The Economic Value of Timely Information and Knowledge; Key to Business Process Integration Across Boundaries in the Oil & Gas Extended Value Chain

Scott M. Shemwell

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"Business and other human endeavors are bound by invisible fabrics of interrelated actions, which often take years to fully play out their effects on each other. Since we are part of that lacework ourselves, it's doubly hard to see the whole pattern of change. Instead, we tend to focus on snapshots of isolated parts of the system, and wonder why our deepest problems never seem to get solved."

-- Peter Senge, The Fifth Discipline (1990)

Executive Summary

This paper develops an integrated concept of the firmφs economic system based on timely, reliable, and valid high-level information. Across and among various components of the firmφs extended value chain, the *forward movement* as well as the *feedback* of information is the backbone for developing corporate economic value. Metrics are posited which will assist in the development of a better understanding of the value of information to the firm and its business units. The metrics are realistic and management can begin using them immediately.

The highest economic value is obtained when the firmφs extended value chain is fully engaged in the management of complex interrelated processes. These are the most difficult to manage and often cross political boundaries as well as institutional boundaries. Political issues surrounding information are not addressed in this paper explicitly; however, as will all processes politics is an implicit component.

The reader is challenged to test these hypotheses in his or her everyday environment. It is only through rigorous review and analysis in the órealô world can we all move forward in our collective quest to make better use of information to add economic value to our organizations.

Introduction

The Exploration and Production (E&P) segment has undergone significant changes over the last fifteen years. Responding to a number of strategic drivers (Treat, 1994), the industryôs reengineering and re-organizational efforts have increased the *shareholder value* of both the oil and gas companies and the myriad of supporting service companies and vendors. However, the industry still faces *one* fundamental issue that has always loomed over the bottom line; its lack of control over the *price of crude oil* and the *price of natural gas*.

Throughout the history of the oil and gas industry, product price and costs have fluctuated significantly and sometimes wildly. Successful firms understand that *strategic cost management* is the key to both short-term and long-term *return on assets* and increased shareholder value (Shank & Govindarajan, 1993). The industry and individual firms have taken significant cost out of processes through a variety of efforts including the reduction of *process cycle time*.

A business process has two attributes. A process can be contained within a discipline or collage of similar disciplines, e.g., geology and geophysics. A process can also bridge broader and more diverse boundaries, e.g., upstream ï downstream, figure 1. As one might expect, typical business / engineering - scientific process(es) cross one or more discipline boundaries. So in the real world, our task is to *optimize* or *maximize* discipline integration.

The issue of optimization versus maximization raises interesting questions. Is the oil and gas operator in the business of optimizing or maximizing the oil field asset? The answer to this question is largely a function of time. The approach to net present value (NPV) will be different, depending on the metrics.

In the simple case, and changing in todayôs environment, the asset operator and its partners expect to *own* the property throughout its life. Therefore, owners may choose to optimize production and with technological and managerial advancements perhaps the *real* economic value of the asset will increase over *life-of-field*. More realistically, an asset may be bought and sold may times throughout its life. Individual owners would therefore be more interested in maximizing their return on investment during the period of ownership.

While these are fundamentally different strategies, the impact on the need for timely and relevant information is essentially the same. Certain decisions are routinely made, and extraordinary decisions are required from time-to-time, e.g., well blowout, environmental concerns such as oil spills.

Many decisions require information from a multitude of sources emanating from different data types, e.g., geophysical, petrophysical, land, SCADA. These multi-discipline, multi-data type, and perhaps multi-time (longitudinal) information present *dynamic* challenges to management.

> *How does management wade through information overload and discern the key variables and their interrelationships, sensitivities, and impact on the* ***asset value proposition****?*

The Value Proposition of Information

We typically approach business and engineering / scientific problems from the *team* perspective. Multi or cross-discipline, diverse teams have shown to yield a better result than a single individual or single discipline can provide. One might expect that as our approach to problem solving is more *systemic*; the nature of teams will be composed of every increasing diversity.

However, teams present a new set of management problems. For instance, who should be on the team; what expertise is needed, which political minefields need to be cleared, etc.

> *How can we maximize the synergistic power that has proven to be possible through high performance teams? How can we make all teams high performance teams*? (Shemwell, in press).

Mountains of paper and electronic media have been generated trying to answer this question. It is beyond the scope of this paper to attempt to address this macro-issue in totality. We can, however, formulate one of the critical components necessary to maximize the output of a high performance, diverse team. This critical component or *critical success factor* is the appropriate generation, dissemination, and analysis of *information*. Right your asking yourself, another paper on data/information/knowledge management.

