Final Draft

A 'VALUE-ADD' ANALYSIS OF THE INFORMATION EXCHANGE LOOP BETWEEN OIL & GAS SERVICE COMPANIES AND EXPLORATION & PRODUCTION COMPANIES: (*The Service Company's Perspective*)

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Abstract

Traditionally, energy service companies provided data acquisition and some amount of data processing and interpretation. Once provided to the operator, data was closely held within the E&P organization. The real 'value add,' the decision support system (DSS), was the operator's sole domain.

Today, the industry is asking the service segment to augment its acquisition capability with data management and information exchange. The partnerships and alliances that are developing between operators and service providers demand that both organizations have equal access to data as part of the joint decision process. Often these transactions use new technologies such as the Internet.

The E&P industry has large amounts of data from a variety of sources and legacies. These data are in a variety of formats and frequently in multiple locations. In-house data is often augmented with third party data.

There are several well-publicized efforts underway to create geoscience data banks; however, engineering data has largely been excluded from these processes. The development of engineering databanks will enable petroleum engineers to employ advanced statistical techniques in the management of the reservoir. Finally, reservoir probabilistic computer models will be enhanced by the marriage of geoscience and engineering data.

It is a substantial task to gather and process all the data types required for computerized reservoir management; however, the industry must develop this capability if it is to reduce the 'total cost' of reservoir management, and increase the overall productivity of E&P technical processes. These endeavors will require alliances between E&P organizations, energy service corporations, information technology organizations, and data providers.

E&P decision support systems of the future will be jointly managed by E&P organizations and energy service companies. These companies will use mutual data and information, facilitating and increasing the inter-dependence between these organizations as they cooperatively seek to optimize the performance of the reservoir.

Value of Information

"Knowledge is power." We have all heard this statement from our childhood until the present. We need good information to make good decisions, or suffer from the old computer parlance - 'garbage in ➡ garbage out'. Our world today increasingly bombards us with more and more data and information. So much so, that it is often impossible to make good decisions. Often, for all the information we have we still don't have enough, in the right format, at the right place, and at the right time. And there are vital pieces missing.

There are many terms used to describe the processes discussed in this paper. The Exploration and Production (E&P) industry usually defines these processes loosely as '*data management*'. Others may call it information management, usually in practice there is not much difference between the two.

E&P Information Value Chain

Like most business processes, there is a value chain associated with data or information management, Figure 1. Initially, data is acquired by some means such as well logging, seismic acquisition, SCADA, or other. This raw data is transformed into information through various processing techniques. The resultant information when coupled with the *core competency* of the individual or the organization transforms primitive information into knowledge.

In the E&P industry, reservoir *knowledge* is typically obtained as the result of extensive analysis on the part of a team of professionals which includes geoscientists, engineers, and third party personnel. The accumulated knowledge of this and other groups becomes the corporate *wisdom* concerning petroleum oil and gas reservoir assets. This wisdom is a precious commodity and can easily be lost as the result of major corporate earthquakes such a re-organization, or small earthquakes such as the retirement of a key individual.

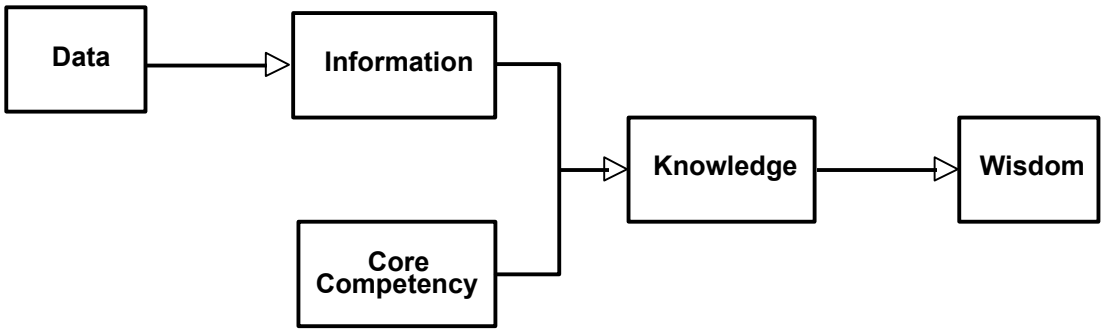


Figure 1. - Information Value Chain

Organizations are realizing that protecting and growing asset wisdom is a core business process. However, major components of the information value chain are deemed not to be in the core business.

Increasingly, the industry is looking to the energy services segment to handle not only the acquisition and initial processing of data, but to take on additional data management functions. These functions include the building and managing of databases; voice and data communication systems; data processing, interpretation, and reservoir characterization centers; and a variety of associated data and information management services.

