Planning for Chaos:
A Scenario Approach to the Oil Market

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No one can forecast oil prices. Yet a sharp change in oil prices can radically alter business conditions for a very large number of companies. In the early 1980s, automobile companies, iron and steel companies, airlines, marine transportation companies, and ultimately financial institutions all suffered whiplash from steep increases in oil prices. Since prices collapsed in 1986, we have enjoyed a period of relative calm, but the possibility of further turbulence remains with us. That possibility, although not forecastable, is nonetheless critical to business planning.

The Scenario Planning Approach

Arthur D. Little's approach to the fundamental uncertainty in energy markets is to base planning on carefully developed scenarios with varying degrees of probability. This approach rests in part on the work of Pierre Wack, who, while he was with the Royal Dutch/Shell group in the early 1970s, built on some early concepts of scenario development pioneered by Herman Kahn. Through the use of scenarios, Mr. Wack introduced Royal Dutch/Shell's top managers to the possibility that the future (the 1970s) might be sharply different from the past (the 1960s). Shell management was able to take actions that would be neutral in their effect on the company if the conventionally forecast future were to occur, and that would be highly beneficial if the future turned out quite different. As a result, Shell decentralized its management process and de-emphasized the integration strategies that had been favored by major oil companies. Shell achieved this revised strategy in advance of the wave of nationalizations in the producing countries. As a result, it found itself much better able to manage in the new environment of the 1970s than many of its competitors.

Arthur D. Little currently considers four scenarios describing future world oil prices:

Managed Recovery. This scenario reflects a commonly held view that oil prices will gradually rise. It anticipates a steady growth in world oil demand, kept in check by periodic decisions by the major oil producers to raise real oil prices. In this scenario, the major oil producers manage oil prices in order to keep demand within reasonable ranges.

Global Expansion. This scenario envisions more rapid growth in the world economy, with strong growth in oil demand in the Third World and in previously communist areas. The price path resembles that of the Managed Recovery scenario but is more volatile, and major oil producers are presumed to be willing to increase production capacity in order to accommodate the rapid growth in oil demand. In this scenario, major producers manage oil production volumes to keep prices within reasonable ranges.

Constrained Markets. The only context in which oil prices are likely to remain low is that of a very gloomy world economy, generating slow growth in energy and oil demand.

Commodity. Our fourth scenario postulates a more chaotic future in which there are quite violent changes in the oil market. Although inherently unpredictable, these changes have important repercussions on other energy markets and on the world economy. In other words, this scenario portrays a future that resembles the last 20 years. Of the four scenarios, the Commodity scenario presents the biggest challenge to corporate and government policy makers.

Normally, we would expect policy makers to be favorably inclined toward predictions of the future that resemble the past, even if the past is chaotic. Yet most companies and government agencies continue to base their decisions on projections that show regular progressions in energy supply, demand, and price.

There are reasons to believe that the Commodity scenario should be taken seriously: Energy forms other than oil are currently subject to a variety of constraints. Global oil demand appears to be gaining momentum. Although non-OPEC supply increases may continue, they no longer match increases in demand. The size and complexity of the global oil market may make it inherently unmanageable.

Constraints on Non-Oil Energy Forms

The strong move toward energy forms other than oil in the early 1980s has lost momentum in the United States, Europe, and Japan (Exhibit 1). Coal is under pressure due to its adverse environmental effects; nuclear energy is constrained by public concerns over safety; natural gas suffers from a variety of resource, transportation, and regulatory handicaps; and no new energy forms have yet become economically viable alternatives.

Exhibit 1

Non-Oil Energy Growth Rates (percent per year)

	United States		Europe		Japan	
	1980–85	1985–90	1980–85	1985–90	1980–85	1985–90
Coal	2.5	2.1	0.6	(1.8)	5.1	0.6
Nuclear energy	8.6	6.5	22.2	4.0	13.5	5.4
Natural gas	(2.6)	0.9	2.0	1.3	8.9	4.3

Sources: National statistics and Arthur D. Little estimates

Coal. Coal consumption grew strongly from 1980 to 1985, mainly in power plants. Coal supplies are located in areas perceived to be politically secure; they are also abundant and cheap. In the early 1980s, Australia and South Africa emerged as sources of major international coal supplies, and export projects were begun in nontraditional coal-producing countries such as Colombia, Venezuela, and Indonesia. Domestic coal industries in Europe paused temporarily in their long-term process of contraction, and Poland's exports to Europe burgeoned.

