

How to Use System Dynamics to Create Your Own Future : A Case Study of a Worldwide Oil and Gas Exploration Group

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Abstract

This paper describes the work and experience gained by a team of senior managers using a systems thinking approach, to develop their own set of future scenarios, to support a realignment of strategy and the redesign of a worldwide exploration group of a major integrated oil company. The opportunity for this experience arose from a need to assess the diminishing returns produced during several years of overseas exploration activity. According to a recent article in The Wall Street Journal, the entire petroleum industry has increased its search for reserves overseas. "...between 1988 and 1992, the world's 234 largest publicly traded oil companies spent \$157 billion on exploration and development overseas, 49% more than in the U.S.", but with diminishing results. " In 1990, the industry discovered 148 barrels of oil outside the U.S. for every 100 barrels it sold abroad; last year it added just 100 barrels of foreign reserves for every 100 barrels sold, while the average cost of replacing crude surged 55% to \$6.56 a barrel."

Against this backdrop, the senior managers used a systems thinking approach to brainstorm the factors influencing the dynamics of the world oil and gas industry. From this process the group was able to develop a set of five distinctly different plausible futures that might develop. To test their group mental model for consistency, they developed a causal model of the industry and discovered that their five different futures all could be explained by a common model.

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Introduction:

From the fall of the Berlin Wall to the rapid rise of the economies of Southeast Asia and the effective collapse of OPEC's grip on the world oil market, the world had changed dramatically during the 1980's. Against this backdrop of change, the nature of finding oil and gas reserves for the major oil companies has changed as well. As new fields have been increasingly more difficult to find, many oil companies have been moved to re-evaluate their strategies. Amoco has been no exception. The managers at Amoco's Worldwide Exploration Business Group (WEBG) have spent a good portion of 1993 evaluating and realigning their global strategy to adapt to the changing environment. WEBG managers have spent several months identifying and then selecting an appropriate strategic alignment for their group using an approach best articulated by Perry, Stott, and Smallwood in Real-Time Strategy: Improvising Team-Based Planning for a Fast-Changing World. While this approach proved useful for helping WEBG identify and define a number of alternative strategic options for moving forward, the group felt a need for better evaluating how the world was changing before committing to a specific course of action.

After attending a series of workshops on systems thinking earlier in the year, the WEBG management team was intrigued with the experience David Kreutzer had with integrating systems thinking with the scenario-planning approach at Royal Dutch Shell. In particular, Amoco wanted to participate in the creation of their own common viewpoint of alternative futures. Building upon the idea of creating future scenarios as articulated by Peter Schwartz in The Art of the Long View, we devised a plan for the team members to brainstorm and map out the relevant paths along which the future might develop.

The Hexagon Process:

We began the process of scenario creation with a half-day exercise with many of the more influential managers and staff in Amoco's WEBG. This group consisted of roughly fifty people, including the senior management team, the exploration strategy team, and a number of senior explorationists from around the world. These were the players that had the most experience, as well as the most at stake, in the future outcome of WEBG. Together with two facilitators from Gould-Kreutzer Associates, we spent a morning brainstorming about the future of dynamics of the worldwide petroleum industry as it will effect global oil and gas exploration.

While the assembled group was larger than we would normally recommend for using the hexagon facilitation process, we felt comfortable with this decision for three reasons. First, we wanted to work with a diverse enough set of personalities and experiences to provide the broadest possible range of ideas to form the basis for creating a robust set of future scenarios. Second, we wanted to open up the process to all and increase the chance of "buy-in" to the future scenarios by being sure to capture all the plausible uncertainties that might be on the minds of all the key WEBG players. Third, over half of the assembled group had participated in a week-long introduction to systems thinking and was already accustomed to working with the hexagon approach and sharing their mental models with the use of causal loop diagrams.

