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Executive *Vision*

By Scott M. Shemwell

A Framework for the Strategic Cost Analysis of Information Technology in the Petroleum Industry: Part 1.

Editor's note: The energy industry needs to streamline information technology to remain competitive but struggles with quantifying the results of these efforts. This is the first in a three-part series that examines methods for determining the value of information technology strategies. Scott M. Shemwell is director of information technology for Halliburton Energy Services.

The petroleum industry is big business. All but the smallest corporations are multi-million dollar entities and many are multi-billion dollar firms. Petroleum products are critical to the national well-being and national defense of the United States.

In other words, this is an important industry; one that employs thousands of people and directly impacts the lives of millions more. It is also an industry that has faced enormous difficulties in recent years.

Is the business of a petroleum company in the 1990's to explore and produce petroleum reserves, purchase crude oil and natural gas for resale through retail channels, optimize existing petroleum reserves, or combinations thereof? Regardless of which scenario a petroleum company adheres to, it will no doubt be in a more competitive environment due to increased regulation and the unpredictable nature of oil and natural gas prices.

These companies are large users of information technology (IT)—using computers of all types and sizes to evaluate and maximize oil and gas production. As George Baker showed in his 1993 study, all companies— both domestic and international— study geologic, engineering and economic parameters when making business decisions.

Not only are hardware and soft-ware heavily used in the normal course of exploration and production but in IT-based services as well. Many argue that computer-aided exploration techniques are so successful that fundamental shifts or reengineering efforts are occurring in the way upstream business is conducted.

If this is true, then this fact is consistent with experiences in other industries, but an extensive IT program cannot be successful alone. Rather, IT is only one component of the overall re-engineering of businesses that industries must undertake to remain competitive.

Strategic Impact

It is difficult to determine the strategic impact that information technology has on a petroleum corporation. Most often, companies evaluate IT projects using short-term oriented financial models like net present value. Furthermore, subjective models are hard to quantify. Strategic cost management (SCM) is a methodology that adds quantifiable modeling to the concept of competitive strategy and the value chain. Statistical techniques can also be used to develop and simulate a strategic cost analysis model for firms in the petroleum industry.

Economic models and simulations drive the industry. Companies develop what-if scenarios constantly. For example, in a 1993 study, Salomon Brothers estimated the level of E&P spending at $24/barrel is 35% higher than spending would be at $1 8/barrel.

One scenario implies that the successful company will need to increase production while keeping its cost down, another suggests that if production is not increased, the company will need to purchase petroleum stocks to feed its refining and/or distribution networks. While another scenario indicates that economic growth in the Far East will drive the demand for petroleum the remainder of the decade.

Fundamentally, the petroleum exploration and production industry faces the classic buy-versus-build decision. In its case, find-and-produce petroleum instead of build. This is nothing more or less than any other industry faces and is a good opportunity to make use of decision support systems (DSS), modeling tools, simulations, expert systems (ES), and other computer tools.

But this decision is not simple. Most E&P companies find themselves - juggling a combination of find and buy activities. Optimizing this mix is probably the biggest challenge companies face as they try to increase petroleum reserves. They must ensure longterm access to raw materials while balancing current cash flow requirements.

IT's Role

The return on the investment in information technology has been elusive. A 1992 study by Short & Venkatraman exposes that most companies have only automated existing business processes but have not achieved desired results from their IT investments. But isn't it likely that IT could contribute to the competitiveness of companies in this unstable competitive environment?

It is widely believed that technology can lower the microeconomics long run average total cost curve for a firm or industry. If this is correct then the appropriate use of information technology can certainly contribute to a firm's strategic drive to be the low cost producer. In the March 5, 1994 edition of *The Economist* the article "Inside the empire of Exxon the unloved" explains that Exxon's longterm approach to the oil industry has been one of cost-control. It refers to a 1918 memo by Walter Teagle, the rescuer of Jersey Standard after the Standard Oil Trust was broken up, which warns of poor prices and calls for more efficiency. Since that time, Exxon's culture has relied on the use of technology to ensure that the company remained a low cost producer Mr. Teagle's memo is as appropriate in 1994 as it was in 1918.