On the surface this assumption would be correct. However, it is the below the surface, latent or *structural dynamics* of the system we are interested in (Shemwell, 1997a). Structural dynamics is a new methodology put forth by the author which couples the power of marketing and econometric models (Shemwell, 1996). Its purpose is to better understand the *current of change* affecting all behavioral (man made systems). Often these currents are not readily visible to management, but can be made more visible using certain statistical and non-statistical techniques. It is only by understanding these relationships among disciplines and individuals can we realize maximum *economic value*.

Economic Value

Economic Value Analysis (EVA) is expressed in monetary terms and is defined as the difference between operating income after taxes and the opportunity cost of the equity of the business (Gouillart & Kelly, 1995). While recently employed to manage our business, as with a number of *new* business models (Shemwell, 1993), the economic value proposition dates back at least to 1890 and the work of economist, Alfred Marshall who wrote:

> *"What remains of this [owner or manager's] profits after deducting interest on his capital at the current rate may be called his earnings of undertaking or management"* (Copeland et al., 1994).

According to Copeland, et al. (1994), as a measure of *dollars of economic value*, economic profit is a function of return on capital (monetary measurement) over a single period (fiscal year).

EP = IC x (ROIC - WACC)

Where,

EP = Economic Profit

IC = Invested Capital (operating working capital + net fixed assets + other assets)

ROIC = Return on Invested Capital (Net Operating Profit Less Adjusted Taxes divided by Invested Capital or, NOPLAT / IC)

WACC = Weighted Average Cost of Capital (equity and debt)

ROIC is a better analytical tool for understanding performance than the traditional industry metric, Return on Assets (ROA), because it focuses on the true operating performance of the firm (Copeland et al., 1994). The other variables in the EP equation are robust as well and take into consideration a number of micro and macro-economic factors that are both under control of management and outside the control of management. However, both macro and micro sets of variables depend on and can be influenced by timeliness, quality, and quantity of information available to the firm.

EVA is a metric that helps managers and shareholders understand whether the worth of the firm or a business unit is growing or declining. This metric is used extensively in corporate America and is often the determining factor in individual incentive programs. Many executives have incentive plans tied to their ability, the ability of our diverse teams, and the ability of the firm itself to add economic value. Certainly top managementôs compensation and the price of the corporationôs stock are directly linked to the organizationôs ability to create economic value. Oil and gas firms are also judged against the universe of firms, not just those corporations in the oil & gas industry. All public and most private firms are competing for funds in the capital markets against the likes of Coca-Cola, Microsoft, etc. At this level it is not satisfactory to just be better at our jobs than our competitor, we must be competitive with everyone else as well.

Economics of Marginal Information

Against the background and criteria of EVA, firms are making decisions every day. Most E&P organizations are augmenting the decision making process with new information, e.g., additional well logs, 4D seismic, new market data, etc. This introduces a new concept, the *expected value of marginal information*, EVMI. Readers should note that we are using the economic definition of *marginal utility; the amount of satisfaction obtained from consumption of the last unit of a good or service* (Rutherford, 1995).

Thus, from Ragsdale (1995) additional information, when added to the firmôs estimate of the probabilities associated with the uncertain outcome of a decision can be expressed as follows:

$$\textbf{EVMI} = \left(\begin{array}{l} \textbf{Expected value of the best} \\ \textbf{decision } \textbf{\textit{with}} \textbf{ new} \\ \textbf{information (obtained at no} \\ \textbf{cost)} \end{array} \right) \textbf{ minus } \left(\begin{array}{l} \textbf{Expected value of the} \\ \textbf{best decision } \textbf{\textit{without}} \\ \textbf{new information} \end{array} \right)$$

EVMI represents the probabilistic maximum *cost* of new information to the decision process. As long as the real cost of new information does not exceed EVMI then the information is adding economic value to the firm. In other words, it is the threshold value proposition or NPV (net present value) =0 for new information.

An NPV in excess of the marginal utility of information represents economic value to the firm.

For example, if the expected cost of new seismic information (acquisition, processing, interpretation, etc.) is $1,000,000 then the economic profit to the firm must exceed this cost. It is beyond the scope of this paper to develop these mathematics, but interested readers can *plug* their own variables into the above equations and see if a project is adding *dollars of economic value* to their firm. Be forewarned, there is an element of subjective analysis involved in this process; it is not a strictly mechanical expertise.

