

Applying a Systems Thinking Approach to Business Process Re-Engineering: A Case Study of a Canadian Oil and Gas Producer

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Abstract: This paper describes the work and experience gained by a team using a systems thinking approach to developing a microworld to support a business process re-engineering and corporate-wide reorganization of a Canadian oil and gas producer. The opportunity for this experience arose from an atmosphere of change produced during several years of depressed prices for oil and gas and the consequent need for the players in the industry to downsize. This work is intended to provide managers with a strategic management learning laboratory of a newly designed decentralized business unit.

Why did the company choose to use systems thinking?

In 1991 the company had gone through a significant restructuring as it moved from a functionally designed structure to one based on area business units. Concurrently, approximately 25% of the staff was released. The company was responding to an environment of low and declining oil and gas volumes and prices, high costs, fragmented portfolio and increased environmental clean-up costs.

The transformation effort was not only directed at changing the structure, reducing the staff count and lowering costs but also was to include a shift in the culture of the company. At that time, the organization was looking for ways to break down the barriers between the various functions in the organization, such as those between geological sciences, engineering, and financial services. The idea was that if the organization could open communications and increase team work with a business focus, the new area teams could be more responsive to change, solve problems more completely, and capture the opportunities that were available to a coordinated multi-disciplinary approach.

When the teams were formed, there were several issues that needed to be addressed. The first was the need to redesign the information system, which was designed to support the old functional organization, not the new decentralized business units. Second, there existed different, often competing, mental models of how the business operated. Third was the lack of a "common language" among the members of the new teams. The geologists spoke about the business differently from the engineers who were different from the financial people.

After the restructuring, it became clear that the business units needed to focus on a new set of performance objectives instead of the traditional focus on technical volumetric criteria that were evident in the industry before 1991. Numbers such as reserves added and volumes processed were tracked more closely than value added, cash flow and profitability.

The company began to create alignment of purpose throughout the business units by trying to be clear about its vision, purpose, values, beliefs and strategies. In order to increase this alignment the company pursued many methodologies to help support this process.

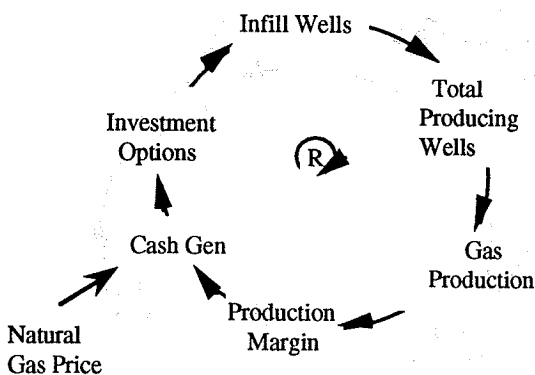
After becoming familiar with systems thinking through Peter Senge's book, The Fifth Discipline, and through several articles on the learning organization, the company participated in a workshop introducing some tools in use in the field. The use of the causal loop diagrams, the computer modeling tools, and the micro-simulation tools appeared to meet the needs of the organization. A systems thinking approach would allow managers to capture existing business assumptions and understand the robustness of various business strategies under several scenarios without risking the real business.

After the workshop, a team from one of the areas in the company decided to prototype the use of these tools to better understand the business and to look for some high leverage strategies that could significantly add value in their area.

INTENDED OUTCOMES

With the assistance of Gould-Kreutzer Associates, a small team from the business unit started to brainstorm and create a business model of the area. The participants brought the perspectives of Engineering, Earth Sciences and Finance to the group. The intended results from this work were:

- to create a common understanding of the business dynamics of the business unit
- to create an understanding of the power of different business levers that exist in the area
- to prototype the tools as support for business modeling in the company



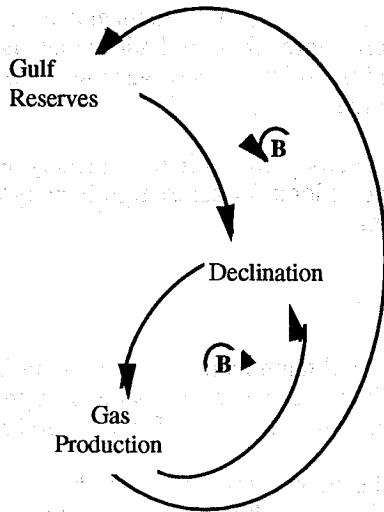
1. Drilling for Profits

THE PROCESS

The area team spent an initial five days using causal loop diagramming and "i-think" simulation software to describe the business of the area. They worked from existing corporate reports and processes, and began with a basic causal loop to explain the growth dynamics of their business: to expand production, more wells are drilled in the existing gas fields so that the rate of take can be increased. This increase in gas volumes allows for more profit and cash flow. More cash flow allows for more investment options to be considered, one of which is to drill more infill wells. This is a simple reinforcing loop.

