced mathematics to predict future demand. If demand forecast changes, a company can reschedule a boatload of crude and sell that crude before it reaches the refinery. If crude arrives at the terminal and demand changes again, the company then has the knowledge to change the product mix. If finished products emerge from the refinery and inventory is sufficient at company-owned retail outlets, they can be sold to independent wholesalers.[26]

But there are limits to a "demand/pull-solution" due to the complexity of the industry. A fully integrated solution is infeasible for the foreseeable future and might never be. This would require an integrated approach to planning rather than the separate demand management, replenishment planning, and transportation management as it exists today. Such an integrated approach would have to automate replenishment and optimize shipment schedule downstream, and refining would have to become more flexible in terms of its product mix in order to adjust to an increased customer base. Changing demand in the upstream segment of the supply chain would have to be managed „en route". Making all these improvements and finally linking the different segments is to complex a task to be performed nowadays.

Improvements that seem somewhat more realistic could come from a common communication platform, which is now in the works. A committee consisting of the major players of the industry, the so-called Petroleum Industry Data Exchange (PIDX) is trying to come up with an interoperable XML for the industry. If successful, this could open the way to standardized process definition – and in a next step process flows.

The challenges that need to be overcome are, however, tremendous. Scalability continues to be a problem, as many oil industry optimization problems are still beyond what is feasible with today's MP programs. But the industry also needs to change incentives and put the right metrics in place to overcome the "silo-mentality" it has

allowed to proliferate for decades. The number and diversity of the actors involved is daunting, even for mere technical tasks such as merging and consolidating legacy systems; and at any rate, the long lead times that purport a three-month minimum time frame for process planning will continue to pose a huge challenge.

As already mentioned above, geographic diversification driven by risk considerations in the upstream part of the business and product diversification driven by regulatory developments in refining are two of the recent trends in the industry. In addition, we have seen that things are on the move in gasoline retailing, where the divide between refuelling and shopping is becoming ever more blurred.

Maybe most pronounced, however, has been a concurrent trend towards vertical fragmentation and horizontal consolidation. The diffusion of computing power, the ready availability of cheap and standardized software, the development of the spot and forward markets, and the dissemination of industry knowledge thanks to consulting and service companies and the commoditization of technical processes had allowed small and specialized players to compete in a market that for most of its history had been reserved to big multinationals.

By focussing on core-competencies and high-margin parts of the value chain without having to integrate vertically, those small companies consistently outperformed the larger ones over the last couple of years.[27] The reaction was a wave of mergers among the established majors, to fight off pressure from the stock markets. The logic behind the merger was that size still matters in raising capital for large-scale projects and spreading risk, especially in the light of ever more capital-intensive and high risk exploration projects. In the aftermath, the pressure shifted again to the small firms which resulted in a wave of consolidation. At the same time, the super majors have begun to question the premise of having to be present in every part of the business. Although they continue to be fully integrated, they are getting more focussed as the divestitures of the past years demonstrate. By now it seems that the smaller integrated majors are the ones that are really left in the cold. [28]

The latest trend has been alliances, which allow for short-term flexibility, especially in the upstream part of the business. Consolidation joint ventures, alliances with specialists, enhanced supplier relationships and outsourcing alliances or production

sharing agreements (PSA) with governments have all become more common as oil companies compete for scarce resources in frontier regions. Putting their experience with resource-management to use, leading service companies such as Baker-Hughes, Halliburton, or Schlumberger have played an important role in many of these alliances, by providing a platform around which the cooperation takes shape.

4

SHELL'S POSITION IN THE INDUSTRY

Technically, Royal Dutch Petroleum Company and the Shell Transport and Trading Company never really merged, but rather each of them took a 60% interest in the Royal Dutch/Shell Group. This structure survived essentially until the present day, in spite of its many flaws. Based in the Netherlands and in the United Kingdom, the two publicly traded holding companies hold between them all the shares in the service companies and, directly or indirectly, all interests in the operating companies. As parent Companies, Royal Dutch and Shell Transport do not directly engage in operational activities. Rather, they appoint directors to the boards of the group holding companies, from which they receive income in the form of dividends. This group runs all the operations and owns the assets, which are split proportionally. Today, London is primarily responsible for the financial aspects of the business whereas the Netherlands is primarily host to the technical side of operations.

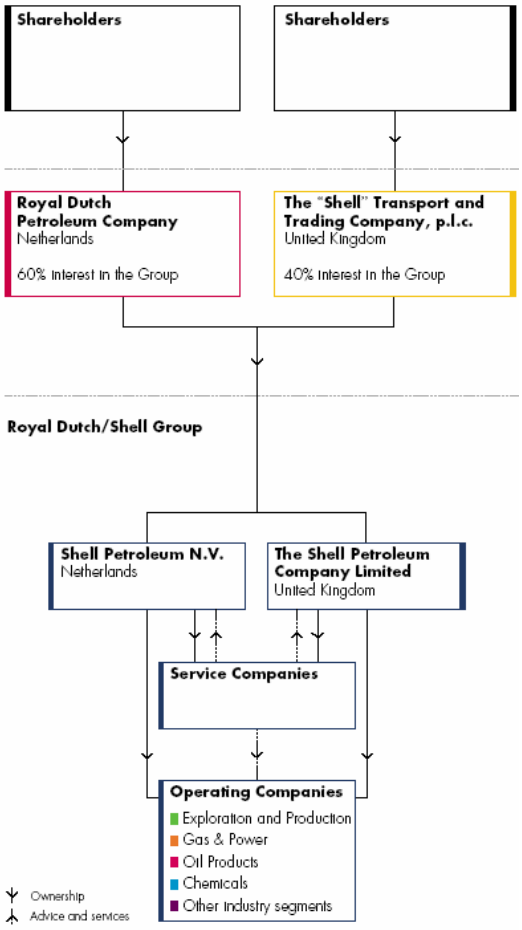


Figure 4.0 Royal Dutch / Shell Company Structure (Shell, 2004)

4.1. Company Overview

Shell today is an integrated oil company with activities in all the principal aspects of the oil and natural gas industry. Shell is the third largest of the world's five "supermajors" with a market capitalization of roughly $175 billion. Besides fuel oils and gas the group has interests in chemicals, power generation, renewable energy and other businesses in 145 countries around the world. In 2003 Shell's revenues exceeded $200 billion and it boasted earnings of more than $12bn. Shell has consecutively been among the Top Ten of Fortune's Global 500 since its early beginnings. As of 2004, Shell employed 119'000 workers. With some 50'000 gasoline stations all over the world, it owns the world's largest single-brand retail network with a traditionally strong presence outside Europe and the US. Thanks to its single brand strategy, the Shell brand is considered one of the strongest brands in the industry.[29] The marketing expertise and the reputation in the downstream part of the business together with a strong gas portfolio are considered Shell's main differentiator versus its direct competitors.[30]

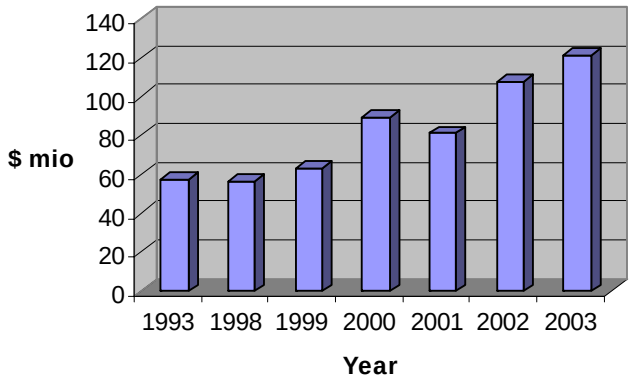


Figure 4.1.a Historical Operating Revenues (Shell, 2003 / Author)

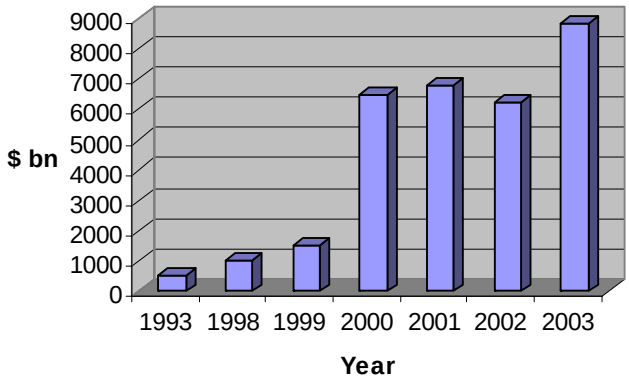


Figure 4.1.b Historical Net Profits (Shell, 2003 / Author)

4.2. Business Units

Shell is organized into four operating companies: Exploration and Production (EP), Gas and Power, Oil Products, Chemicals, Other Industry Segments

Exploration and Production at Shell takes place in more than 34 countries, and provides employment for approximately 17,100 people. It extends from the search for and recovery of oil and gas to the delivery of oil or gas to the refinery or a storage facility. The unit accounts for roughly 3% of world oil supply and boasts some $9.1 billion earnings with a total of $39.3 billion capital employed. The majority of these upstream activities are carried out in ventures with external partners.