So, how can IT contribute, can it be measured, and if it cannot be directly measured can a business model and simulation be developed to support IT's contribution?

Next issue: Various models that are used to evaluate competitive strategy.

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Executive *Vision*

By Scott M. Shemwell

A Framework for the Strategic Cost Analysis of Information Technology in the Petroleum Industry: Part II.

Editor's note: This is the second in a three-part series that examines methods for determining the value of information technology strategies. Scott M. Shemwell is director of information technology for Halliburton Energy Services.

In 1980, Mike Porter developed his classic model of industry driving forces, which is one of the methodologies companies use to attempt to evaluate investments in technological change. While this model is a good representation of the relationship between technological change and competition, it lacks the ability to conduct a formal financial analysis within an industry.

One of the key strengths of this model is the concept that firms must either strive to become the low-cost producer or find a way to differentiate their products and services from others. Using technology to reduce risk might be a way of reducing cost in the exploration and production industry. Additionally, quality and service can differentiate a firm's products and services in the market. Gasoline is basically gasoline, but people will buy one brand or the other, and in fact appear to have brand loyalty.

Porter's 1985 concept of the Value Chain augments his original model. This concept suggests that information technology should be treated as part of the corporate infrastructure. It is a thread that weaves its way throughout the entire corporation— inbound logistics, operations, and outbound logistics as well as the company's marketing, sales and services efforts. This indicates that the effects of IT might be cumulative. A small change in the input segment could have a profound impact on later divisions of the Value Chain. This model also suggests, as determined by Paul Strassman in The Business Value of Computers, that the value of IT cannot be measured directly.

Finally, the value-chain model takes into consideration structural cost drivers like complexity, experience, capacity utilization, and Total Quality Management (TQM). These drivers exist throughout the value chain. As Shank and Gouindarajan stated in 1992, technology is an important driver of cost at the critical junctures in the chain. Furthermore, technologies are interrelated and different technologies can have a profound impact on the corporate system.

Change is inevitable, and in the world of technology, change appears to be constant. Porter argues that the judicious management of technological change will lower cost or enhance differentiation and shift cost drivers in favor of a firm.

Models like Net Present Value (NPV) are insufficient when evaluating the long-term ramifications of adopting significant technological change. They place too much emphasis on short-term results, with little importance applied to long-term strategic implications.

Kaplan's model addresses the issue of deterioration of the technical base if no further investment is undertaken, as well as the tangible versus intangible benefits of the investment in technology. He recognizes that the early investment in technology can have ramifications throughout the corporation. Criticisms of Kaplan's model center on the fact that the model is fundamentally an extension of the NPV model, and although correct, it still does not adequately address strategic issues.

Prior to and after acquiring data through seismic, logging operations and other means, scientists and engineers must organize, retrieve and analyze large amounts of data quickly and efficiently. With this data in hand, these individuals develop various technical models and recommend additional exploration, development or production activities to maximize the return on the corporation's investment.

These technical models are probabilistic by nature. Any business decisions made on the basis of these models will involve an element of risk.

While even probabilistic technical models can be approximated by mathematical optimization models, the socioeconomic or corporate planning models are not so easily solved. The systems dynamics of a petroleum corporation's business model must take into consideration the lag between initial exploration, field development and refining to bring petroleum products to market. The investment can be enormous and it can take years to pay it back, let alone to make an acceptable return. One example is the North Sea, where development required billions of dollars of investment before returning a single dollar in revenue.

In this environment, economic and political considerations can and do severely impact a company's financial performance. These issues are difficult to predict or quantify, and contribute to the probabilistic and non-linear relationship between input and output in this industry.

Strategic Cost Management

Strategic Cost Management (SCM) is quantitative methodology grounded in Porter's qualitative, structural strategic thinking. This approach develops a model based on ValueChain Analysis, Cost-Driver Analysis and Competitive-Advantage Analysis. As a blend of these analyses it strongly suggest that without evaluating all three, the job is not complete.

Critical to this analysis is the understanding that value is added throughout the firm's value chain. This implies that value obtained at the beginning of the value chain can cascade through the chain. This is particularly true in the petroleum exploration industry where it has been shown that deterministic inputs only obtain probabilistic outputs.—

In the next issue we use the Strategic Cost Management model to evaluate technology benefits at 227 of the largest energy companies in the world.