In our first session we used a nominal group technique in which we asked all the participants, in advance, to think about the following question: "What are your concerns, fears and hopes regarding world wide exploration for the next 30 years?" We chose a long time frame to get participants to really stretch their thinking beyond their typical day to day focus. We also wanted the group to think beyond the negative factors which had resulted in the need for their current strategic realignment, so as to consider all the positive trends which might be on the horizon. Also, along the lines of Schwartz's approach, we wanted to anchor the underlying focal issue to encourage people to think about the relevant key factors and driving forces.

We felt that this approach worked well. Within the first two hours we had elicited well over one hundred ideas and filled four (4 x 6 feet) white boards (Figure 1). These ideas covered all realms of possibilities from “totalitarian backlash in the former Soviet Union” (22) and “nuclear attack in the Mid-East”(81) to “worldwide standards of living driving demand”(53) and “gasoline being displaced by natural gas as the transport fuel of choice”(53).

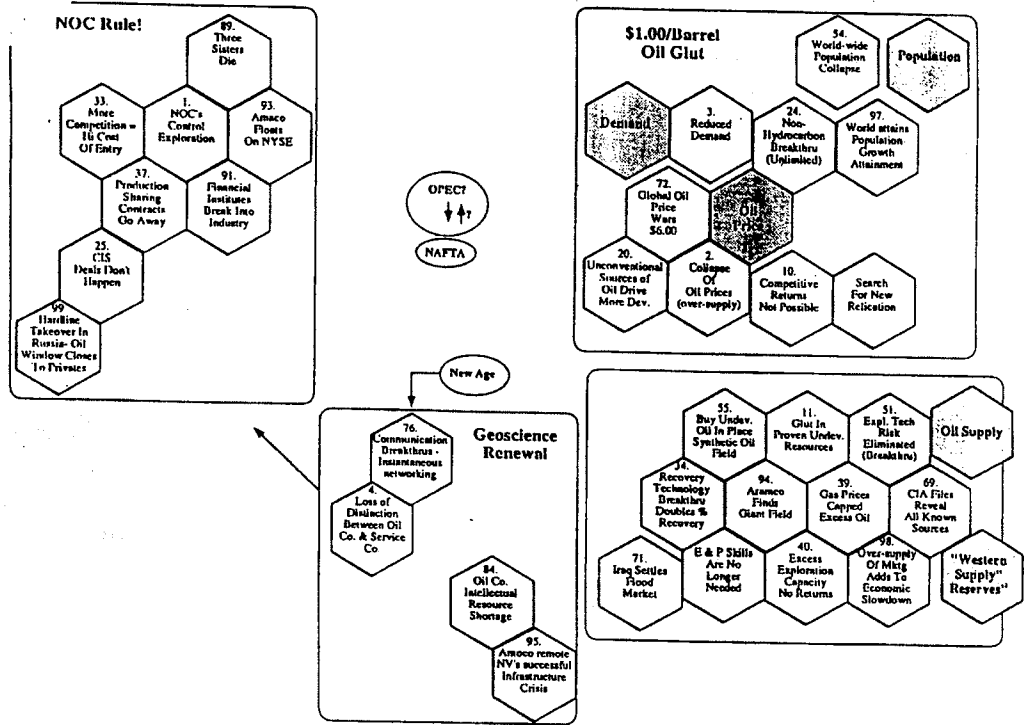


Figure 1: One of the Four White boards from the First Session

While we were very productive in generating ideas during the first half of the morning this made our task for the remaining time all the more challenging. We worked with the group to find related associations among the ideas collected. As these related “clusters” of ideas emerged we looked for an engaging name which would best represent the underlying connecting idea. Using this converging approach we were able to bring order to the collected ideas by uncovering roughly twenty clusters of related ideas.

It was at this point that we were ready to begin the search for future scenarios. We began a second hexagon process by “collapsing” each cluster of ideas to a single idea represented on its own new hexagon. We worked with this new and smaller collection of hexagons to begin a new clustering process. Rather than just looking for related associations as before, we started to group the hexagons based upon the likelihood that their underlying ideas would occur at the same time, or as a result of those ideas of the adjacent hexagons. While we were not yet looking for logical cause and effect explanations, we were finding the uncertainties that would likely evolve together.