After the oil price collapse of 1986, the situation changed. The major cost advantage of coal over oil (and also over natural gas, whose price is often linked to oil) disappeared. The environmental movement strengthened worldwide (this is no coincidence and is significant to managers: environmental businesses and upstream oil businesses are countercyclical).

From being the solution to electric utilities' fuel problems, coal became the source of a new set of environmental concerns. Many coals are high in sulfur and contribute to acid rain. Coal is primarily carbon. When burned, it emits carbon dioxide, which is believed to be a cause of global warming. In older plants, it also causes particulate emissions and dust. With the exception of carbon dioxide, these problems can be overcome, but at a cost that reduces the attractiveness of coal, particularly when oil and natural gas are cheap.

Nuclear Energy. Nuclear energy showed spectacular growth in the early 1980s as plants initiated in the 1970s were brought on stream. However, nuclear energy was already moving into public disfavor before the widely publicized accidents at Three Mile Island and Chernobyl. It has been argued that more standardized designs and higher construction standards allowed safe and efficient industries to develop in France and Japan, and that these models would serve as examples upon which international growth could be built. However, even in these countries there is public resistance to new nuclear power plant sites, and growth rates have been declining.

New, modular designs for nuclear plants using passive cooling systems have emerged that offer substantial improvements in safety. In addition, concern over the greenhouse effect favors nuclear energy over fossil fuels. But the problem of disposal of spent nuclear fuel elements has not been resolved to the satisfaction of many people. In the United States, it would be a brave utility that initiated a new nuclear power plant, in light of current public sentiment, without substantial government support.

Natural Gas. Natural gas showed uneven progress in the early 1980s. In Europe, there was steady, albeit unspectacular, growth based on supplies from the North Sea and the U.S.S.R. In Japan, expanded liquefied natural gas (LNG) output from Indonesia and Malaysia allowed strong growth, mainly as an electric utility fuel. By contrast, the United States had created inflexible regulatory and contracting requirements that resulted in declining natural gas consumption even as deliverability increased.

Natural gas is a fuel source currently favored by governments, oil companies, and many environmentalists. It has many advantages. Being largely methane, its combustion generates less carbon dioxide than oil or coal. Many sources contain no sulfur, and the technology of sulfur removal in natural gas plants is well established. But natural gas is not necessarily a panacea. In the United States, the resource is highly uncertain. Current high projections of future supply may reflect undue optimism. For example, the U.S. Department of Energy increased its projection for U.S. national gas supply in the year 2000 from 13 trillion cubic feet (tcf) in 1982 to 18 tcf in 1988. However, the resource is finite at any assumed price level, and much of the success in adding reserves over the past few years has been from „infill drilling" that redefines the already known resource rather than adding new resources through genuine exploration.

Although international natural gas resources abound, many are expensive to develop and bring to market. Canada has abundant natural gas reserves. However, the more optimistic Canadian export forecasts assume development of reserves in the Mackenzie Delta area of the Canadian Arctic. Development of Eastern Siberian

resources for delivery to Europe or as LNG to Japan will be very expensive. Almost any international LNG project requires natural gas prices to be about double today's U.S. levels in order to generate a satisfactory return on investment. Moreover, it is not clear how the environmental benefits of natural gas will be reconciled with public concerns over the safety of LNG shipping, reception, and regasification facilities.

Other Sources. Finally, although many ideas for exotic energy sources emerged in the early 1980s, most turned out to have more interest as tax shelter investments than as genuine energy contributors. Windmill farms and active solar energy do not appear to be economically viable at today's oil and gas prices. Synfuels projects face both economic and environmental hurdles that may be difficult to overcome.

Recent scientific advances (e.g., nuclear fusion, superconductivity, and space-based solar energy) may become more important in the next century. In addition, new architectural and engineering designs incorporate numerous energy-saving concepts that bode well for the continued improvement of energy efficiency. However, nothing seems likely to challenge the supremacy of oil in the international energy equation over the remainder of this century.