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Executive *Vision*

By Scott M. Shemwell

A Framework for the Strategic Cost Analysis of Information Technology in the Petroleum Industry: Part 111.

Editor's note: This is the third and final installment in a series that examines methods for determining the value of information technology strategies. Scott M. Shemwell is director of information technology for Halliburton Energy Services.

As stated last issue, Strategic Cost Management attempts to integrate Porter's models with quantitative methodologies. The petroleum industry appears to be an appropriate industry in which to use SCM techniques.

The industry is very competitive, with numerous firms attempting to secure competitive advantage, each with different cost drivers. The buyers of the firm's goods and services are in a strong position—gasoline is a commodity. Furthermore, many IT suppliers to the industry, such as computer hardware firms, have other non-petroleum customers and are not wholly dependent upon oil and gas customers. Likewise the threat of substitution is real and apparent. Finally, IT plays a role in the firm's infrastructure throughout the Value Chain.

A spreadsheet-based financial model of the oil and gas industry was developed using data obtained from the *Oil & Gas Journal* 300 database (1992). It contains financial and other data for fiscal 1991 from the 300 largest oil and natural gas producers including: Total Assets, Total Revenue, Net Income, Return On Assets, Capital and Exploration Expenditures, Worldwide Liquids Production, Worldwide Natural Gas Production, Worldwide Net Wells Drilled, Average Crude Price, and Average Natural Gas Price. Firms with incomplete or inconclusive data were eliminated, and the final model consisted of complete data sets for 227 companies.

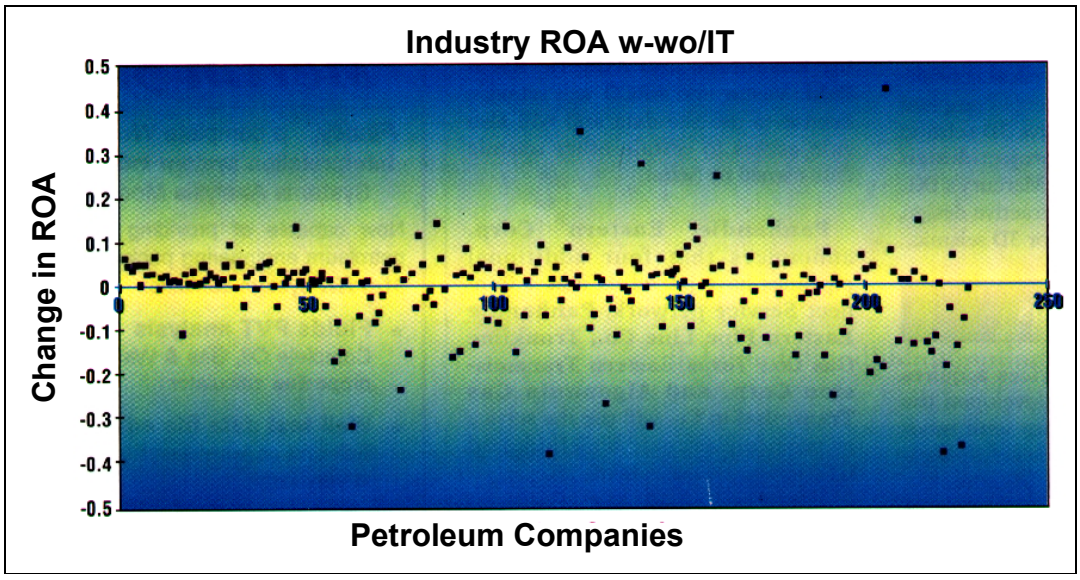

Figure 1.

Assumptions

The framework made the assumption that each firm in the industry added 1% to their Capital & Exploration Expenditures for IT. Additionally, the assumption was made that only 25% of that amount would be directly spent on computer hardware and software, the remainder was for non-asset items, like personnel, and various IT services like maintenance and training. Under this assumption, the Total Assets with IT were only increased by 0.25%. It makes no difference whether the firm owns the IT assets or outsources IT capability.