As these new clusters emerged, we started to see the possible paths that the future might plausibly evolve toward. Five distinct scenario paths began to develop, and we had a little fun giving them creative names (Figure 2). The resulting future worlds began to be referred to as 1) Green Gas World, 2) Beyond Your Wildest Dreams, 3) The World in Turmoil, 4) NOC’s Rule and 5) Supply Glut. While we did not set out to create exactly five scenarios when we began the process, we did have a healthy discussion of what would be the appropriate number. The Amoco team talked about the fact that the planning group at Royal Dutch Shell has routinely narrowed the number of future

scenarios employed to no more than two or three so as to simplify their eventual use with their operating managers. We discussed the possibility of reducing the five scenario paths that had emerged down to two or three, but the group nearly unanimously agreed that to do so would force some separate but possibly mutually exclusive trends together and that we should stay with the all the emerging paths which they created. Our personal feeling, is that as "creators" of all the underlying ideas, the operating managers assembled did not have a problem working with five plausible scenarios and would have felt "slighted" if any had been consolidated. This contrasts with the Shell experience, whereby the external planning group creates the scenarios and the operating managers are not as familiar with all the underlying nuances and are less likely to "buy - in" or might be confused by more than a couple distinctly different alternatives.

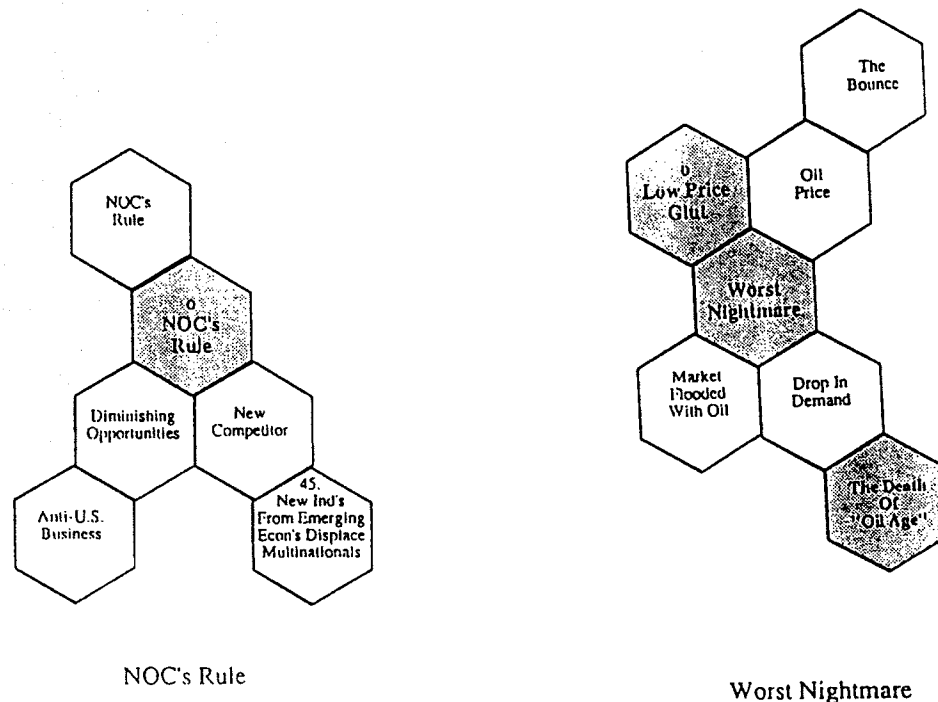


Figure 2: One of the Two White Boards from the Second Session

Envisioning the Future:

After generating a rich set of ideas on the morning of the first day, we spent the remainder of the two days fleshing out the ideas behind each of our five scenarios. We wanted to create a story for each scenario to give meaning to the underlying events. In the words of Peter Schwartz, stories have many advantages. They open people to multiple perspectives and help them cope with complexity. We worked with a team of four from within Amoco along with the two facilitators from Gould-Kreutzer Associates to create these stories as well as search for the underlying systems structure. We wanted to make certain not only that our stories sounded plausible, but we wanted to map out the logic in a causal loop diagram to uncover-and change any flaws in our thinking. Most of the team from Amoco had either been through a week long workshop of systems thinking or had been working over the previous months on a project to uncover the systems structure behind their business unit and worked well with exploring their mental models using causal loop diagrams.