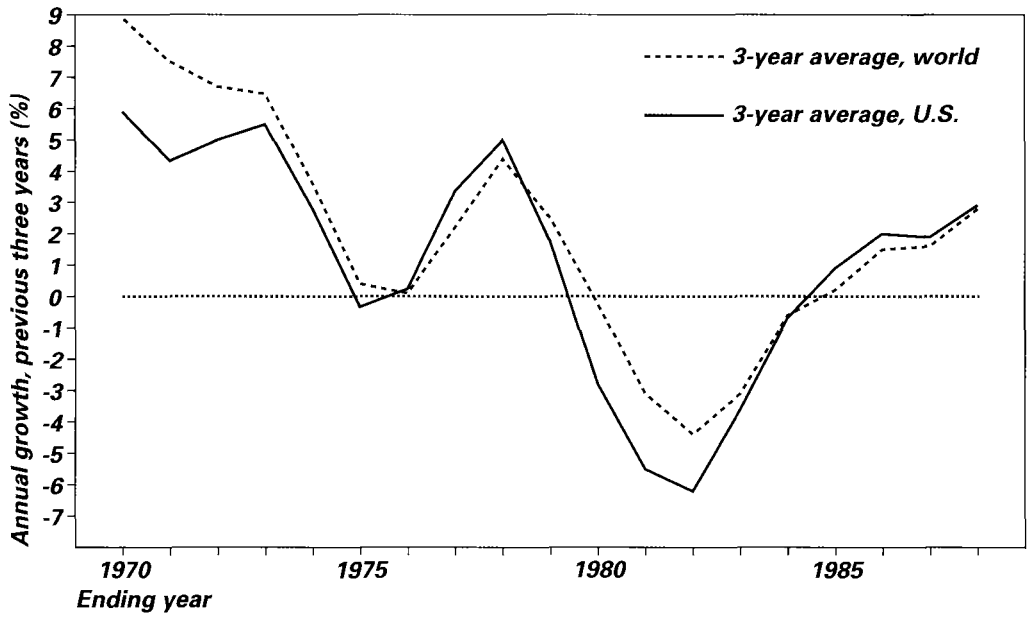
Growing Global Oil Demand

It seems likely that world oil demand outside the communist area will show an average annual growth rate of about 2.5 percent from 1985 to 1990. By comparison, the preceding five years showed an average decline rate of about 1.5 percent per annum (Exhibit 2). The reasons for this turnaround are well known. The global economy has been strong overall, and oil prices have been low in dollar terms and even lower in terms of most other major currencies.

Furthermore, in the global political arena that forms the context for the global economy, major changes permit a cautiously optimistic view of the future. *Perestroika* in the U.S.S.R., political change in Eastern Europe, and economic liberalization in China (though this is less certain) appear to have achieved dominance over doctrinaire and territorial ambitions. Trade pacts between the United States and Canada and within the European Community may be the precursors of a globally integrated economy. A number of regional conflicts have simmered down, reflecting in part a less destructive relationship between the superpowers.

Exhibit 2

Annual Growth: U.S. vs. World Oil Demand



Over the past year and a half, oil companies have repeatedly assured investors that they expected low oil prices to remain in the long term. They wish to reassure investors that they have lowered their breakeven costs in order to prosper in this environment. We agree that low oil prices are quite likely in the near term. The volume aspirations of some major OPEC producers appear to be substantial. So long as we are in a supply-push environment, it is difficult to imagine significant oil price increases.

If oil prices remain low, recent patterns of growing consumption will tend to continue because low oil prices will discourage the development of alternative fuels and will inhibit conservation. In our view, the apparent conservation we have seen in the 1980s falls into three categories. The most important has been a restructuring of industrial economies toward higher-technology products and services and away from basic energy-intensive industries. The second component has been the closure of many inefficient industrial plants, their replacement by more efficient units, and retrofitting of existing plants to be more energy-efficient. Third has been a voluntary reordering of consumer priorities as people accepted more energy-efficient automobiles and lower thermostat settings in order to maintain living standards in other areas.