With the "limits to growth" archetype in mind, the team knew to look for balancing loops that would restrain the continued growth of their first reinforcing loop. The reservoir engineers noted that for any given gas field, production will decline over time as reservoir pressure drops. This declination process is described in the second causal loop of the group's mental model.

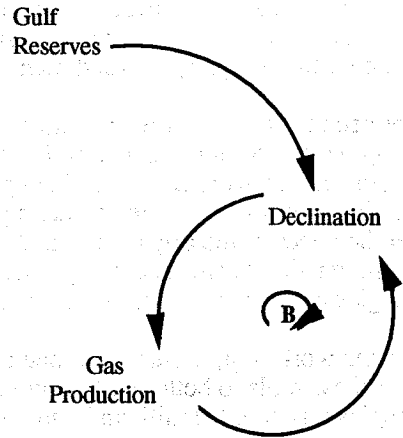
Further, it was pointed out that not only is production lost through declination, but more importantly there are finite reserves in any known field which are depleted through increased production. It was at this point that the group experienced it first "a-ha" insight,



3. Finite Reserves in the Area

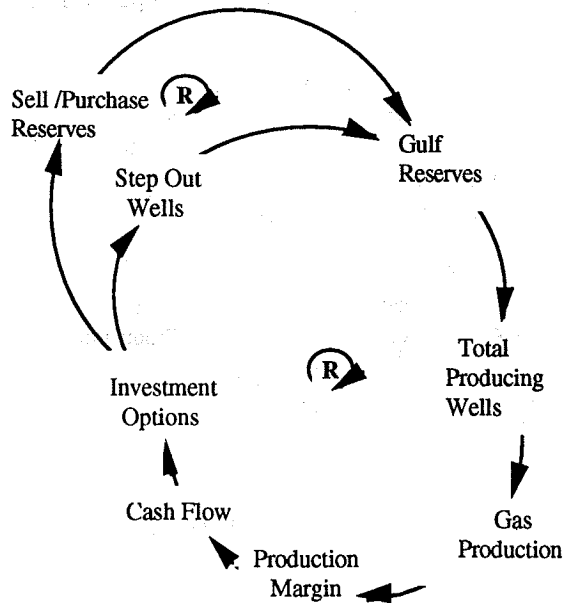
would not be a sound practice if gas prices are currently perceived to be at low historic levels.

The geologists were quick to point out that the way to increase production and profits should be through the drilling and development of exploratory step out wells which would prove out more reserves in the area and allow for more sustainable levels of production. The finance people responded that step out wells were financially risky, and suggested that the area could more readily purchase known reserves from competitors in the area or limit their risk by "farming-in" to another group's exploratory play.



2. Lost Production Over Time

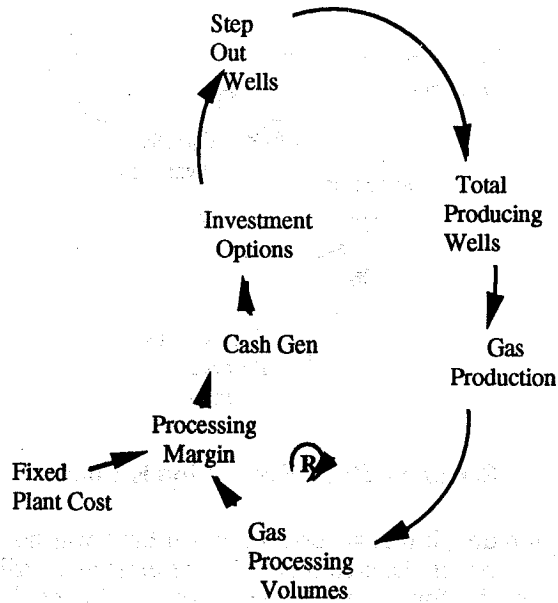
and was able to illustrate and explain that drilling more infill wells to increase cash flow was only a temporary solution. Initially production would be accelerated, but this would come at the cost of more rapid declination and lower production several years out. Production would only be shifted from later years to the current time; this



4. & 5. Replace Your Reserves

By this time, a picture began to emerge which captured the group's discussion about the production side of the business. At this point the engineer from the area's gas plant pointed out that the natural gas had no market value until it was processed at one of the three company-owned gas plants in the area.