Comparative Advantage

Organizations spend considerable sums acquiring, analyzing, and archiving data and information. Whether they consciously know it or not, they are seeking to obtain *comparative* as opposed to competitive advantage through asymmetric information, or that information that the firm exclusively holds. Asymmetric information is a source of value to the firm and should be jealously guarded.

Comparative advantage is structural by nature. It is developed as part of a firm's core competency and are the actions taken based on asymmetric information the organization possesses about its customers, processes, assets (capital and labor), and markets.

Asymmetric information has value and is acquired at a cost. However, in and of itself it has no economic value. Only when acted upon can the organization realize the value. Asymmetric information is not confined to one process or even one set of interrelated processes, it often manifests itself throughout the firmôs value chain. Likewise, information obtained in various segments of the value chain may be of interest to those whose value creation took place earlier in the process.

Physical (mechanical and biological) and economic systems depend on *feedback* or that information and knowledge generated later in the cycle to improve or fine tune the process(es). The concept of *continuous improvement*, one that we are all familiar with is an example of the feedback or *learning* process.

Inside the Box / Outside the Box

Another buzzword from the 90ôs. Letôs think outside the box ï again! Skeptical, well you should be. However, as with structural dynamic forces, this statement is not what it seems.

Most of our daily business activity revolves around a set of repeatable, understandable processes. Occasionally, such as when firms re-engineer, fundamental changes take place, but quickly we reach a state of quasi-equilibria that can include ócontinuous improvementô. We will refer to this state of economic equilibria as *inside-the-box*. Business units are adding stakeholder value every day this way. Likewise, there is another group in the firm operating in a similar fashion.

What happens when we put these two boxes together? What happens when we integrate *N* boxes? Potentially, significant *outside-the-box* or multi-box economic value!

The integrated oil & gas firm is composed of a series of interrelated, interdependent, *boxes* that is often referred to as the value chain. Other oil & gas firms, E&P service companies, downstream operations, etc. participate in segments of the industry value chain, figure 1, and will have value chains of their own.

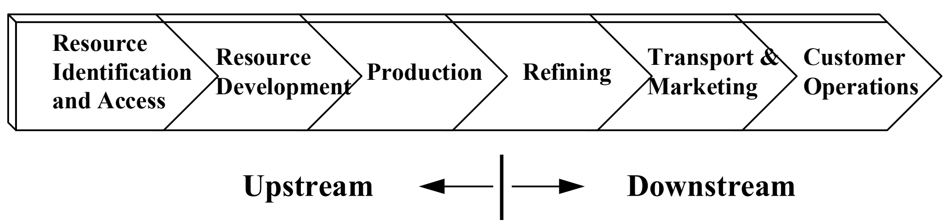

Figure 1. ï Oil & Gas Firm Value Chain

For our purposes, we will treat each six segments of the industry value chain as a ôboxô. The astute reader will note that these are indeed big boxes, which contain a number of boxes of their own. Within each sub-box, there are another hierarchy of boxes, etc. This is exactly the point!

Forrester (1961), as later supported by Senge (1990) and others viewed business processes as systems. Not unlike the way engineers view technical problems as systems, complete with *feedback* loops. As a student of the systems school of marketing, these issues were understood by Porter (1980) when he developed his value chain model, figure 2.

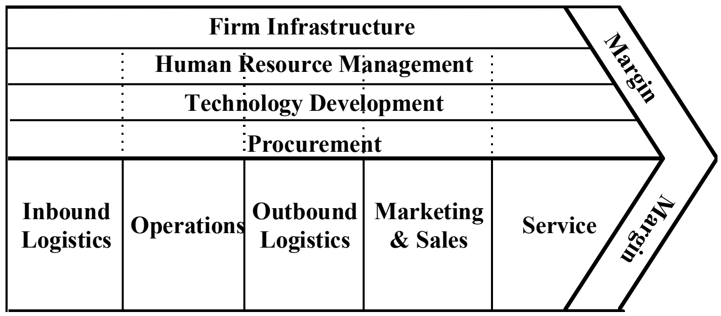

Figure 2. ï Generic Value Chain (Porter, 1980).

Porter also understood the role of information as value is added through each step in the process. This aspect is shown in the upper portion of the model, figure 2, and is considered to co-exist in Firm Infrastructure, Human Resource Management, Technology Development, and Procurement as well as the linear lower half of the model. In reality, all processes in the firm rely on information management to fulfill their function(s).