It is not unreasonable to assume that the world economy is now moving forward in a more balanced pattern between basic industries, high-technology industries, and services. Another reasonable assumption is that the oil price shock of the early 1980s has been fully absorbed and that further improvements in energy efficiency may be realized only slowly at current energy prices. Further, it is possible that the extraordinary growth rates of the countries in the Asia-Pacific region (see *Prism,* First Quarter 1990), which is now causing double-digit growth in regional oil consumption, may continue. Finally, if *perestroika* is successful in the U.S.S.R. and if China also liberalizes its economy, the potential for increased consumption in these countries and in Eastern Europe is enormous.

To be sure, other economic scenarios suggest a possible slowdown in oil demand growth. There are also different interpretations of the relationship between low oil prices and oil consumption. That is why different scenarios need to be considered. However, continuing strong growth in global oil demand is certainly a real possibility.

Limited Non-OPEC Production

Non-OPEC crude oil production has increased in several areas despite a low-oil-price environment. The reasons for this increased production include the significant geological potential in many non-OPEC countries, the substantial progress oil companies have made in reducing oil field development costs, and the more liberal fiscal terms that many countries are offering in order to maintain the momentum behind exploration and development.

However, the pace of increase is slowing. Between 1980 and 1985, non-OPEC production increased by more than 5 million barrels per day. Between 1985 and 1990, there will be a net increase of about 0.5 million barrels per day as additions around the world are offset by declines in North America.

In the early 1990s, we expect at best similarly modest growth in non-OPEC supplies. This growth rate will fall well short of demand growth, which, if recent trends continue, may exceed 2 percent, or more than one million barrels per day each year. Again, there are different scenarios. We could go through a period of economic stagnation, with lower oil demand, or there may be large oil discoveries in unexpected areas.

However, there are also more pessimistic scenarios for non-OPEC production. The recent series of accidents in the North Sea may result in new safety rules that again increase the cost of field development. The incident at Valdez, Alaska, may further complicate the development of frontier resources in the United States and may even have an impact in other developed countries.

In the U.S.S.R., there is a serious question whether production can be maintained economically at current levels. Also, China's oil industry depends on Western technology that may be less available following the incidents in Tiananmen Square. Therefore, the potential for communist bloc exports may be limited.

While we don't know what will actually happen, a future in which world oil demand growth substantially outstrips production increments from non-OPEC areas seems to us to be well worth thinking about.

The Chaotic Global Oil Market

The world oil market is a highly complex system. It depends on a number of external factors that themselves are interrelated in highly complex, nonlinear ways (Exhibit 3). Experience has shown that this system cannot be modeled in any but the most simplistic way. When a system can't be modeled, there is reason to believe that it also can't be effectively managed.

A great deal of work has been undertaken in the past decade by mathematicians, physicists, and natural scientists studying complex systems. The new science of „chaos" has emerged from this work. Three interesting findings from this work are:

• Very minor changes in the initial conditions of a natural system can result in major divergences after a relatively short period of time.

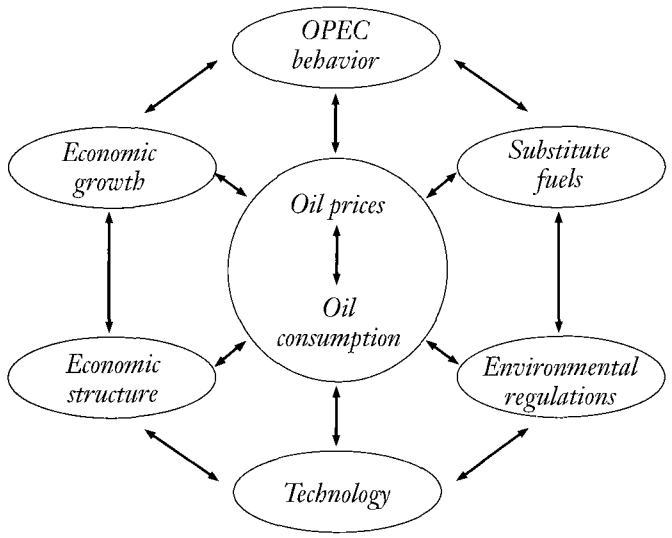
• As the degree of non-linearity of the systems increases, so does the unpredictability and apparent randomness of the system's behavior.