The EP portfolio is diverse: the four largest sources of Shell equity crude oil lie in different regions of the world - the USA, UK, Oman and Nigeria. Some EP interests date back to the beginning of the century, reflecting the long-established relationships of Shell companies in some countries. Some of the activities include contracting; surveying, assessing exploration data, planning, drilling, running production operations, or carrying out maintenance work. The current strategic focus lies on four key portfolio areas: existing oil, new material oil, more integrated gas and more unconventional oil.

Gas & Power develops infrastructure, liquefies and transports natural gas, trades both gas and electricity, and converts natural gas to liquids. The business unit employs some 2'000 people and has a 3.5% share of the world gas market. The unit generates some $2.3 billion in earnings and employs $12.2 billion in capital. As in EP, the majority of activities, in particular liquefied natural gas (LNG), are carried out by associated companies. Activities stretch across more than 30 countries; most of the operations are joint ventures with international and local partners or governments. Gas and power cooperates closely with the units involved in production of oil and gas reserves and in the downstream part of the business to process and transport natural gas, develop power plants and market gas and electricity to customers.

The **Chemicals** unit is one of Shell's core businesses. It consists of some 70 companies which collectively number among the largest petrochemical suppliers in the world.

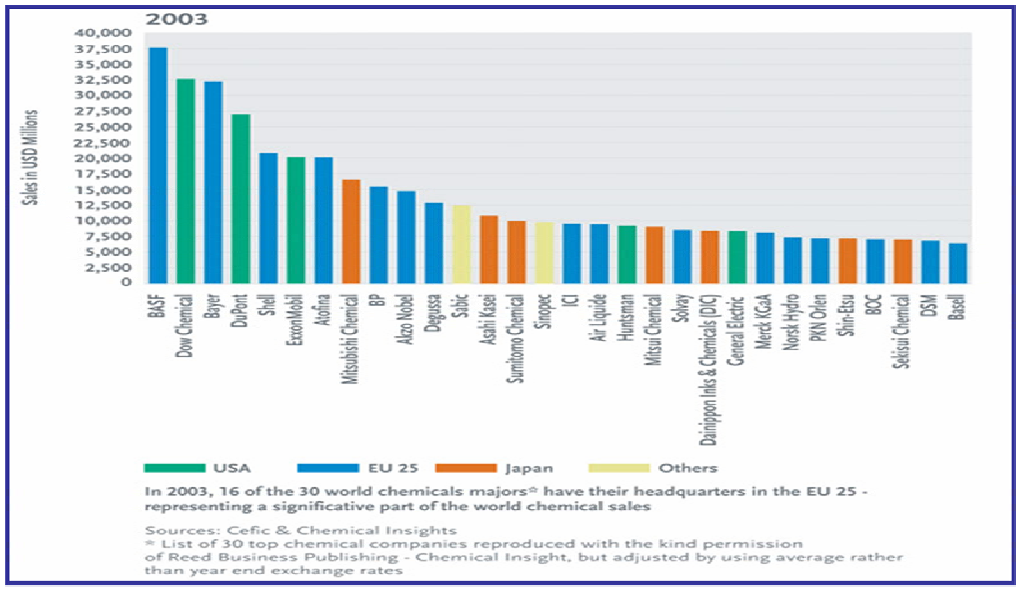


Figure 4.2 Major Competitors in the Petrochemical Market (CEFIC, 2003)

It operates on a worldwide basis and employs 8'600 people. In 2004 it posted a loss of $209 million with a total of $10.4 billion capital employed. It produces and sells petrochemicals that are further processed by industrial customers into plastics, coatings, and detergents. The products made by the Shell chemicals companies range from basic petrochemical building blocks, such as ethylene, propylene and aromatic chemicals, through intermediates such as styrene monomer, ethylene glycols, solvents and detergent alcohols. Three joint venture companies – Basell, Infineum and CRI International - extend this range by making polymers such as polypropylene and so-called specialities such as fuel additives and catalysts.

The **Oil Products** unit markets fuels and lubricants, refines, supplies, trades, and ships crude oil and petroleum products and in addition it provides technical consultancy and research services. It is by far the biggest division in terms of workforce with 81'600 employees. Earnings in 2004 were the equivalent of $2.9 billion earnings and this result was achieved with $35.3 billion capital employed. The oil products division serves both domestic and industrial clients with the modes of transport ranging from road to shipping and aviation. The unit comprises all the activities necessary to transform crude oil into petroleum products and deliver them around the world. To do so effectively, it is

organized in five divisions. Manufacturing is responsible for refinery operations. Shell holds a majority interest in thirty refineries, and a smaller interest in another twenty-five. The Supply and Distribution division is made up of supply chain professionals whose job it is to ensure the customers gets the product on time in the right place. The same group is responsible for supplying Shell's own refineries and chemical plants with feedstock. And finally Marketing and Trading is responsible for managing sales and balancing supply through the market. All units coordinate their operations carefully.

Other Industry Segments summarizes all the other operations such as hydrogen, fuel cell technology, bio fuels, geothermal energy, wind or solar power. The unit is organized in Renewables, Hydrogen, and Consumer and employs 2'800 and posted a loss of -$267 million in 2004 with just under a $1 billion of capital employed and it has the strategic task of building up commercially viable businesses that eventually will add an additional income stream.

The operating companies are supported by a number of service companies.

Shell Global Solutions is both an internal consulting group with technical centres in France, Germany, Malaysia, the Netherlands, Singapore, the UK and the USA. Some 4500 people work to support operations at Shell and external customers worldwide.

Shell Trading integrates Shell's various trading activities, which move the equivalent of 14 million barrels of crude oil per day, in the form of crude oil, refined products, natural gas, electrical power and chemicals. By summarizing these activities under a single banner Shell effectively leverages its scale, global reach and financial strength.

Shell Shipping handles cargo operations and provides manning services for more than 40 vessels. In addition, it provides consulting services both internally as well as externally.

4.3. Products and Services

As becomes clear from the broad range of activities in which Shell participates, the company has a vast range of products on offer, too many to list them all. Shell Chemicals' companies offer products from basic petrochemical building blocks, such as

ethylene, propylene and aromatic chemicals, through intermediates such as styrene monomer, ethylene glycols, solvents and detergent alcohols. In addition, Shell manufactures polymers such as polypropylene and specialties such as fuel additives and catalysts through its joint venture companies (see "Business Units" above). The biggest contribution to the product range, however, comes from the Oil Products unit, which promotes differentiated fuels, lubricants and specialty products. The product groups are: Shell Aviation, Shell Marine Products, Shell Gas LPG, Commercial Fuels, Shell Bitumen, Shell Lubricants

4.4 Sales Channels and Customer Segmentation

Shell's downstream is organized as a matrix and looks as follows:

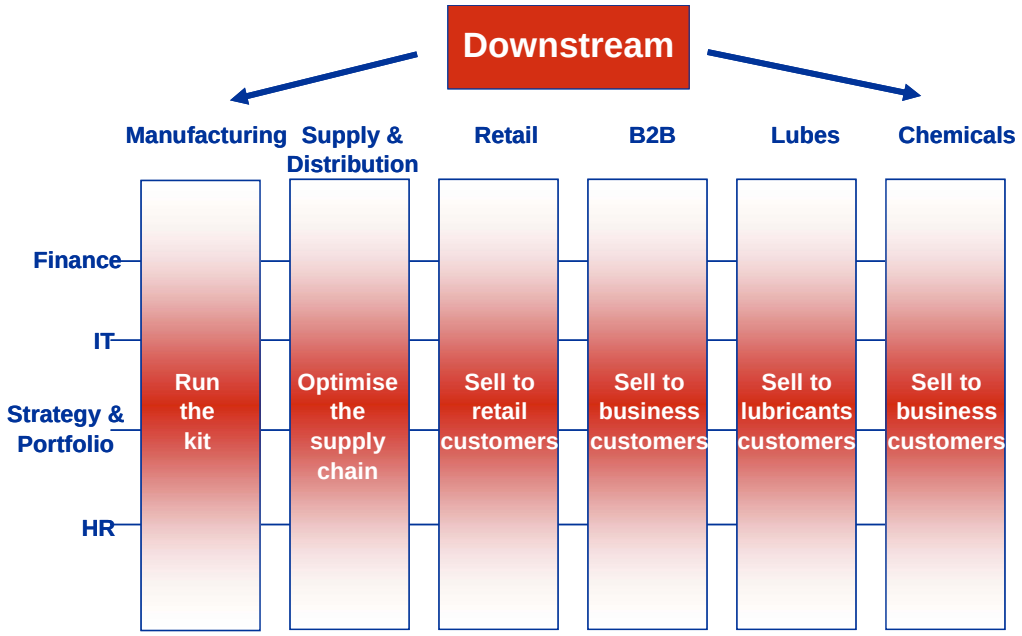


Figure 4.4 Shell's Downstream Organization (Shell, 2004)

Shell's customer segmentation comes somewhat naturally with the different nature of its various products, which use different channels and have customers that range from individual clients to corporations and governments. As a general rule, however, oil is not a differentiated product or at least has not been advertised as such by the companies nor has it been perceived as such by the customers.[31] The biggest chunk of Shell's complex network of sales channels is the retail network. Roughly 25 million customers are served

every day at one of Shell's 50'000 service stations, 10,000 of which have a proprietary convenience store attached.