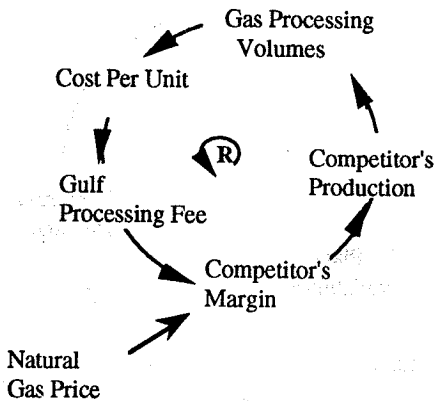
Further, since the region was in a mature stage of development, current levels of gas production were substantially below that of the peak over a decade earlier. The gas plants in the area were built to accommodate this previous level, and so were currently being operated at a fraction of their rated capacity. The gas plants have high fixed operating costs irrespective of the volume of gas processed. By increasing throughput at the plants with the same fixed costs, the operating margins of the



6. Increase Gas Plant Throughput

processing side of the business would be substantially improved.

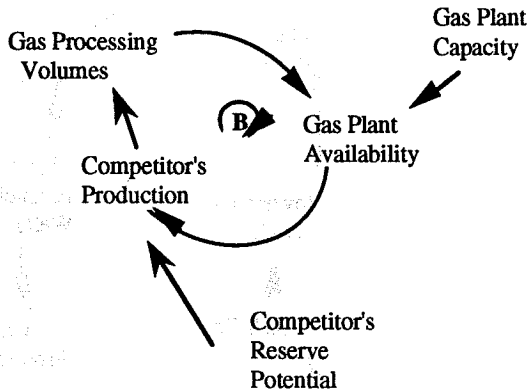
However, the group noted that the opposite had been happening. As the region matured, production volumes in the area were declining. This resulted in a higher processing cost per unit which the firm passed along to all producers in the area in the form of higher processing fees. Since the firm controlled the only processing plants in the region, and it was prohibitively expensive to build additional plants or a distribution pipeline outside the area, the firm's competitors must send their gas to the firm to be processed. With a rising processing margin and a drop in the price of natural gas, the competitor's margin was squeezed, and producers began to shut in production and withhold their gas from the market. With falling



7. Pass The Savings Through to Your Competitors

gas processing volumes at the plants, per unit costs rose further, resulting in a need to raise processing fees to the remaining customers even higher.

At this point, the group experienced another "a-ha" revelation, as they could now illustrate and articulate a problem which they had seen repeated in the past. They referred to the process as "sterilizing" an area so that no gas producers would want to expand production. They saw that they could use the structure of the system to their advantage by perhaps working with their competitors to offer lower processing fees to encourage investment in increased production in the area.

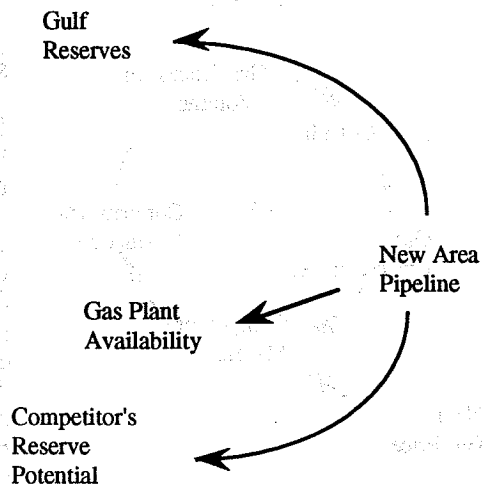


As the group's discussion became visible through the development of their causal loop diagram, additional levels of subtle argument were introduced to the process. It was pointed out that not all the plants in the area were operating at the same capacity. While it was true that the main gas plant in the area was operating at below 50% rated capacity. One of the smaller plants to the north was at full capacity. This reduced gas plant availability limited the producer's ability to develop new gas reserves. Aside from a few isolated areas of

8. Competitor's Production is Limited

exploration, it was generally felt that there was not much potential for major new gas discoveries in the area served by the existing distribution network. Whereas any discoveries found outside the network would not be economic to develop since it would be cost prohibitive to bring the gas to market.