These systemic-industry changes are already evident. Energy service companies are active in all parts of the E&P industry information value chain. Strategic alliances, outsourcing, and other management vehicles, the bonds that integrate the E&P company with multiple service providers, grow stronger every day. Many of these activities have been traditionally operated by E&P companies, not energy services companies. Aldrich and Tey (1994) refer to these *Meta-industry alliances* as *business transformation*.

Business transformation is defined as the *reframing* of corporate responses to external drivers, *restructure* of organizational efforts towards future customer needs as opposed to singularly addressing present concerns, *revitalizing* the business by leveraging core competencies, and *renewing* the firm at an ever-increasing rate.

Information Feedback Loop

In reality, the value chain is actually a feedback loop. Successful organizations are constantly learning (Senge, 1990). New data is transformed into new information, and when coupled with existing/changing core competency generates new knowledge. When the new knowledge is added to the existing knowledge base, the accumulated knowledge base or wisdom enables the company or team to make better decisions. Often this new insight recognizes the need for additional data, and thus additional data acquisition services are required, and the cycle repeats itself, Figure 2.

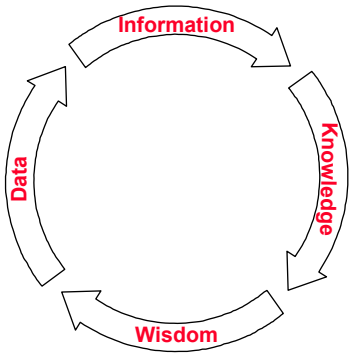


Figure 2. - Information Feedback Loop

The concept of the feedback loop is important, and often disregarded in value chain analyses. The true value in the E & P decision analysis is the ability to learn and implement this new learning in future decisions. This is the way that this industry reduces its Total Costs (Shank & Govindarajan, 1993) of operations and drives towards asset 'optimization'.

Bottlenecks in the flow of information potentially degrade the quality of the decision making process. Traditionally, departments and geoscience/engineering groups have been separate entities; the linear view of the value chain. Increasing the flow of information among those individuals and entities which depend on the output of a previous stage in the process is the main ingredient to making better decisions, Figure 3 (Campbell, et al, 1987).