The petrochemical base products are either sold to Shell's joint venture chemical companies, or to wholesalers. Aviation fuels are marketed directly or through contracting parties in 90 countries. They provide some 80 million litres of fuel to 20'000 aircraft at over 1,100 airports. Marine fuels and lubricants are sold to vessels ranging from ocean-going tankers to small fishing boats, whereas Shell Gas LPG markets LPG for domestic, commercial, agricultural and industrial use to around 40 million customers in over 55 countries and territories. Shell Bitumen serves infrastructure and construction with over eighty years experience across the world, including cycle-lanes, pipelines, airport runways and motorways. Bitumen is sold directly to construction companies or through wholesalers. Finally, buyers from the lubricants network of blending plants range from individuals to the soft-drink industry industrial customers.

5

SHELL'S CURRENT STRATEGY AND COMPETITIVE POSITIONING

Shell's latest strategy overview, entitled "more upstream, profitable downstream", was completed on September 22nd, 2004.[32] The Strategy Review was conducted with investors' confidence at a historical low, after the company had repeatedly communicated downward adjustments or its reserves. That the new strategic focus would be on "more upstream" had therefore been expected, as Shell was under great pressure to make up for the 25% decrease of its upstream portfolio in its books.

But even without the latest scandals for overstating its reserves, the greater focus on the upstream business is a broad industry trend and did thus not come as a surprise to anyone. Some simple numbers help to explain Shell's interest in the upstream. The value of assets employed in EP is roughly equal to that in Retail and Marketing, which together make up almost 80% of total assets. This breakdown is similar for all the big integrated oil companies. It is, however, quite a different story when one takes a look at the breakdown of net profits. EP contributes almost two thirds to total profits, whereas the contribution of Retail and Marketing is only half of its assets usage rate.

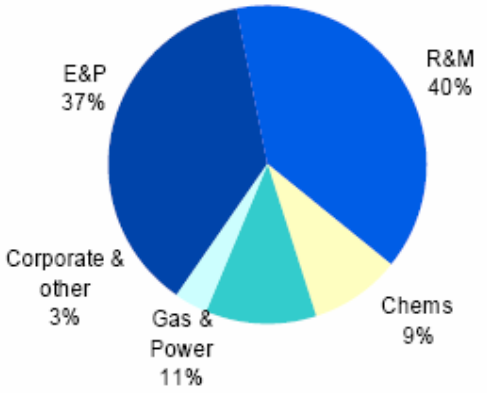
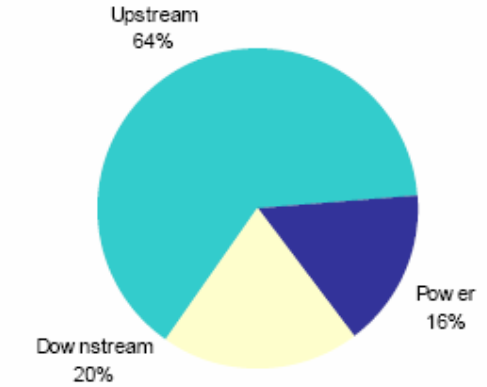


Figure 5.0.a Asset Breakdown by Segment 2003 (PFC Energy, 2004)



**Chemicals and Corporate segments reported losses*

Figure 5.0.b Net Income 2003 (PFC Energy, 2004)

Much more revealing was the second part of Shell's revised strategy, the part concerning the downstream. Although not a complete about-turn, it

constitutes a significant deviation from Shell's previous strategy:

"The reduction in refining and marketing assets would be notable in and of itself, but for Shell, whose downstream approach has always been one of early market entry and unflappable weathering of difficult market conditions, the reductions of position represent a true strategic departure. Prior to the mid-1990s, Shell market exits were extremely rare and the company had by far the most wide-spread and diversified downstream portfolio among the major operators. This distinguishing factor, although still in place, may begin to be blurred by continued marketing reductions."[33]

What "profitable downstream" really means is that it should generate stable cash flows in order to serve as a cash cow for financing the upstream investment. With the role of the downstream business such defined, Shell has begun to become more focussed in its downstream ventures. The future emphasis will be less with established markets in Europe and the US and more with so-called growth markets, which means primarily Asia. Above all, China, India and Indonesia are being targeted, and to a lesser extent Poland and possibly Russia. In India Shell obtained the first foreign retail marketing license and in Indonesia it acquired a conditional fuels marketing license. In Nanhai, China, Shell is building a huge petrochemical complex and pursues a massive retail expansion though its joint venture with Sinopec. For the time being, however, reorganization of the downstream portfolio means primarily divestment. Shell exited a number of markets in 2004, among them the Baltic States, Romania, the Iberian Peninsula, Peru, and Venezuela. At the same time, major restructuring of its US, French, and German operations are under way. [34]

As mentioned before, there is some logic to this step and the picture is similar at its major competitors, as they move from comparable positions. All of the majors have a comparable structure in terms of their current asset and net profit breakdown and all of them are drawing the same conclusion with their investments in the upstream being multiples of what flows into the downstream business.

All numbers 2003	*BP*	*Exxon Mobil*****	*Total*******	*Royal Dutch/Shell*	*ChevronTexaco*	*Total Majors*
Crude oil & NGL reserves [in 1,000 b/d]	7749	12856	7323	6605	8599	43132
Crude oil produced [in 1,000 b/d]	2121	2516	1661	2333	1808	10439
Crude oil processed [in 1,000 b/d]	3097	5510	2481	4167	1987	17242
Refined products sold [in 1,000 b/d]	6723	7957	3652	7445	3738	29515
Revenues [m $]	232571	246738	118340	268892	120032	986573
Net income (loss) [m $]	16413	21510	7944	12496	7230	65593
CapEx Total	14029	15461	8740	12252	7363	57845
CapEx Exploration [m $]	9658*	11988*	5996*	8129*	5675	41446
CapEx Production [m $]	na	na	na	na	na	na
CapEx Transportation [m $]	na	na	na	na	1100***	na
CapEx Refining and Chemicals [m $]**	755	692	1261	470	197	3375
CapEx Marketing [m $]	3006***	2781*****	1397***	3388*****	na	na
CapEx others [m $]	610	na	86	265	391*******	1352

Notes: BP and Amoco, and Exxon and Mobil merged to create BP Amoco and ExxonMobil in December 1998 and November 1999, respectively. In 2003, BP Amoco was renamed BP. Both data series have been adjusted to include the new companies. TotalFina merged with Elf Aquitaine in February 2000 to create TotalFinaElf, which was renamed Total in 2003. The data series has been adjusted to include the new company from 1997. Chevron and Texaco merged to create ChevronTexaco in October 2001.

*	Exploration and production.
**	Chemicals only.
***	Refining, marketing, and transportation.
****	Includes expenditures of majority owned and consolidated companies and acquisitions.
*****	Refining and marketing.
******	Converted from original figures in French francs and euros.
*******	Includes investment share in non-subsidiary companies.

Figure 5.0.c Positions of the Major Integrated Oil Companies 2003 (OPEC, 2004)

Shell's revised strategy therefore seems to have a solid foundation thus far. To see if the strategy also makes sense from a supply chain perspective, let us take a closer look at each part of the supply chain, its particular competitive landscape and the supply chain-related questions that need to be addressed.

5.1. Upstream Environment

Shell intends to focus its future efforts mainly on the upstream part of its business. We have already seen that this is the part where Shell generates most of its revenues, but the upstream is also the part of the business, where industry experts expect the greatest benefits from applying supply chain management techniques. This might come somewhat as a surprise at first, as supply chain management is a concept that has above all been known and applied with great success in retail. The upstream with its project-based approach seems less suited to apply common supply chain rationalization techniques, as many of them take advantage of processes routine and standardization. But it is mainly this belief which is responsible for the potential of SCM in the upstream.

First and more generally, because SCM has been virtually non-existent to date in that part of the business, any improvements should bring correspondingly large marginal gains. Secondly, and aiming in a similar direction, given the dimension of the capital

involved in upstream operations even small improvements can quickly lead to large absolute savings. Finally, a number of technological innovations make the technology used in geological and engineering ventures more scaleable, and thanks to new techniques business processes and project management are becoming more standardized and routine tasks: the availability of survey data, decision making with regard to exploratory wells and the interpretation of drilling results, and the designing and building of oil platforms are all becoming more of a commodity service.

In the past, mathematical methods were only sparsely applied to the upstream, but easier and cheaper access to knowledge, skills, and computing power, are gradually changing this. It is above all the service company, which in order to gain a competitive edge over their competitors are beginning to apply advanced techniques to the very heart of upstream operations. Their innovative potential together with their increasingly important role as businesses continue to outsource more and more activities to focus on areas of core strength are transforming the way the upstream operates. A good recent example is the suite which Scicon, a software company and former BP subsidiary that was taken over by EDS in 1991, developed for the Kuwait Oil Company (KOC). The suite is an attempt to optimize upstream operations, thereby taking a more integrated look at the supply chain based on refinery demand.