From a system or nesting of systems perspective, we might view the value chain with a different lens. The firm exists in a universe of firms or industry / industries. The industry is also ótouchedô by suppliers who are not directly part of the industry value chain. For example, from the information technology perspective, the computer hardware suppliers to the oil & gas industry are not typically seen as part of the industry, but rather as part of the computer hardware industry supplying goods and services to firms in oil & gas and other industries. One might view the relationship of an industry with other industries as a set of interconnected and overlapping processes, figure 3.

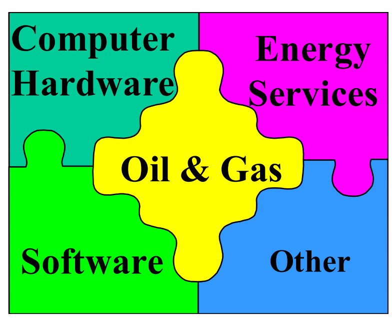

Figure 3. -- Multi-Industry Dependencies

Just-in-Time manufacturing is an example of process, company, and industry dependency. In the oil and gas industry the energy services segment and the operators are increasing intertwining activities. We see an increasing number of alliances, joint ventures, and prime contractor relationships where processes, even *core processes* are integrated across corporate boundaries. Most expect this trend to continue.

Information Driven – Process Integration Model

Most readers will be familiar with the concept of process reengineering and the *enabling role of information technology* that has been in vogue in the oil & gas industry for several years.

> *It is the 'disruptive' power of technology, its ability to break the rules that limit how we conduct our work, that makes it critical to companies looking for competitive advantage.* (Hammer & Champy, 1993).

However, we are still struggling to measure the value of information technology (Melloan, 1997). Perhaps as Melloan argues we have yet to see the payoff of this huge investment or perhaps we are measuring the wrong things.

Almost no one would argue that we should turn in our personal computers, and have our administrative assistants take dictation, make three carbon copies, and put critical information into the company mail system. Today, we e-mail or overnight almost everything (Shemwell, 1997b). Certainly the reengineering process has begun, but perhaps we will undergo *several stages of continuous improvement* under the reengineering umbrella before we see the long sought after *payoff* of our investment in information technology.

The concept of systems integration is well established, in the E&P industry segment, the major software systems suppliers, GeoQuest and Landmark both offer technology for managing diverse data types. As a result of analyses using these systems as well as others such as SAP financials, supply chain, SCADA, etc., operators develop an understanding of the performance characteristics of their oil & gas assets. Typically, a multi-discipline asset management team is responsible for these decisions.

We all suffer from information overload and struggle to make sense of the mountains of data our firm's generate. Data warehousing and data mining technologies are attempts to capture and make sense from the raw data and primitive information. However, these technologies are somewhat static and to-date have had limited application in the E&P segment.

New Perspective

If we take a system's view of our process and those interconnected processes we can begin to develop an understanding of the impact our process make on other processes and vice versa. Figure 4, suggest a model that includes several processes within the firm as well as relationships and dependencies on suppliers and customers.

As shown in figure 1, the oil & gas industry is composed of several segments, each with a number of internal processes; however, greater economic value is realized when multiple processes are integrated together. A case can be made that without integration, individual processes have limited if any economic value. Seismic spec data has no value if no operator has interest in the geographical location where it was shot.