At this point in the discussion, the advantages of a recently proposed multi-million dollar pipeline project became more readily apparent. The proposal was to connect the three existing gas plants in the area to each other in order to shut down the less efficient plants, rationalize capacity and lower overall operating expenses. In the process, more producers would be assured access to a processing plant. In addition, the proposed pipeline would open a large corridor of land for the economic exploration and development of new gas reserves.



9. Benefits of a New PipeLine

By the end of the first five days, the group generated a series of relationships that described how the balance between step out drilling, infill drilling, plant operation, pricing, and development of a pipeline contributed to the cash flow of the area. With the first pass of the model created, the group began to debate the underlying quantitative assumptions and compare the output reports from the model to recent operations reports from the area to identify that all the major components were included in their thinking. Gould-Kreutzer was charged with facilitating the group discussions, development of the quantitative model, and validating the integrity of the model from a design perspective.

In two months' time, the group met again to discuss new ideas to add to their emerging mental model. New decisions were considered and added to increase the robustness of the model. By this time there was an emerging consensus that this type of modeling process

was extremely powerful. The participants declared their understanding of the business in the area had increased over the two sessions. They reported they would consider a broader range of options with more variables than they would have before starting this process. Through the process, a number of alternative strategies for the area business unit to follow began to emerge. Initially, two alternative strategies were discussed. The first was a pure harvest strategy which argued that the area should not invest any more capital funds and should only produce the remaining gas from the existing fields. The alternative, suggested by the geologists, was to invest in new drilling in order to find and develop more gas reserves to keep the area economically viable.

As the process unfolded, a third strategy became clear. Before the group began, the gas processing side of the business was considered as a cost center necessary to support production. In fact, few people in the area even considered that a gas plant had any financial value. However, in light of a recent sale of a near-by gas plant in the province, together with an objective valuation of the cash flows associated with processing, the value of the gas plants became apparent. This led to the suggestion of developing the proposed pipeline to rationalize processing, encouraging other producers in the area to develop the potential gas reserves, and collecting a margin based on processing other producer's gas. This was dubbed the "Utility" strategy.

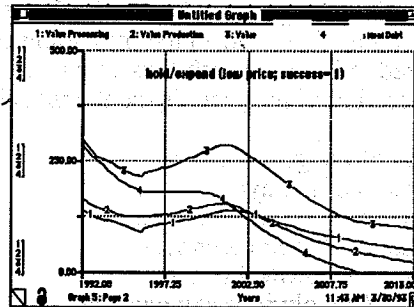
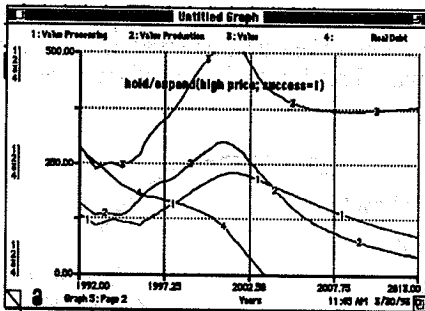
As can be seen in the following chart, the "i-think" modeling allowed the group to quantify the value created by the area in pursuing each of the proposed strategies. Since the model was not meant to predict the future, the group debated the key uncertainties about the

Hold & Expand Strategy (build pipeline in 1996, 36 step-out wells 1995-2000)