The software provides decision-support for selecting the wells to produce from. Individual wells differ with regard to the quality of their oil; the main variation comes from the density of the oil and different sulphur contents. With known demand at the refinery, a linear programming tool that uses detailed information on the characteristics of different wells and on the cost and availability of transportation calculates the combination of wells that is optimal for the company to operate. [35] Another issue which the software addresses is the decision on daily oil production rates. Here, the challenge is to keep the production rates as stable as possible, given demand fluctuations at the refinery and taking into account limited buffer storage. Finally, the software combines the two before-mentioned modules into an APS which uses stock levels, predicted tanker arrivals, time, and even a modest anticipation function of demand to support planning over a large integrated chunk of the supply chain.

The quality of any such software-assisted solutions still depends on many decisions which have to be taken beforehand and exogenously, and in which human judgment is critical. In the case of the suite describe above, such a critical factor is the importance assigned to a stock-out scenario, i.e. exhausting the buffers. Somehow, a measure of priority for such an event will have to be manually entered into the model, a decision which will depend on the robustness of the supply chain, contract penalties to ship owners, etc,. The solution will always hinge on how these factors are valued on an artificial scale and therefore never be perfect. But since it is a conscious decision the model will at least force the user to think about the cost involved in his decision and can, if wisely used, bring enormous benefits to oil companies.

So there is nothing wrong with focussing on the upstream from a supply chain perspective. The problem of so doing is more basic and long-term: on the surface, it seems to be rooted in the competitive landscape, but ultimately, it lies in the geographic occurrence of oil and the fact, that it is a finite resource. Indeed, advances in technology keep making oil production possible from deposits whose exploitation was hitherto considered economically unfeasible and the effective utilization of currently active fields is constantly being improved; but shifting out the frontier comes at a price. It is generally agreed that the biggest and cheapest oil fields have been known to mankind for a while – and as it happens they are owned by the NOCs of the states in which they are located. Because of this, most NOCs by far outweigh the majors in terms of reserves. According to proved oil reserves, Aramco, the biggest NOC, is twenty times the size of ExxonMobil, the biggest private company.

WORLD'S TOP 20 OIL COMPANIES — 2003

	PIW INDEX*	COMPANY	COUNTRY	STATE OWNERSHIP (%)	RESERVES LIQUIDS (MIL. BBL)	RESERVES GAS (BCF)	OUTPUT LIQUIDS (THOUS. B/D)	OUTPUT GAS (MMcf/D)	REFINERY CAPACITY (THOUS. B/D)	PRODUCT SALES (THOUS. B/D)
1.	100.0	Saudi Aramco	Saudi Arabia	100	261,800	230,000	8,013	5,542	2,220	2,777
2.	98.6	Exxon Mobil	US	(public)	12,623	55,718	2,496	10,452	6,322	7,757
3.	97.7	PDVSA	Venezuela	100	77,900	147,600	2,900	4,000	3,280	2,625
4.	97.1	NIOC	Iran	100	99,080	812,300	3,553	5,945	1,474	1,264
5.	95.7	Royal Dutch/Shell	UK & Netherlands	(public)	10,133	53,438	2,372	9,423	4,533	7,399
6.	93.1	BP	UK	(public)	9,165	48,789	2,018	8,707	3,534	6,563
7.	92.0	ChevronTexaco	US	(public)	8,668	19,335	1,897	4,376	2,223	3,868
8.	88.3	Pemex	Mexico	100	17,196	14,985	3,529	3,126	1,692	1,482
9.	86.0	Total	France	(public)	7,231	21,575	1,589	4,532	2,660	3,166
10.	91.1	PetroChina	China	90	10,999	38,819	2,109	2,175	1,986	1,411
11.	80.0	KPC	Kuwait	100	96,500	54,962	1,867	753	905	1,136
12.	79.7	ConocoPhilips	US	(public)	5,137	16,040	986	2,047	2,610	2,258
13.	79.1	Pertamina	Indonesia	100	4,000	69,375	845	5,013	993	1,009
13.	79.1	Sonatrach	Algeria	100	9,200	159,000	971	7,605	450	715
15.	76.9	Petrobras	Brazil	33	8,955	9,473	1,535	1,650	2,021	2,441
16.	75.1	ADNOC	UAE	100	55,210	196,100	1,690	5,802	508	200
17.	69.7	ENI	Italy	36	3,783	18,629	921	3,306	654	1,048
17.	68.3	Repsol YPF	Spain	(public)	2,019	18,206	584	2,336	1,234	1,171
19.	67.4	Petronas	Malaysia	100	3,700	87,500	700	3,846	429	920
20.	64.6	Lukoil	Russia	8	15,258	24,164	1,545	345	1,151	924

Figure 5.1 World's Top 20 Oil Companies 2003 (Petroleum Intelligence Weekly, 2003)

In other words, a huge imbalance exists in the basic competitive position of the majors versus their direct upstream competitors, the NOCs. And what is more, the imbalance is growing. In their quest to replace their reserves the majors see themselves forced to switch to ever more unconventional oil, both in terms of geology and geography; and in so doing their oil portfolios are becoming correspondingly more high-cost and high-risk. At least in the short-term, the prospect of the NOCs moving downstream might be even more threatening. And it is actually happening, although it has not reach a point yet where it becomes an immediate threat to the majors. [36]

From this it becomes clear that the majors do not compete on a par with the NOC's in the upstream. At the same time, there is a very real prospect of forward integration by the NOCs, thereby taking the competition with the majors downstream. Let us therefore take a closer look at the competitive position of the majors in the segments that make up this part.

5.2. Refining Environment

Refining is the linchpin of the oil supply chain, although it is considered closer to the downstream than the upstream. From a supply chain point of view, there are many decisions a refinery faces, even if we ignore questions related to network design.

Generally speaking, a refinery operates within a decision space that is defined by two basic decisions: on the one hand, there is the decision which crude oils should be procured and on the other hand, the decision which products should be produced.[37] Within these confines, the refinery decides on the optimal process to make the transformation from crude input to product output as efficiently as possible; i.e. it has to decide what processing conditions to use and how to blend the products from the intermediary components. Theoretically, this leaves an almost infinite number of possible decisions.

In practice, however, a fully integrated approach has never existed. And this in spite of the fact that worldwide refining is dominated by the majors[38], which at least theoretically have a better knowledge of and access to future crude supplies than independent refiners and therefore face less pressure to hedge against imperfect spot markets through long-term contracts.

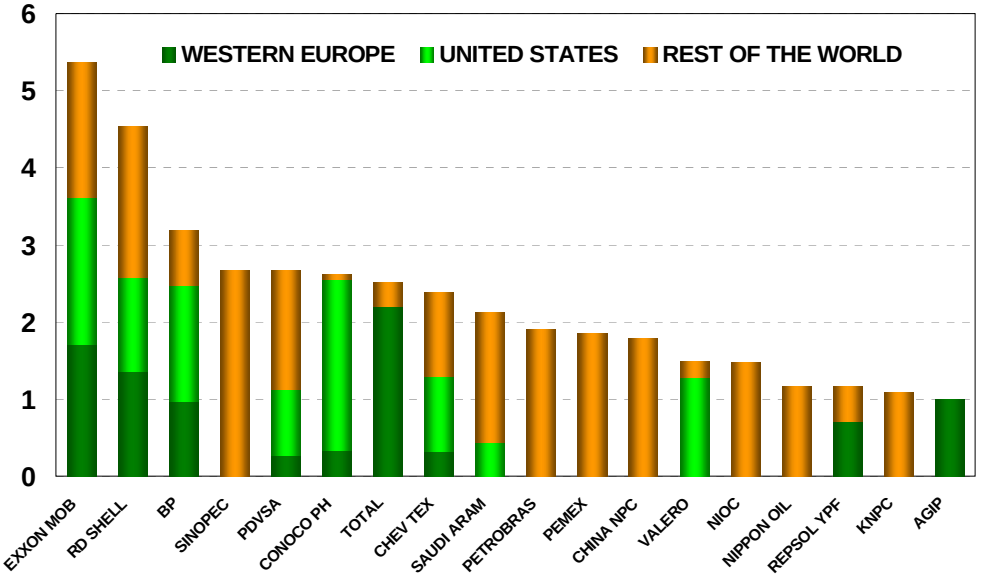


Figure 5.2 Major Players in Worldwide Refining (Oil and Gas Journal, 2003)

Recently, there has been a trend in the US to operate refineries as profit centres within the vertically integrated company, but that does not explain why the oil industry has been dragging to adopt an integrated approach to refining. Rather, the crude supply from the

majors' upstream operations limits the refineries' procurement choice. Furthermore, balancing procurement contracts which are made 1-6 months ahead of time with short-term supply and trading and transportation rates is judged too complex a task as to link it directly to demand-fulfilment considerations.

On the other end of the supply chain, demand for the different products does not correspond exactly to the components of crude. Especially in the developed markets, demand for heavy fuel oils, which are used for generating electricity, has virtually disappeared. As a consequence, the goal of oil companies is often to get the maximum amount of petrol components from heavy fuels. This again greatly reduces refineries' flexibility in deciding on their product mix.