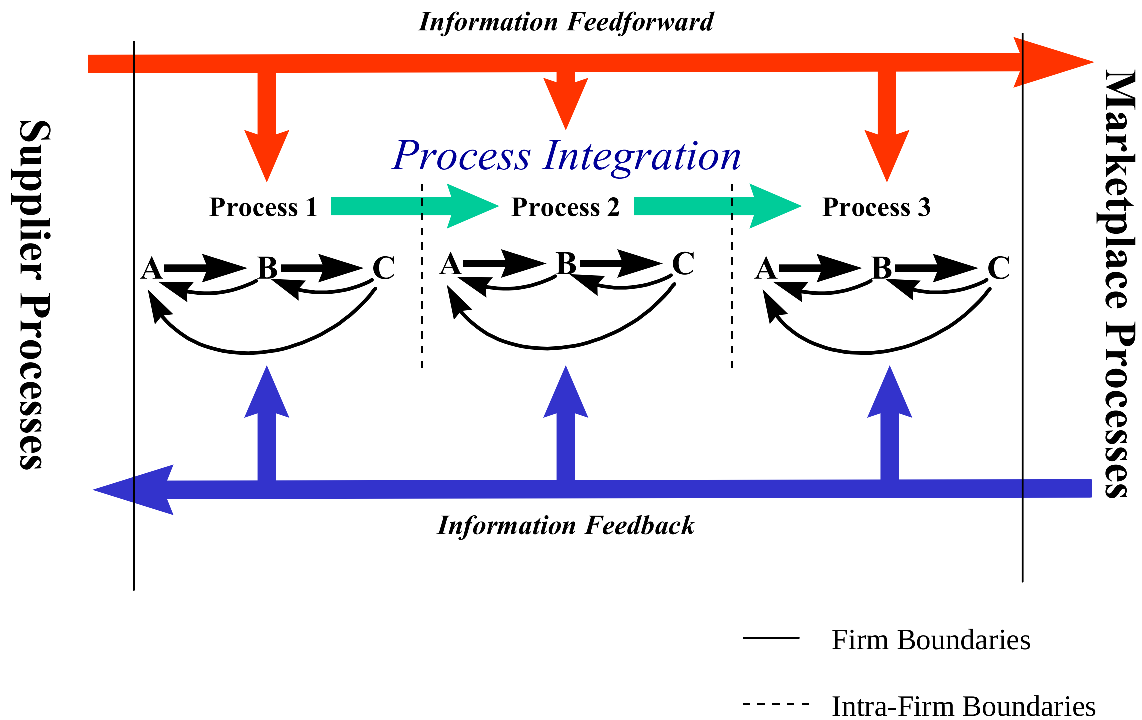

Figure 4. ï Information Based Extended Value Chain

This model of the firm adds *multi-dimension information* flow to the typical approach to the value chain analysis, figure 4.

> *Complex, multi-discipline, multi-data type, multi-directional, and perhaps longitudinal information that add economic value to multi-components of a firm's extended value chain.*

While this adds a level of complexity to our analysis, the expected economic profit should be higher as a result.

Each process owner acquires, processes, and analyzes data he or she deems appropriate and necessary to make good decisions. Often data and information are shared among processes, e.g., well logs. Process owners also attempt to add incremental economic value to the overall firm. The information *content* of the economic value proposition is more than just the sum or synergy of data, information, even knowledge associated with the process, it is *economic marginal utility* contribution the process adds. The information associated with the economic proposition takes many high level forms, e.g., reservoir model as input into surface facility infrastructure design.

High-level as well as required data and low-level information from one process is often required by adjacent or affiliated processes. Usually, the processes are outside the individual process ownerôs box. Furthermore, only selective or filtered information and data are required, albeit in a timely manner. Often important information must *feedforward* to downstream processes (those that come afterwards in a chronological or engineering order). Information flow in this direction is as important as the better understood *feedback* mechanism.

There are ultimately two methods of evaluating this model; perhaps a combination of the two as well. Most managers will rightly analyze the model based on experience or ógut feelô. This approach will yield some insight, but not necessarily a comprehensive view. Advanced statistical techniques and computer modeling techniques (Shemwell, 1996) may be appropriate. However, these are the subjects of future research and journal articles.

Conclusion

We live in an increasingly complex world of interrelated and interdependent processes. Process owners and decision makers require the right information, at the right place, and the right time (Shemwell & Rueff, 1996).

This paper presents an integrated *information based* economic and process model. The author asserts that this model will assist management maximize definable and hence measurable value throughout the firm◌̂s integrated and extended value chain. Shared information is the fundamental premise upon which this model is built. Furthermore, the model suggests that the feedforward and feedback of high-level information are critical success factors; certain value is not obtained if either one or both these functions are not understood and/or not implemented.

Information is generated and captured throughout an asset life cycle. Appropriate and timely feedforward and feedback is essential if maximum value is to be captured. Delays in time sensitive information not only does not add value, but may actually subtract value.

This paper is one more data point in the continuing discussion the industry is engaged in finding ways to increase the return on invested capital employed our shareholders demand. The information era is only several decades old. According the economist Paul David of Stanford University it took 40 years from the invention of the electric dynamo to see the *real* increase in productivity (Melloan, 1997). It is hoped that dialogues such as the one posited in this paper will hasten the implementation of information management into productivity metrics.

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About the Author:

Scott Shemwell is the Director of Oil and Gas at MCI Systemhouse. He has over 20 years experience in Information Management, International Business, and Executive Management in the petroleum industry, and has written extensively on a variety of management subjects. He holds a BS in Physics, an MBA, and a Doctorate in Business Administration.

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