As we discussed each scenario path we started writing the stories that would weave all the related events together. In one likely scenario, the supply of the world's remaining oil and gas resources becomes dominated by state-run national oil companies (NOC's) resulting in a stable supply of oil to meet increasing world demand at the detriment of the global multinational oil

companies (MNC's) who find it increasingly difficult to discover and develop resources overseas. The following is an excerpt from the "NOC's Rule" scenario:

"The new century dawns with the announcement that Aramco has purchased Exxon to gain outlet to monetize its massive oil reserves. Economic growth and stability in emerging economies have inspired many developing countries to reclaim control of country resources. As a result, many NOC's now dictate the terms on which multi-national oil companies can participate in exploration and development activities. This has resulted in the high risk, frontier basins being the only open playing fields for companies like Amoco, and even there they face fierce competition as new independent oil companies from emerging economies also pursue the remaining opportunities. The NOC's themselves have added to the competition. With access to global financial markets as well as internal funds, NOC's have started to expand regionally, focusing on countries with similar cultures and stage of economic development...."

While the length of this paper does not permit us to describe in detail the other four scenarios, the following offers the highlights:

Supply Glut - This future is characterized by the collapse of OPEC and a flooding of the markets with increased production. While this results in historic lows for oil prices and increased worldwide GDP growth and energy demand, the multinational oil companies suffer.

Green Gas World - Rising pollution and environmental restrictions limit the demand for oil and gasoline. The search for alternative fuels leads to a major conversion of automobiles to run on compressed natural gas (CNG) and a subsequent rise in the exploration and development of natural gas resources.

Beyond Your Wildest Dreams - A "New World Order" brings peace and stability to the world. Rising GDP in emerging countries creates over one billion new consumers all desiring mopeds, autos and the "conveniences" of modern society. Demand for oil and gas rises accordingly.

The World in Turmoil - Continued unrest in the Middle East sparks a new war as another dictatorship tries to dominate the region's oil supply. The resulting increase in oil prices triggers runaway inflation and interest rates reminiscent of the 1970's.

The Causal Loop Diagram:

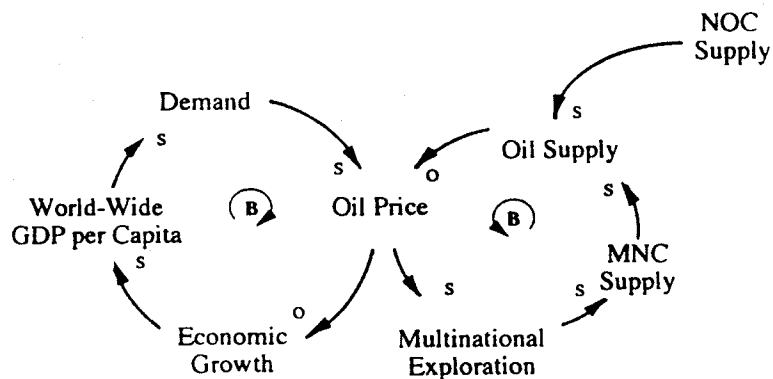


Figure 3: Adam Smith: Supply and Demand Balance Through Oil Price

With our five scenarios articulated as stories, we were able to explore the underlying dynamics in more detail. We did this by searching for the relevant reinforcing and balancing loops

which would need to be present for each scenario to occur. For this process we used a group approach to brainstorm and draw out causal loops, building upon and refining our logic as we progressed. This approach is similar to that articulated by Genta and Sokol as presented at last year's System Dynamics Conference. While space does not allow us to describe the causal loops behind all of the future's which we created, what follows is an explanation of the "NOC" s Rule" scenario.