Refineries are therefore left mainly with the decision how to operate the refinery, which is still a challenging task. Refinery operations are intrinsically interconnected, with long-term decisions providing a framework for decisions with a shorter-term horizon. The sequence of decisions thus cascades from an annual cycle that includes planned shutdowns for maintenance and variations in the demand for seasonal products to a monthly horizon for scheduling the crude processing to deciding on a weekly basis which crude cocktails to make; henceforward it is the daily routine to determine the cut points to use on the crude distillation units (CDUs), the process conditions to use in the various units, agree on a blending strategy and draw up contingency plans to handle logistical difficulties; on an interval that is measured in hours the various processes are monitored and controlled, the valves operated, and the blending of individual products both for storage and direct exports managed; advanced control systems maintain process conditions from second to second; and basic feedback loops to maintain safety are run every millisecond.

This characteristic of refining, namely that it works with a nested set of time horizons, provides plenty of opportunities for the use of sophisticated mathematical programs, and the industry has done so for a long time. But the hierarchical structure of the problem with a variety of time horizons makes the application of MP by no means straightforward. The decision variables and the data differ from level to level to reflect the idiosyncrasy of each decision. As a consequence, the problem is decomposed and

then different techniques are applied to its various aspects. Accordingly, there is no singular model, structure, or technique to run refineries. [39]

But in spite of the complexity and the variety of the problems and approaches, there are only so many MPs. And the software that makes them applicable is developed by a handful of private service companies such as Scicon or Aspentech. State-of-the-art technology and innovations are therefore readily available to the whole refining industry. Although we have not taken into account the physical set-up of refineries, it can be said that with regard to hardware, the industry is considered mature and no major changes are expected in the near future.[40] Consequently and in spite of their complexity and the near-infinite theoretical possibilities to run refining operations most refineries operate in similar ways and the alternatives for differentiation are few.

One of the few truly distinguishing features has been the rate of physical breakdowns. Efforts at improving reliability continue at refineries throughout the world, but as everyone has rushed to gain a competitive advantage, this erstwhile advantage is eroding fast. As processes become simpler and personnel better trained, reliability has become a necessary rather than a sufficient component of competitive strategy. Current levels of refining reliability are so high that no strategic advantage are to be gained from further improvement.

5.3. Downstream Environment

With the upstream dominated by the NOCs and refining a commodity business with little scope for differentiation, let us now turn to the downstream, i.e. marketing and refining. It is not a surprise that we turn to this segment in the search for supply chain improvement potential, as it basically consists of marketing and logistics activities. This fact also explains why the downstream is widely considered a rather boring business. Although downstream supply chain activities are key to the industry to bring the product to the customer, it is not exactly the first thing that comes to one's mind when thinking of the oil business, with its sometimes controversial but always grand image.

Given the supply chain nature of the downstream one would expect that there are plenty of opportunities for improvement. Among others, the following are areas in the downstream which are essentially logistics activities: inventory segmentation, inventory

management, production management, transportation, warehouse and distribution management, customer segmentation and management, better demand planning and forecasting, sales management, order quoting, promising, and fulfilment, or after-market and post sales report. If one takes into account the broad range of products offered by the industry and the geographic scope on which this is done, the supply chain possibilities for linking the different activities over various product groups and geographic regions seem potentially huge. Yet another opportunity which has not been considered so far is on the customer side. Refining is fairly restricted in terms of the product mix due to the dominance of fuels from lighter crude. So far, the purchaser of a gallon of petrol is not interested in the source of the crude oil nor does he care how the refinery has turned that crude oil into the blend components. And he does not know what the gasoline at the service station really contains, nor does he care, as long as his engine runs properly. Some flexibility could be gained back by the oil companies through a strategy of product differentiation. It will be hard to make people care about where their gasoline comes from or how it has been produced, although an environmentally-conscious customer might welcome the opportunity to have a choice. The results of recent attempts to differentiate the end product certainly seem promising. By putting in more effort into this, oil companies could gain back some flexibility in choosing their product mix.

6

SHELL'S COMPETITIVE ADVANTAGE

As we have seen above, there is great potential for supply chain management benefits both in the upstream and the downstream. In terms of SCM as a strategic differentiator, the biggest potential lies in the downstream. In the long-term the majors will have to excel in the downstream segment in order to stay in business. However, just being a leader in the downstream will most likely not be enough.

6.1. What It All Comes Down To

If the big oil companies want to continue to operate as so-called integrated majors, they will have to convince their investors that integration brings a long-term competitive advantage. So far, integrated oil companies argued their case with the need to strike a balance between supply and demand. That is you had your oil wells (as Royal Dutch in its beginning), therefore you needed your retailing outlets to sell the oil to the customer; or you owned a retail network (as did Shell in its beginning), and therefore needed the oil reserves to feed the network. Today, however, in a market with well-functioning spot markets, specialized players, and service firms, this is not necessarily the case anymore.

Instead, the vertical value chain will have to be managed as an integrated entity; and it will be the synergies from the integrative approach from which the majors can gain a true competitive advantage. Although the oil industry considers a true pull system that links the downstream with the upstream impossible, it is exactly the direction in which the majors need to move. To some extent, the widespread believe that the oil industry is too complex to treat it as one supply chain has been a self-fulfilling prophecy and held supply chain integration back. As SCM has been neglected in the industry on this basic argument for so long, there lies an opportunity in challenging this fallacy. And the companies which move first will potentially reap the greatest benefits. The goal does not have to be a perfectly integrated supply chain, but rather incremental steps aimed at linking as many of the processes over the value chain as possible. By moving towards the general direction of "more supply chain integration", companies will develop superior management skills and experience. Integrating the supply chain will also have to include

seamless cooperation with service firms, the complementing of activities through trading, etc.

If the key to maintaining a true competitive edge therefore lies in linking as many segments of the business as possible and optimize them over an extended part of the supply chain, what then are the cornerstones of an excellent supply chain in the oil industry?

6.2. Supply Chain Excellence: What Does It Take?

To answer this question, let us start by taking a look at the basic drivers. As in most industries, money is generated through sales. Additional value can therefore be created by either increasing sales, be it to end-consumers at retail outlets or wholesalers buying directly off the refinery, or by improving sales margins. An additional potential source of revenues is trading, but it is not core to major oil companies and will thus not be discussed here. On the other hand, a company incurs operating expenses for development, transportation, feedstock supply, manufacturing, overhead, and inventory cost. Again, there is an ancillary way to incur negative financial flows, i.e. through the inefficient use of capital, which we will not consider here.

On the revenue generation side, the key value drivers are demand management, improved communications, and the quality and timeliness of information. On the cost side, these are crude allocation, feedstock and blend component transfer between refineries, better transportation scheduling, and warehouse and distribution management. Individually, however, none of these drivers will make a significant change. The true potential lies in the way they are applied as part of an all-encompassing strategy, which as a whole can have a far more significant impact than just the sum of the performance of individual drivers. A successful strategy in this sense, however, inevitably consists of numerous interrelated processes, many of which are from areas beyond a narrow definition of supply chain management. In the oil industry, the most important complementary areas that need to be watched when devising a supply chain strategy are business processes, people, and technology. Today, many problems persist in these complementary areas. The main challenges are:

Business Processes

Business processes are often inadequate as they rely on fragmented planning or planning cycles that are calendar-based instead of being event-based. Another factor that needs to be taken into account is insufficient communication across interfaces.

People

A basic obstacle is the widespread lack of trust and transparency. In addition, decision-making is oftentimes procedure-based and employees are not empowered to act outside their area of accountability. Finally, most companies simply lack the supply chain experts to design and carry through a large-scale reform project.

Technology

In the realm of technology, there is a widespread lack of adequate decision-support systems; in addition, integration across geographic and functional silos is poor.

In any attempt at improving supply chain efficiency in the industry, a close eye has to be kept on a number of basic enablers, on which all successful management depends. Of overriding importance are accurate demand forecasts and global visibility of crude intake. It is essential that the firm has a clear understanding of what is going on at the two respective ends of its supply chain, in order to better execute its role of linking them. In between, on an operational level, intelligent transportation mode and routing selection capability, stock replenishment planning, a more integrated refinery and distribution scheduling, faster throughput and more executing flexibility are the most important enablers. More generally speaking, simpler and more standardized business processes should also be listed as a basic enabler. If well managed, the combination of these enablers can lead to greater stability and a leaner pipeline. This will make companies more flexible and responsive to changing market conditions and thereby allow them to take advantage of short-term opportunities.

An excellent supply chain takes into account the value drivers, how they fit into a strategy that is complemented by a couple of factors that are outside the confines of SCM and how they rely on a number of basic enablers. If this is done successfully, a

number of supply chain-specific benefits and opportunities can be obtained that help to increase revenues or reduce cost, respectively, such as:

- Increased revenue through cross-channel coordination
- Increased revenue through optimal pricing strategies
- Increased on-line revenues (for example, from web storefront)
- Increased ability to manage multiple order fulfillment modes
- Improved customer experience through standardized product catalogue,
- Better management of service and parts inventories
- Refinery production improvement
- Production optimization
- A more optimal product mix management
- Collaborative bidding and rate negotiations with core carriers
- Improved service
- Improved collaboration with suppliers and design partners
- Proactive monitoring of the status of shipments and intelligent exceptions management
- Warehouse planning and execution process management[41]
- A higher degree of planned versus unplanned activity
- One global work process
- One global set of planning tools
- Interchangeability of personnel
- Better management of product exchanges
- "Tighter" schedules reflecting less contingencies
- Reduced design cycle time
- Reduced overall lead-time
- Reduced transportation cost
- Reduction in manpower
- Reduction in fixed and working capital
- Reduction in inventory levels of raw materials and finished products
- Reduced material spend or reducing off-contract procurement
- Reduction in the cost of goods sold

Some of the most common problems encountered in projects that aim at improving supply chain efficiency are the inability to measure key value drivers, the fact that inefficiencies are often not visible across interfaces, a lack of benchmarks for comparison purposes, or the properties of existing performance measurement systems that were not designed to function supply chain-wide.