• Windows of apparent serenity can emerge in a chaotic system, but they are short-lived.

We believe that the oil market is a system of this type. Relatively minor events can trigger major repercussions in subsequent years. The oil industry is still feeling the effects of the Santa Barbara oil spill in the 1960s, which resulted in a profound public suspicion of the environmental risks of offshore exploration for oil and gas. Unpredictable large discoveries (e.g., Spindletop, North Slope, North Sea, Gulf of Campeche, the Middle East) are fundamentally destabilizing. Technological advances can add to energy demand or improve the efficiency of its use. Who knows what the repercussions of the Valdez incident will be? What would have happened if the Shah of Iran had not fallen in 1978? After all, oil demand growth was already slowing, and non-OPEC supplies had begun to grow at one million barrels per day per year. The more fundamental point is that, even if the emerging political instability in Iran had been fully understood, its implications for oil markets would still have been inherently unpredictable.

Exhibit 3

Forces Affecting Oil Prices and Consumption



Chaos scientists have found that when natural systems approach certain boundary conditions rapidly, the degree of instability increases. If the oil market is such a system, then we would expect instability to increase when demand for oil approaches production capacity. Experience tells us that this has occurred in the past. Not only do traders in a tight market enter a stage of „feeding frenzy," but the political pressures within major producing countries mount as their perceived power increases. It may be no coincidence that major political events such as the 1973 embargo or the 1978 Iranian revolution occurred during periods of high utilization of oil production capacity. Therefore, the natural conclusion of a period of high growth in demand and moderate growth in non-OPEC production capacity may be rising volatility and eventually another oil crisis, possibly intensified by political turmoil in a major producing country. Only deliberate efforts by producers to add capacity or by major consumers to restrain consumption can forestall it.

Moreover, the political response to another crisis will probably be extreme. At the very least, we would expect the momentum behind the non-oil focus of clean fuels to build substantially. An analog might be the major consumer response to higher gasoline prices in the early 1980s, which reinforced – and soon overtook – the objectives embodied in the Corporate Average Fuel Economies (CAFEs) specified in the 1975 Energy Policy and Conservation Act. The result could be another boom-and-bust cycle for the oil industry, as high prices caused by a crisis induce a series of reactions that cause unsustainably low prices. Indeed, the nature of chaotic systems is that boom-and-bust cycles are difficult to stop once they begin

Planning for Volatile Futures. We believe that the Commodity scenario needs to be taken seriously. The problem is that it has no place in any rational budget exercise. In fact, in many companies there is no mechanism for thinking constructively about how to behave in such a chaotic environment. Nevertheless, there are a number of actions that companies and governments can take to prepare for this eventuality.

Clearly, governments should make a concerted effort to adopt national and international policies that prevent such a chaotic future from occurring. Both oil producers and oil consumers share an interest in implementing

such policies. Areas of concentration might be programs to curb oil demand growth and encourage production capacity increases. In the United States, at least, current trends appear to be mainly in the opposite direction.

Notwithstanding government efforts, companies must recognize that the oil market may just be unmanageable. This is important not only for companies in the oil industry, but also for those whose businesses are affected by oil prices, such as the automobile, airline, electricity and gas, iron and steel, and chemical industries. Therefore, they should reconsider their approach to planning.

In many large companies, planning has become a ritualistic exercise involving an enormous number of man-hours, not just of planning staff but also of operating personnel. Prices and margins are forecast, negotiated, and eventually agreed to. Finally, although no one can be sure whether oil prices will be $12 per barrel or $22 per barrel next month, five-year (or more) budgets are created. Ironically, top executives and operational management have adapted quite well to highly volatile energy market conditions. It is just that they no longer seem to be well supported by their planning systems. Top executives of the best companies have focused on their areas of strength and have either reinforced or withdrawn from areas of weakness. Large energy consumers have taken advantage of low spot market prices. Chemical companies have invested in flexibility to take advantage of whichever feedstocks are least expensive.