Figure 4: Newly Emerging Economies Increase Demand

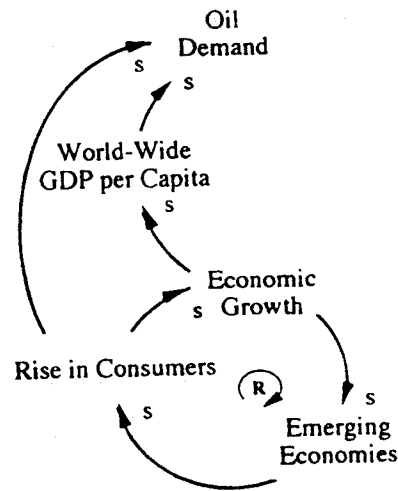


Figure 3 shows the basic law of supply and demand explained over two centuries ago by the Scottish philosopher, Adam Smith. This century has seen a dramatic rise in western economic growth spurred by the advent of the automobile and based in large part on the rise of petroleum as the dominant fuel source. Since "Colonel" Drake discovered oil in Titusville in 1859, our voracious appetite for oil has historically outstripped the industry's ability to meet demand leading to rising prices and a subsequent search for new sources of supply. As new sources of oil were brought to market, prices would fall spurring yet more economic growth..

Three trends became increasingly evident in the Post-World War II era. With the discovery of oil in the Middle East, most of the world's oil supply became increasingly held outside of the western world, first under the control of major multi-national oil companies operating overseas, and later under the control of state run national oil companies as various nations nationalized their domestic oil industries.

Figure 5: Economic Growth Leads to Stability and World Trade

Second, as North America, Japan and Western Europe's economies have matured in the later half of this century, the dominant sources of economic growth have shifted to the highly populated emerging economies of Southeast Asia and more recently to Latin America and Eastern Europe. As the economies of these rapidly developing regions grow the world is seeing a dramatic rise in the number of people who are able to escape the subsistence poverty of agricultural society to become consumers in a more urban setting. This rise in consumers is beginning to drive the demand for a broad range of products and services ranging from soap and razor blades to mopeds and air conditioning, leading to a corresponding increase in the demand for energy, particularly oil and gas (Figure 4).

Third, along with this rise in worldwide living standards, we are witnessing a revolutionary growth in the democratic political process. From the student activism of South Korea to the fall of the Berlin Wall and the break-up of the Soviet Union, the world's people are demanding participation in the political process to go hand and hand with their new found economic freedoms. As more freely elected governments come to the world scene, we hopefully should see more of a concern for economic growth and the welfare of the average citizen and a move away from militarily dominated states. This should lead to increasing world political stability and an increase in world trade (Figure 5).

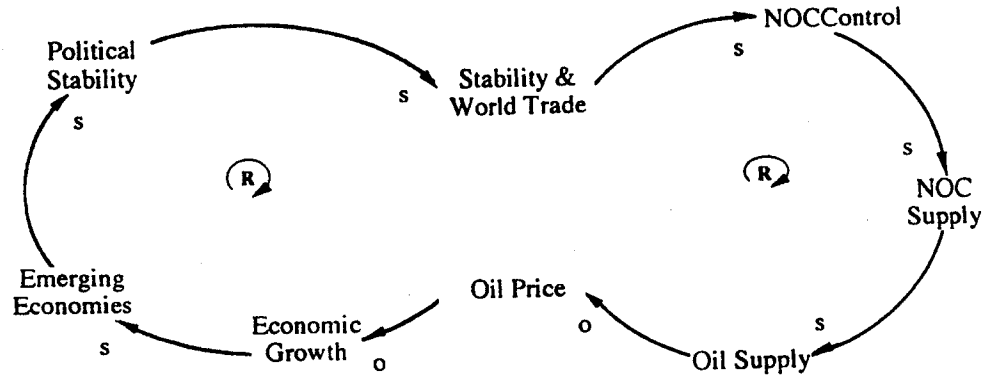


Figure 6: NOC's Rule: Stability and World Trade Puts NOCs in Control of Resources

With increasing access to capital, economic growth and stability, the emerging economies will be increasingly inspired to reclaim control of their own resources. Since the national oil companies (including those in the former Soviet Union) control more than 90 per cent of the world's oil reserves, they will be able to control its supply and ultimately the price (Figure 6).