6.3. Other Factors to Watch

The trend to take a more integrated look at the supply chain and to focus on core competencies means that companies are becoming leaner and also more vulnerable along their global supply chain. To compensate for this, they will have to carefully consider each instance that a source/make decision has to be made. As many of the decision will be in favour of outsourcing, supplier management becomes important and thus potentially more long-term. Alliances and alliance management will thus be a key to future success.

At the same time, securing a steady supply of crude mix will continue to be critical for the time being. A broad crude portfolio, access to other sources of crude and a wise procurement will therefore continue to play a critical role.

As companies market more differentiated products, the importance of brands will grow. It is surprising, that the big oil companies do not make better use of their large retail networks, as witnessed by their somewhat disappointing performance in the Interbrand brand ranking.[42] At the same time, this constitutes a risk, as a negative event in one part of the world can easily endanger non-related operations in the rest of the world.

The risk of NOC's moving downstream and competing with the majors in their own turf has already been mentioned. At the same time, large retailers such as WalMart, Costco, or Albertsons are entering the business from the other side. Since these retailers buy cheap unbranded gas from wholesalers, they can undercut the majors in terms of price. With their natural customer base and a vast experience in retail, they are a formidable threat and one day might break the exclusive franchise system of the incumbents.[43]

6.4 Shell's Competitive Position

Where does Shell stand? Shell is clearly committed to remaining a vertically integrated company with the stated aim of being "one of the world leaders in energy and petrochemicals"[44]. Upstream, the company is gaining more efficiency by using an operating model based on regional hubs which allows it to enhance its global growth capability. At the same time, Shell is broadening its portfolio, shedding non-strategic and underperforming assets, and focussing on select profitable markets and businesses. In so doing, it is enhancing its expertise at alliance managements, as it increasingly combines forces with other companies in order to leverage its key competences.[45]

Downstream, Shell is simplifying organisational structures and becoming more focussed in order to cut its cost base and become more responsive. This focused approach is consistent with its priorities of streamlining and developing the portfolio of products, customers and assets. In retail, Shell has a strong position to build on: the company owns some 12 fuels refineries, 24'500 service stations, and 6 petrochemical sites in the Americas, 13 fuel refineries, 11'000 service stations, and 8 petrochemical sites in Europe, and 6 fuels refineries, 12'500 service stations, and 5 petrochemical sites in Asia and the Middle East. In recent years, the company has put a lot of effort into product and service innovation. Anticipating new markets driven by customer preferences, Shell has been pushing product differentiation through its V-Power Premium fuels. In addition to providing added value to customer, this move is designed to increase profit margins and counter the competition emerging from retailers. The chemicals companies are focussed on delivering sustainable growth, above all in their bulk petrochemicals, which serve large industrial customers.

Clearly, managing such a complex global network requires implementation capabilities, which in turn depend on functioning organizational structures and highly trained employees. Shell is working to make its structures more simple and efficient and deploy the talent of its diverse workforce even more efficiently. It is aligning employees' incentives better with corporate goals and enhancing personal accountability at all levels. In order to retain the talent at hands and attract new one, Shell is actively developing its second key enabler, the Shell brand. The goal is to attract knowledge, skill and future top talent at the same time as it helps building a loyal customer base. As a consequence,

Shell is pursuing a single-brand strategy, in contrast to other majors. To hedge against the risks of this strategy, the company commits to sustainable development. By being seen and as a good corporate citizen, Shell hopes to become the industry's first choice for customers, staff, investors, suppliers, partners and the communities in which it operates.

In terms of supply chain, Shell is continually reorganizing and consolidating. Above all the consolidation with its focus on leaner organisation and rationalization of sites has a strong effect on the supply chain. The strategy of regional hubs in the upstream, the integration of the refining network and reduction of unplanned refining downtime, or shared service centres and the single-brand strategy in the downstream all help to simplify global structures. Using explicit benchmarking, efforts are under way to standardize systems and processes and to increase throughput and asset utilization.[46]

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APPENDIX

	1997	1998	1999	2000	2001	2002	2003
North America	27,476.8	25,910.8	26,468.8	26,900.9	27,101.1	27,167.0	27,200.0
Latin America	140,091.3	122,163.6	123,790.6	119,669.6	123,999.4	116,627.4	116,437.5
Eastern Europe	67,373.9	74,708.4	77,686.7	80,586.7	80,217.4	86,190.5	88,290.5
Western Europe	18,751.4	18,348.3	18,843.1	18,032.6	18,128.3	18,267.5	18,385.9
Middle East	676,755.3	677,806.2	678,736.9	694,705.9	698,813.3	730,966.3	735,866.3
Africa	73,811.5	76,178.5	84,258.4	92,415.2	95,876.5	101,004.3	105,507.2
Asia and Pacific	53,951.7	55,128.3	53,558.8	52,132.5	47,043.9	45,885.0	45,862.3
Total world	1,058,211.9	1,050,244.1	1,063,343.3	1,084,443.4	1,091,180.0	1,126,108.0	1,137,549.8
OPEC	805,967.0	810,264.3	818,247.0	840,537.7	847,883.6	881,678.8	891,115.9
OPEC percentage	*76.2*	*77.2*	*77.0*	*77.5*	*77.7*	*78.3*	*78.3*

Proven Crude Oil Reserves (OPEC, 2003)

	1997	1998	1999	2000	2001	2002	2003
North America	7,865.7	7,679.4	7,227.1	7,213.1	7,178.9	7,191.3	7,190.8
Latin America	8,481.5	9,477.1	9,124.7	9,167.2	9,319.4	9,464.5	9,539.6
Eastern Europe	7,093.0	7,083.3	7,212.0	7,629.3	8,245.3	9,050.1	9,937.7
Western Europe	6,202.2	6,109.1	6,176.9	6,287.5	6,033.6	5,949.6	5,624.5
Middle East	19,608.0	21,117.5	20,288.9	21,430.5	20,779.5	18,648.1	20,451.6
Africa	6,589.8	6,705.0	6,348.5	6,769.8	6,620.9	6,452.4	7,270.8
Asia and Pacific	7,040.1	6,965.7	7,024.6	7,165.9	7,124.6	7,177.7	7,075.1
Total world	62,880.3	65,137.0	63,402.7	65,663.2	65,302.3	63,933.8	67,090.0
OPEC	25,431.8	27,739.7	26,227.8	27,745.0	26,873.5	24,322.5	26,885.4
OPEC percentage	*40.4*	*42.6*	*41.4*	*42.3*	*41.2*	*38.0*	*40.1*

Crude Oil Production (OPEC, 2003)

	1997	1998	1999	2000	2001	2002	2003
North America	17,627.6	17,802.7	18,452.6	18,444.8	18,508.4	18,606.8	18,686.1
Latin America	7,922.6	7,606.3	7,664.6	8,106.7	7,993.4	8,255.3	8,128.8
Eastern Europe[1]	11,976.2	11,294.4	11,317.3	9,972.2	10,164.6	10,128.3	10,085.5
Western Europe	14,864.4	15,065.0	14,929.2	14,982.5	15,045.9	15,098.6	15,156.8
Middle East	5,781.0	6,134.5	6,353.9	6,337.9	6,409.2	6,423.9	6,370.0
Africa	2,888.3	2,944.5	2,982.5	3,257.7	3,247.3	3,278.3	3,303.8
Asia and Pacific	16,866.6	18,681.8	19,491.0	20,130.0	20,248.2	20,269.1	20,101.9
Total world	77,926.8	79,529.2	81,191.1	81,231.8	81,617.0	82,060.2	81,832.9
OPEC	8,035.1	8,448.8	8,656.3	8,811.4	8,882.7	8,915.5	8,666.3
OPEC percentage	*10.3*	*10.6*	*10.7*	*10.8*	*10.9*	*10.9*	*10.6*

Refining Capacity (OPEC, 2003)

	1997	1998	1999	2000	2001	2002	2003
North America	18,675.2	18,918.4	18,934.9	19,305.1	19,200.2	19,282.6	19,697.8
Latin America	6,554.7	6,750.3	6,592.6	6,653.1	6,801.6	6,843.4	7,076.2
Eastern Europe	5,839.8	5,768.0	5,697.9	5,828.0	6,165.4	6,543.4	6,652.3
Western Europe	14,885.9	15,262.7	14,572.8	14,833.1	14,774.8	14,925.0	15,012.0
Middle East	5,190.6	5,534.4	5,554.4	5,534.2	5,593.2	5,726.7	5,873.0
Africa	2,365.1	2,298.6	2,376.3	2,404.8	2,583.5	2,738.7	2,678.5
Asia and Pacific	16,351.5	16,306.8	17,256.7	17,843.9	17,941.8	18,194.5	18,237.7
Total world	69,862.9	70,839.1	70,985.5	72,402.2	73,060.3	74,254.3	75,227.5
OPEC	7,386.7	7,657.5	7,622.2	7,638.7	7,912.8	8,121.9	7,984.8
OPEC percentage	*10.6*	*10.8*	*10.7*	*10.6*	*10.8*	*10.9*	*10.6*