Top executives of the best companies have provided an environment that allows operations management to succeed by pushing down responsibility to the lowest reasonable field level and by providing those responsible with the information necessary to make good decisions. In those companies, operational management has responded with innovative programs emphasizing responsiveness to changing market and customer requirements. The best companies also have carefully measured the success of these programs against objective criteria, separating those items that are controllable from those that are not.

Planning systems, however, do not appear to have changed much in the last decade. They do not seem to reflect the current oil business environment, to allow for the possibility of future shocks, nor to relate to objective performance measures.

A robust and relevant planning system is particularly important in turbulent times. It is vital for managers not to have to „fly by the seat of their pants“ during a severe external storm.

What can we do to improve planning systems? The problem is that they serve multiple masters, at different levels in the corporations and with differing time horizons. They need to be disaggregated and reconfigured to support the decisions they are meant to support.

One of the most important functions of a planning system is to provide an organization’s senior managers with a shared vision of the context within which they must operate. Through the use of scenarios, companies can consider futures that are different from the conventional wisdom, and may come to adopt a nonconventional vision for corporate positioning purposes. Pierre Wack calls this a „new worldview.“

If a „new worldview“ becomes accepted as a serious possibility, companies can then develop strategies that are robust to the cycle, if it occurs. The natural focus of each company will vary with its situation: oil and gas producer, purchaser of feedstock, or energy consumer.

Hydrocarbon producers, if they subscribe to the scenario described above, may wish to become somewhat less risk-averse. They will continuously test the financial waters for the availability of funds for well-conceived explorations, development, and acquisition programs. If this scenario materializes, they should avoid overenthusiastic responses and should seek to return the increased cash flow to their investors in the most fiscally efficient way. A renewed oil crisis might induce Congress to provide tax incentives for domestic resource development, and may allow innovative ways to provide high returns to the investors who have taken an early risk.

Oil refiners and commodity chemical companies stand to lose most in a new oil crisis. As the price of their feedstock rises, so will their margins be squeezed. Moreover, demand for their products will shrink as they attempt to pass through the cost increases to their customers. They are also facing substantial capital expenditures in order to meet increasingly stringent environmental standards. The best advice may be to stay cool; cycles have always characterized these businesses.

Companies that do not like the heat of commodity businesses should leave the kitchen. But the best time to exit is at the top of the cycle – as Arco did in its sale of stock in Arco Chemicals and Lyondell Petrochemical – not at the bottom, like those companies that sold their plants to Gordon Cain.

Also, the exits reduce competition for the steadfast and increase the potential for improved returns for those that remain. Many of these companies have been steadily investing in value-adding activities. Oil refiners such as Arco and Ashland have built excellent convenience store chains. Phillips and Dow have built strong positions in specialty polyethylenes while maintaining their positions in the cyclical ethylene manufacturing business.

These value-added businesses will buffer the commodity cycles.

Large energy users that take this different „world-view“ seriously must clearly invest in energy efficiency. Utilities should be aggressively approaching their state commissions to allow conservation investments into their rate base. Also, it seems to us rather irresponsible for utilities and their commissions to pass the entire electric generation buck to new independent power plants using natural gas with oil backup when there is a chance these fuels may not be available at an acceptable price. Similarly, large energy users in other industries that have taken advantage of the natural gas „bubble“ should develop contingency plans. It would be nice to be able to point to an alternative fuel that would allow energy users to escape the consequences of this scenario, but current technology does not seem to offer an obvious choice. This may be the right time to increase funding for research into clean coal and passive nuclear systems, as well as focusing heavily on energy efficiency.

None of the above suggestions would have adverse effects under a different oil scenario. All seem to us to have absolute merit. Yet they may not be considered seriously enough under conventional-wisdom-based scenarios. The power of the scenario approach lies in its ability to generate a broader range of options.

From an organizational standpoint, the uncertainty and potential earnings variability of this next commodity cycle suggest the need for more integration. However, the form of the integration may be more akin to the partnering arrangements growing in many industries between suppliers and purchasers than to the concession arrangements that characterized producer/major oil company relationships in the 1960s. The concept will need to stress long-term relationships and risk-sharing.

Many companies still focus their planning on the annual five-year budgeting exercise. A more flexible system may be essential if we are heading toward another oil crisis and will be useful even if we have a more orderly market.

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