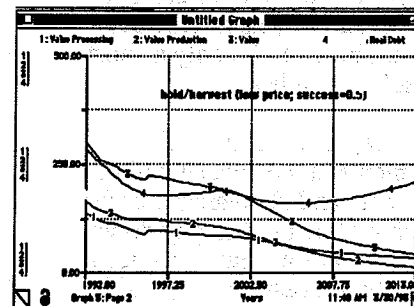
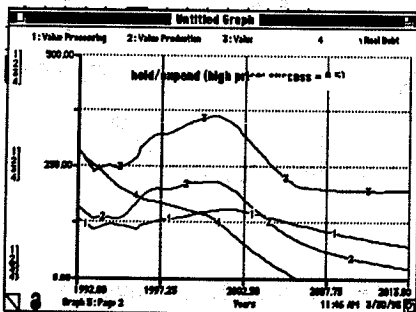
High Price

Low Price

High
Prospectivity

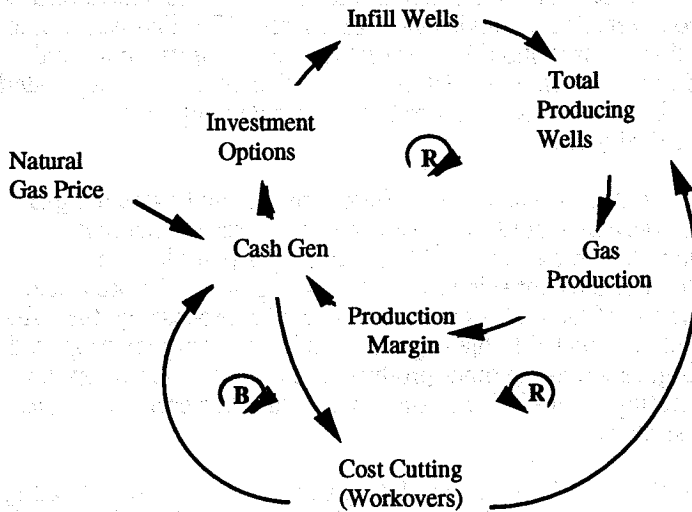


Low
Prospectivity



Typical Scenario Run

future which would have the greatest impact on the business unit. The two largest uncertainties revolved around the price forecast for natural gas (high vs. low price), and the likelihood of finding new gas reserves in the area (high vs. low prospectivity). For each possible future outcome (or scenario) the asset value of each strategy was presented for each of the next twenty years. This proved to be much more informative than simply calculating the expected net present value for each strategy, since it allowed the group to visualize the robustness of a proposed strategy by dramatizing the impact on value if the group's expected price forecast or probability of finding gas reserves failed to materialize.



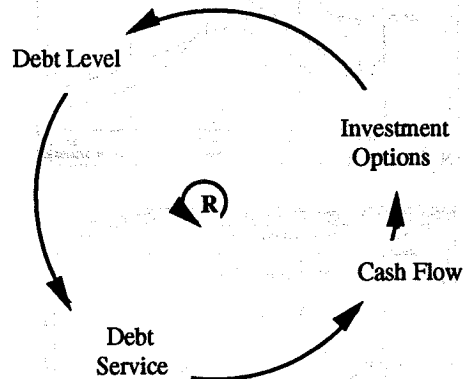
10. Cost Cutting as a Fix that Fails

expected NPV but was less robust than the utility strategy which greatly limited the firm's exposure in a low gas price scenario.

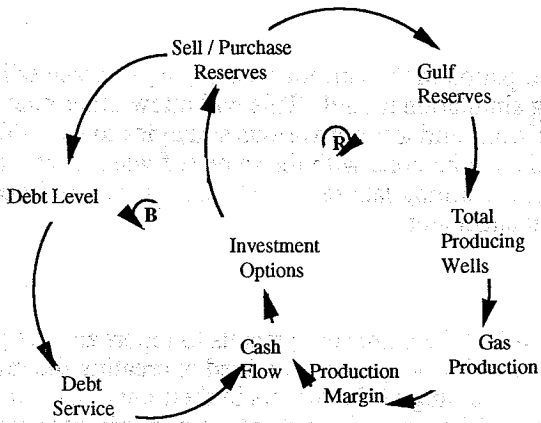
By the time the group met for a third session, they began to include the perspective of the corporation. At this level the overriding concern was the onerous level of debt in place and the need to improve cash flow to pay this down. This led to further discussion and modification of the group's mental model.

In light of the group's new awareness of the dynamics of systems, they began to critically view some of their attempts to improve cash flow through cost cutting. One obvious savings was to defer the workover of damaged wells for future years. However, this was shown to be only a short term solution at best.