However, this does not imply that today's multi-nationals will be shut out of the game completely. No doubt production sharing agreements as they exist today may be irrelevant in this new world order. On the bright side, with rising worldwide economic growth, more capital should become available for investment. With cheap and abundant supplies of capital, long term oil development projects should become more economically viable (Figure 6).

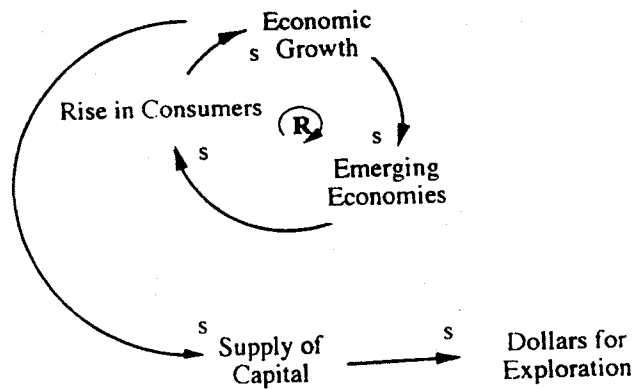


Figure 7: Rising World Economy Provides Cheap Capital for Both MNCs and NOCs

In addition, political stability and increased world trade from sustained peace and prosperity should lower the barriers to entry for emerging independent oil companies. While today's established NOCs such as Saudi Arabia's Aramco and Venezuela's PDVSA should have easy access to world capital flows and oil industry expertise, this might not be the case for the newly independent NOCs in the former Soviet Republics and the newly opened countries of Vietnam and Myanmar. As the number of new independents increases, the supply of investment capital per company will tend to diminish, encouraging these new NOCs to cooperate with today's multi-national companies to gain access to capital, technology and downstream markets. In return, the MNCs will enjoy the expansion of many new market opportunities (Figure 8).

Using the Scenarios in the Strategy Renewal Effort

With our scenarios developed, we began to introduce them back into the strategic alignment effort. First, we introduced the future stories to the participants of the original hexagon session. They were well received and as we further explained the underlying causal loop diagrams to them, we were able to get more detailed feedback to revise the industry map. Because the future scenarios were created by the team responsible for changing the strategic design of WEBG, we used them to help them to refine and select the strategic alignment options that were under consideration.

We realized that there was no way to predict which future scenario, if any, would take place. Rather, we engaged the team in debate and discussion to consider how all of the strategic options under consideration would fare under each of the five scenarios. This series of exercises proved valuable to both help more clearly define the strategic options as well as to help determine which one would be most robust under a variety of changing conditions.

With the strategic direction of WEBG defined, the team will begin to further refine and develop their industry map. As described by Peter Schwartz, the group has been gathering information, such as recent news articles, to either confirm or disprove the underlying logic of their causal loop diagrams. Similar to the way the Canadian, Athabasca University has been organizing their organizational research described by Smalldon, Mohammed, and Genta and presented at last year's System Dynamics Conference, the group has set up a "thinking room," a large conference room equipped with magnetic white boards and the ability to post notes on all the walls. Here the team has space on a large bulletin board devoted to each of the five scenarios and relevant news articles are posted next to their corresponding causal loops. In this way, the group's shared causal loop diagram is being used as an intuitive way to organize a large collection of ideas. This systemic approach to learning is proving to be a very efficient way to make sense of a range of complex phenomena ranging from the rise of alternative fuels to the opening up of Vietnam and the on-going turmoil in the former Soviet Republics.

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