The second assumption made is that the Worldwide Liquids Production and Worldwide Natural Gas Production would each increase 1% based on the additional 1% additional spending for IT. This assumption suggests that an increased IT budget will increase overall production.

The third assumption is that the number of wells drilled will remain the same with the additional IT expenditure, and the average price the company receives for its oil and natural gas products remains constant. IT needs to have a beneficial impact on the organization's cost drivers to have a positive impact on the firm's bottom line.

Finally, the model calculates the Return On Assets with IT and the Difference in Return On Assets without IT (Figure 1). Return On Assets (ROA) was chosen as the output of the model for two reasons:

1. It was measurable based on the available data.
2. This ratio eliminates the affects of the firm's capital structure.

On the basis of the above assumptions, the model also calculated: Net Income with It, Increase Revenue Liquids with IT and Increase Revenue Natural Gas with IT.

Statistical Assumptions

While input is deterministic, we make the case that the output of any investment in this industry is probabilistic. (See previous issue.) Input may vary and since the relationship between input and output is non-linear, an input

of less than one percent may generate an output of greater than one percent.

For these reasons, both the input, Capital & Exploration Expenditures with IT, and the outputs, Liquids Production with IT and Natural Gas Production with IT were treated as normal distributions with a standard deviation of one. Future models may change the shape and standard deviations of these curves, as well as input and output values.

Computer Simulation

Once the model was developed, it needed to be tested. Implicit in any statistical model is the need to conduct a number of iterations to simulate the expected value(s) of the model. The @ *Risk* software package from Palisade, 1992, was used to perform this simulation.

The simulation conducted 500 iterations using the Latin Hypercube stratified sampling technique. This technique tends to force convergence, or stability, of a distribution using fewer samples than with Monte Carlo sampling.

The simulation generated detailed statistics for the following variables: Total Revenue with IT, Net Income with IT, ROA with IT, Capital & Exploration Expenditures with IT, Worldwide Liquids Production with IT, and Worldwide Natural Gas Production with IT.

Of specific interest is the ROA with IT. This is the output of the model that is the best indicator of the change in financial performance based on IT expenditures.

Conclusions

On the basis of the ROA with IT measure, this model suggests that the investment in IT is warranted in many cases. Small increases in ROA are significant in the large corporations evaluated. It is important to note however, that if a company has a negative ROA before IT investment, it most probably will have a negative ROA after IT investment.

The probable explanation of this circumstance lies in the strategic nature of the SCM model. The data tested in this paper represents one fiscal year. Strategic investments will not necessarily generate significant increases in the firm's financial statements immediately. Most likely, the results of this investment will manifest themselves sometime in the future.

It will be necessary to run the model using data from more than one year, adjusted for business cycle variables, to ascertain whether or not increases in ROA are universal within the industry. Actual case studies would further test the validity of the framework.

Limitations

Productivity and reduced risk are hard to measure. While these issues are addressed in the SCM methodology, they are difficult to quantify. This implies that the impact of IT can never really be predicted, but as with other infrastructure components of the firm, IT will simply contribute to the overall performance of the firm's core business units.

Also, this model and simulation can only be considered as a framework. Individuals interested in the impact of IT on a specific firm or segment of this industry may wish to conduct a more indepth analysis on this firm or segment.

Finally, the use of ROA as an indirect measure of the effectiveness of IT may not be appropriate in some cases. As firms in this industry continue to downsize, outsource, and otherwise divest themselves of assets other ratios may be more appropriate to investigate.

Summary

Given the strategic and infrastructure nature of information technology, it is very difficult to measure the return on the firm's investment in IT. Although several models have been proposed, all are lacking in some regard.

SCM methodology appears to be a valid approach to this problem. This is particularly appropriate to the petroleum industry today. This paper has presented an SCM model and petroleum industry simulation.

The results of this simulation suggest that properly deployed, IT can have a significant impact on the bottom line of firms within this industry. However, the model further suggests that there are no panaceas. A firm cannot strategically reverse a poor financial position in the short term. IT is not a cure-all. It is only another tool that a firm can utilize to help it secure strategic advantage.

There is a great deal of work to be done in this area. The framework presented here is only the outline of an approach towards solving the problem on the strategic use of information tech nology in the petroleum industry.