Output of Refined Products (OPEC, 2003)

	1997	1998	1999	2000	2001	2002	2003
North America	20,288.4	20,571.2	21,206.8	21,419.3	21,522.3	21,940.7	22,332.1
Latin America	6,038.3	6,299.6	6,259.3	6,347.4	6,276.9	6,192.6	6,189.7
Eastern Europe	5,558.0	5,404.1	5,147.0	4,858.3	5,161.5	4,979.8	5,059.6
Western Europe	13,830.2	14,064.4	13,991.0	13,899.0	13,993.9	13,835.2	13,899.6
Middle East	3,314.2	3,787.8	3,735.6	3,838.5	3,956.3	4,074.3	4,199.9
Africa	2,027.1	2,100.1	2,152.0	2,201.4	2,278.6	2,258.9	2,363.0
Asia and Pacific	18,558.1	17,955.9	18,947.8	19,541.3	19,529.7	19,990.5	20,857.1
Total world	69,614.5	70,183.1	71,439.6	72,105.3	72,719.1	73,272.0	74,900.9
OPEC	4,388.6	4,817.9	4,720.8	4,899.7	5,089.4	5,192.2	5,437.1
OPEC percentage	*6.3*	*6.9*	*6.6*	*6.8*	*7.0*	*7.1*	*7.3*

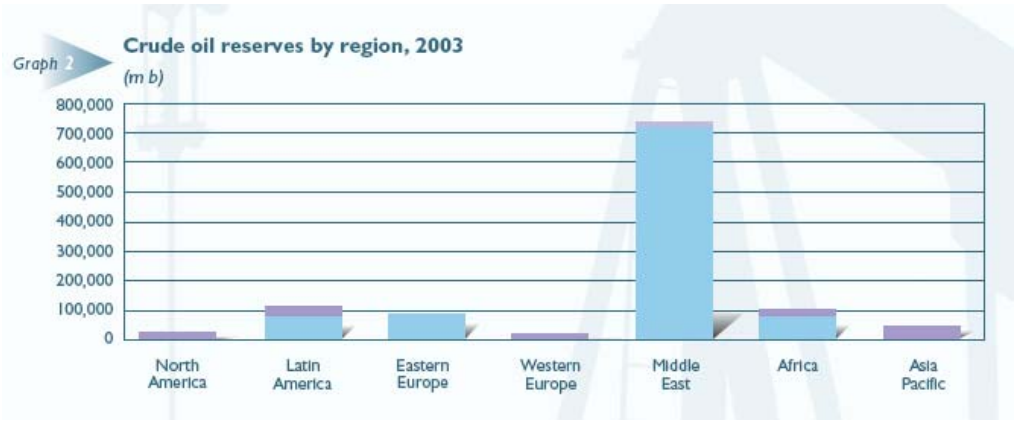
World Consumption of Refined Products (OPEC, 2003)

	1997	1998	1999	2000*	2001*	2002*	2003*
North America	1,139.6	1,258.7	1,168.0	1,226.7	1,150.4	1,447.4	1,575.7
Latin America	5,061.7	5,188.5	4,715.5	5,039.5	5,060.9	4,610.8	4,768.4
Eastern Europe	2,177.9	3,045.3	3,440.9	4,144.9	4,593.9	5,583.7	6,482.2
Western Europe	4,553.9	4,510.9	4,646.6	4,960.0	4,853.4	4,763.5	4,371.5
Middle East	14,553.7	15,597.9	15,147.0	16,016.5	15,129.2	13,781.9	14,707.7
Africa	5,035.2	5,226.1	4,863.0	5,172.4	5,261.5	5,153.4	5,968.1
Asia and Pacific	2,275.6	2,210.7	2,222.1	2,266.2	2,212.8	2,214.1	2,191.8
Total world	34,797.6	37,038.2	36,203.0	38,826.3	38,262.1	37,554.8	40,065.8
OPEC	19,331.1	20,586.9	19,405.5	20,526.7	19,619.4	17,735.6	19,495.7
OPEC percentage	*55.6*	*55.6*	*53.6*	*52.9*	*51.3*	*47.2*	*48.7*

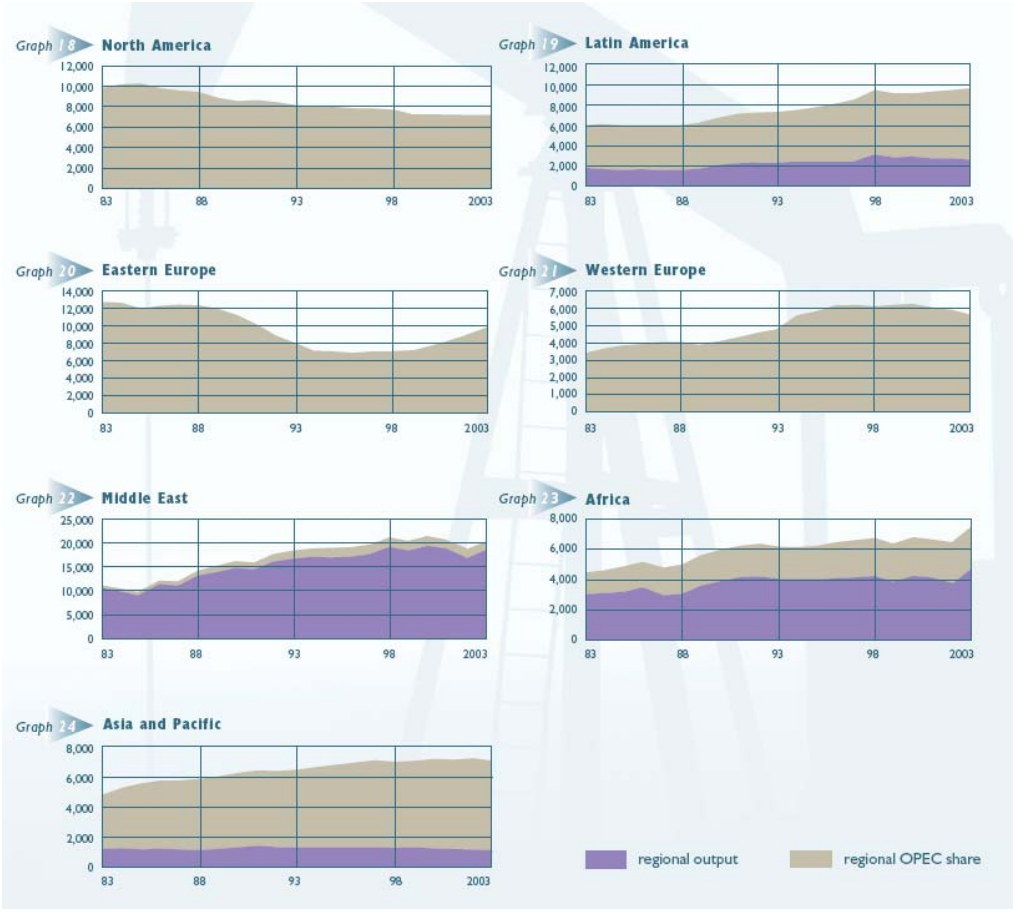
World Crude Oil Exports (OPEC, 2003)

	1997	1998	1999*	2000*	2001*	2002*	2003*
North America	1,230.3	1,114.3	1,114.3	1,274.7	1,377.5	1,414.6	1,482.1
Latin America	1,988.2	2,122.2	2,106.8	2,094.3	2,201.1	2,002.4	2,068.6
Eastern Europe	1,177.6	1,064.8	1,089.5	1,272.3	1,456.2	1,800.7	1,879.1
Western Europe	4,000.7	4,022.5	4,025.5	4,171.0	4,171.0	4,222.0	4,566.0
Middle East	3,335.9	3,284.2	3,302.1	3,140.3	2,962.6	2,876.0	3,096.7
Africa	1,049.4	957.6	1,162.2	1,172.7	1,213.6	1,193.8	1,113.9
Asia and Pacific	2,930.8	2,881.0	2,826.2	2,788.5	2,803.6	2,569.8	2,739.1
Total world	15,713.0	15,446.5	15,626.7	15,913.6	16,185.4	16,079.3	16,945.4
OPEC	4,668.0	4,580.2	4,745.3	4,536.8	4,337.8	4,017.6	4,052.2
OPEC percentage	*29.7*	*29.7*	*30.4*	*28.5*	*26.8*	*25.0*	*23.9*

World Exports of Refined Products (OPEC, 2003)



Crude Oil Reserves by Region (OPEC, 2003)



World Crude Oil Production, 1983-2003 (OPEC, 2003)