One viewpoint, was that all investments in the area should be put on hold and all available cash flow should be used to pay down debt. This was primarily the idea behind the harvest strategy and is visible in the accompanying causal loop diagram.

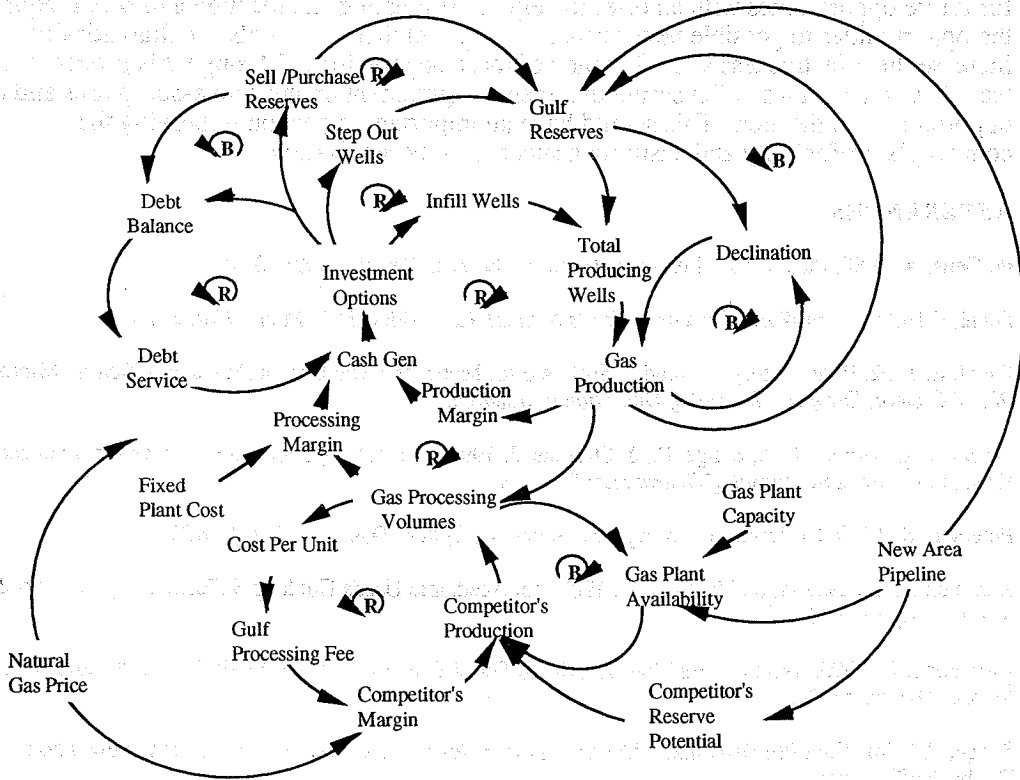


11. Pay Down Debt As an Investment Option



12. Selling Reserves to Pay Down Debt

This discussion led into the view that the only true way out of the company's debt crisis was wholesale divestment of a number of oil and gas producing properties. As can be seen in the adjoining diagram, this has the immediate benefit of providing cash to pay down debt, but does so at the expense of future production and opportunities. With the use of the modeling tools the area team has a robust method of testing this option together with the previous strategies discussed. The complete mental model that the team has developed thus far is included below.



Next Steps

In order to encourage broader participation in the current process, an interface will be combined with the group's existing simulation model. This will allow other manager's form the business unit to make decisions and test out various strategies to see which ones increase the value of the area. This will be done with the same software technology that was used to create the People Express learning laboratory which is successfully being by used at the MIT Sloan School of Management.

Conclusions

Within the first six months of this project there are some results to report and the potential results are beginning to be understood. For the people involved in creating the model there is a significant increase in their understanding of the drivers in their business and inter-links between the elements of the business. The group feels that type of participatory modeling is very powerful and can create a living document of the mental model for the area.

The original team has approached another part of the business that is trying to find partners for future opportunities with an offer to help in the creating an area model to better explain the opportunities to possible new partners. They feel that these tools can dramatically increase the effectiveness and efficiency of these negotiations. Through this process the team has created a way of ensuring that there is agreement on the core assumptions and the opportunities in the area. This should have an important impact on improving the company's profitability and ensuring a successful reorganization.

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