	Crude Oil	Natural Gas Liquids	Refinery Feedstocks	Naphtha	Liquified Petroleum Gases	Motor Gasoline	Aviation Gasoline	Jet Kerosene	Kerosene	Gas/Diesel	Residual Fuel Oil
Unit - 1000 Tonnes											
Production	3302276	237091	0	184094	101202	867197	1674	209172	89874	1036485	597665
Other Source (Primary)	0	0	26266	0	0	0	0	0	30	116	0
Other Source(Secondary)	0	0	0	0	0	0	0	0	0	0	0
Imports	1960099	20085	51666	79360	56603	111967	549	38627	15655	186363	171544
Exports	-1844917	-42506	-7164	-68676	-57164	-120408	-336	-41215	-18857	-203963	-212132
International Marine Bunkers	0	0	0	0	0	0	0	5	0	-27315	-121654
Stock Changes	-4421	-89	2575	820	1804	2150	30	1087	1103	5319	2662
Domestic Supply	**3413037**	**214581**	**73343**	**195598**	**102445**	**860906**	**1917**	**207676**	**87805**	**997005**	**438085**
Transfers	1	-158576	64189	-115	101189	-113	178	-1325	-2067	-3326	-7085
Statistical Difference	-10895	-1216	2266	2407	-1194	-347	-3	-1439	-140	464	9074
Total Transformation	**3382460**	**52238**	**139798**	**19891**	**4695**	**998**	**0**	**0**	**739**	**47850**	**210450**
Electricity Plants	26685	44	0	34	839	29	0	0	543	44965	165140
CHP Plants	6	0	0	191	28	0	0	0	2	1108	26108
Heat Plants	1120	0	0	0	87	0	0	0	20	806	14465
Petroleum Refineries	3354649	52194	139798	76	0	0	0	0	0	0	0
Other Transformation	0	0	0	19590	3741	969	0	0	174	971	4737
Energy Sector	**7544**	**928**	**0**	**457**	**2805**	**824**	**0**	**0**	**305**	**9756**	**54074**
Distribution Losses	2961	53	0	0	45	14	0	3	0	42	13
Total Final Consumption	**9178**	**1570**	**0**	**177542**	**194895**	**858610**	**2092**	**204909**	**84554**	**936495**	**175537**
Industry	8845	1570	0	177542	79611	5896	1	54	6161	101517	139122
Transport	5	0	0	0	14447	845773	2091	204154	755	572958	14301
Agriculture	0	0	0	0	0	0	0	0	0	0	0
Commerce and Public Services	0	0	0	0	0	0	0	0	0	0	0
Residential	0	0	0	0	0	0	0	0	0	0	0
Other Non-Specified	328	0	0	0	100837	6941	0	701	77629	262020	22114

Product Breakdown (OPEC, 2003)

NOTES

[1] MIT Supply Chain 2020 homepage http://web.mit.edu/ctl/www/research/sc2020/re_sc2020.htm

[2] For convenience I will henceforth only use Shell when referring to Royal Dutch/Shell

[3] For Shell's history see chapter 3.

[4] For companies in the two advisory councils http://web.mit.edu/ctl/www/research/sc2020/re_sc2020_advisors.htm

[5] Peterson, D.J. and Sergej Mahnovski. *New Forces at Work in Refining: Industry Views of Critical Business and Operations Trends*. Rand, 2003.

[6] IEA, IEA Statistics, 2002.

[7] OPEC. *Annual Statistical Bulletin 2003*. Vienna, 2003.

[8] Fortune's Global 500 2003

[9] "Petroleum in Bulk and the Suez Canal," *Economist*, January 9, 1882: 36-38.

[10] The paragraphs above are largely based on Yergin, Daniel. *The Prize: The Epic Quest for Oil, Money & Power*. Simon & Schuster Inc., New York, 1991. Some additional information comes from Henriques, Robert. Marcus Samuel: First Viscount Bearsted and Founder of the "Shell Transport and Trading Company, 1853-1927. London, Varrie and Rockliff, 1960 and Gerretson, F.C. *History of the Royal Dutch*. 4 vols. Leiden, E.J. Brill, 1953-57.

[11] The seven sister was a term coined by Italian oil tycoon Enrico Mattei and refers to Exxon, Mobil, Shell, BP, Socal (Chevron), Texaco, and Gulf Oil (which was acquired by Chevron in 1984). Those companies came to dominate oil in the Middle East through a number of exclusive agreements, designed to stabilize oil prices but in effect creating an oligopoly. Although the official agreements were abandoned in the aftermath of the Second World War, the former seven sisters could maintain their dominant positions and in 1972 still accounted for 70% of world oil production. For details see Sampson, Anthony, *Seven Sisters: The Great Oil Companies and the World They Shaped*. Bantam Books, 1981.

[12] Yergin, *The Prize*, p. 190.

[13] Information from company homepage at www.total.com.

[14] Standard&Poor's. *Industry Survey Oil and Gas: Production and Marketing*. October 21, 2004.

[15] In "Big Oil's Biggest Monster", The Economist, 6 January 2005. Deutsche Bank: "Oil & Gas: Frontier Issues Competition for New Supplies", *IAEE 26th Annual Conference*, Prague 7 June 2003.
For ranking see *Petroleum Intelligence Weekly*. Energy Intelligence Group, Inc., December 13, 2004.

[16] Recently some state-owned companies have made great progress in making their numbers public (see Economist, "Big Oil's Biggest Monster", *The Economist*, 6 January 2005).

[17] It is not so much for technical or economic reasons that the upstream part is dominated by state-owned companies and the downstream part by privately-owned companies, respectively. Rather it is for political reasons in the producer nations and regulatory reasons in the nations of the end consumer.

[18] John S. Herold. *Global Upstream Performance Review*. September 2004.

[19] Yergin, *The Prize*: p14.

[20] Palisade Europe. "Fluor Bases Global Oil and Gas Estimates on @RISK". *Case Study*. 2003.

[21] Peterson, *New Forces at Work in Refining*, 2003.

[22] George, Dev. (ed.) "Refining Capacity Creeps Higher in 2003", in *Oil and Gas Journal,* vol. 101, issue 49.

[23] Ibid.

[24] For more information on pipelines as a means of transport see Long, Douglas (ed.). *International Logistics: Global Supply Chain Management*. Kluwer Academic Publisher Group, Dordrecht, 2003: pp. 146-48.

[25] For example World Fuel Services, which is one competitor in that market, focuses exclusively on airports and shipping companies.

[26] Banker, Steve, and Tom Fiske. „Aspen Tech Expands Oil & Gas Solution", *ARC Insights*, June 7 2000.

[27] Ernst, David and Andrew M.J. Steinhubl. „Petroleum: After the Megamergers", in *The McKinsey Quarterly*, 1999, no. 2.

[28] Ibid. See also Bleakley, Tim and Dave Gee. "The Atomization of Big Oil" in *The McKinsey Quarterly*, 1997, no. 2, and Ernst, David and Andrew M.J: Steinhubl.. "Alliances in Upstream Oil and Gas", in *The McKinsey Quarterly*, 1999, no. 2.

[29] PFC Energy. *Shell: Strategy and Performance Profile*. 2004.

[30] Ibid.

[31] The last couple of years have seen indications that this might be about to change.

[32] Shell Strategy Review September 22nd, 2004: "Regaining Upstream Strenght, Delivering Downstream Profits".

[33] PFC Energy. *Shell: Strategy and Performance Profile*. 2004.

[34] Ibid.

[35] This does not apply in high-cost environments, such as the North Sea, where all the wells are used. But for example in OPEC countries, which are subject to an export quota and therefore produce below capacity, the decision of which wells to produce from is important.

[36] Dow Jones & Company. "Discounters Gain as Price of Gas Rises". In *Wall Street Journal*. April 7th, 2005.

[37] As has been described in chapter three, the decision between refining flexibility and crude oil decisions are two sides of the same coin. Given the average life-time of a refinery and the investment necessary to set it up, I will not consider the setting up of refineries as an option, The reason why a more integrated approach has not been pursued by the majors is simply that the task is too overwhelming and g

[38] The situation in the US is somewhat different from the rest of the world due to the specific regulatory environment.

[39] The two paragraphs above on refinery operations are largely taken from Exodus Systems, Ltd., a company that applies mathematical techniques to operations in the oil industry. See Robert Simons. "Mathematical Programming in the Oil Industry", in *MP in Action: The Newsletter of Mathematical Programming in Industry and Commerce*, June 1996 and Simons, Robert. "Planning and Scheduling in Oil Refineries" in *MP in Action: The Newsletter of Mathematical Programming in Industry and Commerce*, December 1996.

[40] See Footnote 21.

[41] The contents of this subchapter are based on "Shell Global Supply Chain Transformation" in *Ken Sharma Awards for Exellence Application*. I2, August 2003.

[42] Businessweek. "2003 Global Brands Scoreboard". *Business Week Magazine*. August 4th, 2003 Issue.

[43] *Wall Street Journal*. "Discounters Gain as Price of Gas Rises". April 7th, 2005

[44] Shell Strategy Review.

[45] A good example is the Sakhalin, which is set up as a PSA with the Russian government and in which Shell leads a consortium consisting of Mitsui&Co., Ltd. and Mitsubishi Corp.

[46] The previous passages are largely based on Shell's Strategy Presentation „Regaining Upstream Strenght, Delivering Downsteam Profits", *Shell Strategy Investor Presentation*. September 2004.