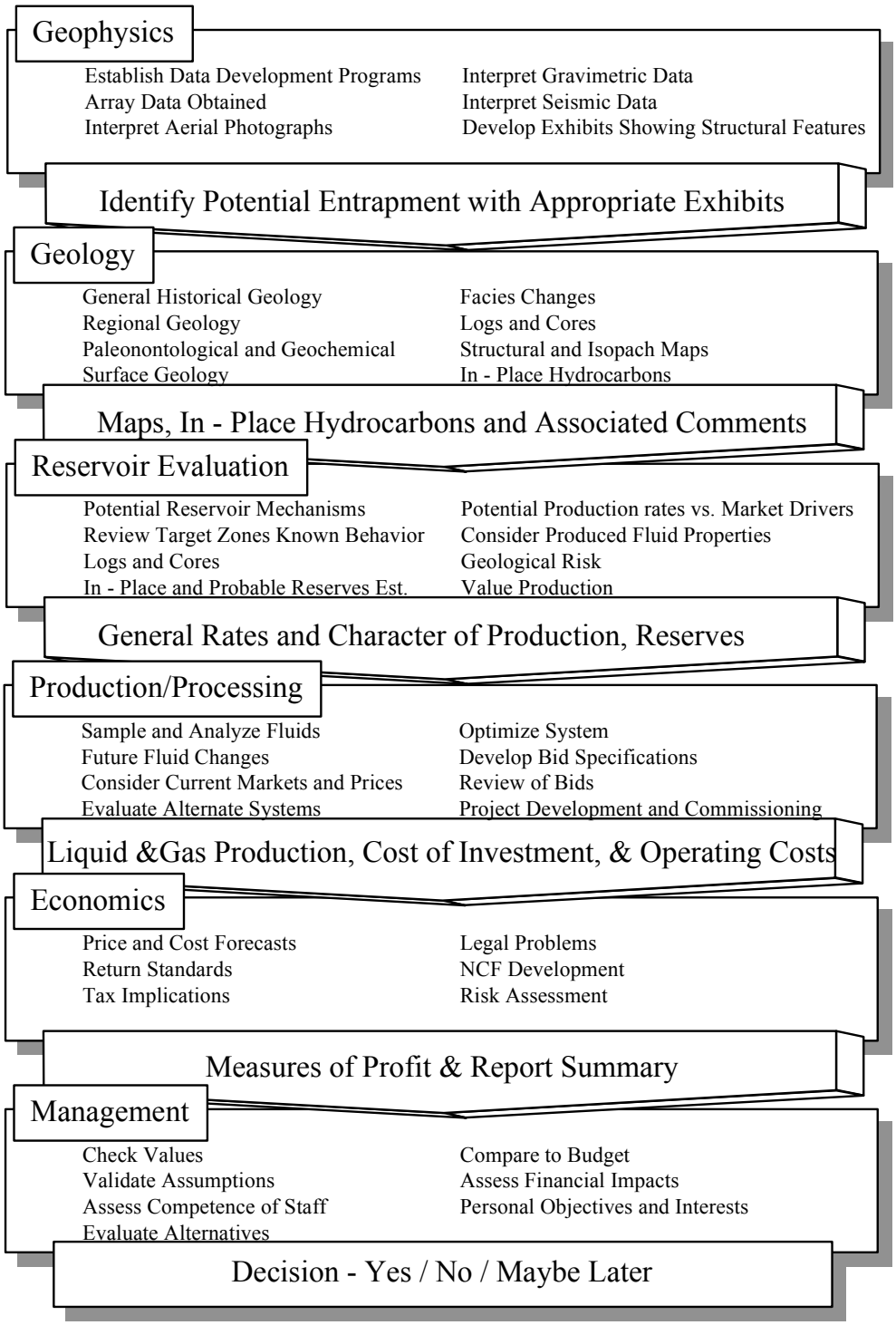
Synergistic Power of Information

Assessing risk in this complex industry is also a complicated and difficult task (Newendorp, 1975), and an integral part of oil and gas asset management, but historically, the industry has attempted to make these decisions in a simplistic manner. According to (Campbell, et al, 1987):

> Many reasons exist for the reluctance to address project risk without bias. One cause is merely that professionals *concentrate on the topics they are interested in and make the calculations they know how to make*. (p. 358)

Reengineering principles (Hammer & Champy, 1993) suggest that companies: combine several jobs into one, push the decision making processes lower into the organization, perform steps in the natural order rather than as prescribed, understand that processes have multiple versions and economies of scale, perform work where it most makes sense to do it, reduce checks and controls, minimize non-value adding work such as reconciliation, empower project managers, and combine the advantages of centralized and decentralized operations. Re-engineering consultants frequently speak of information technology as the enabler in these processes, but it is the *disruptive* power of this technology and its ability to break the rules on how we work that makes it the critical component in an organization's quest for competitive advantage.

Today, most E&P organizations are moving reservoir decision processes to multidisciplinary asset teams (Gochnour, 1996) and capitalizing on the power of reengineering. Some organizations have begun the process of truly transforming their operations, integrating the full capabilities of the energy service company and moving well beyond the point of using information as an enabler. These companies are maximizing the value of information in all its forms and from many sources to reduce the total cost of asset management and optimize performance. For these companies, 'knowledge is power'.



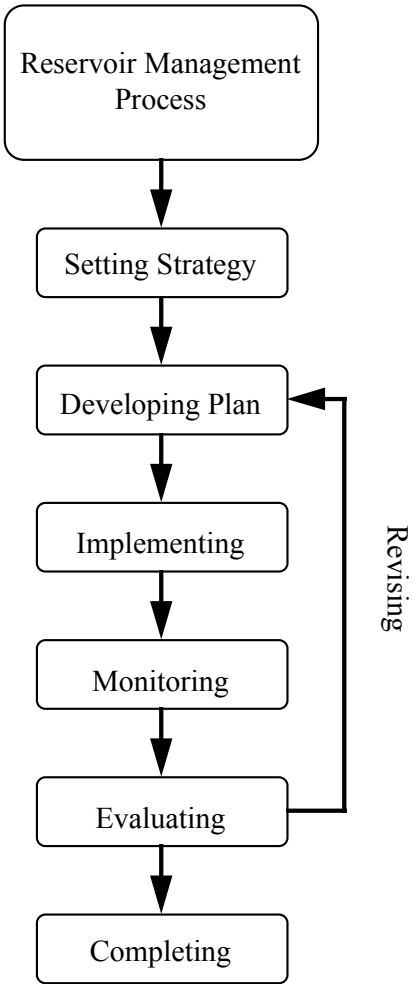
Source: (Campbell, et al, 1987) p. 360

Figure 3 - Transfer of information between disciplines

Reservoir Information Management

Thakur (1996), and others provide well documented treatises on current industry thinking of *integrated reservoir management*. Sound reservoir management integrates and maximizes financial, technological, and human resources with the intent of minimizing CAPEX (capital expenditures) and OPEX (operating expenditures) while maximizing economic recovery from the reservoir asset. Sound reservoir management from the beginning throughout the asset life cycle is the key to successful operation.

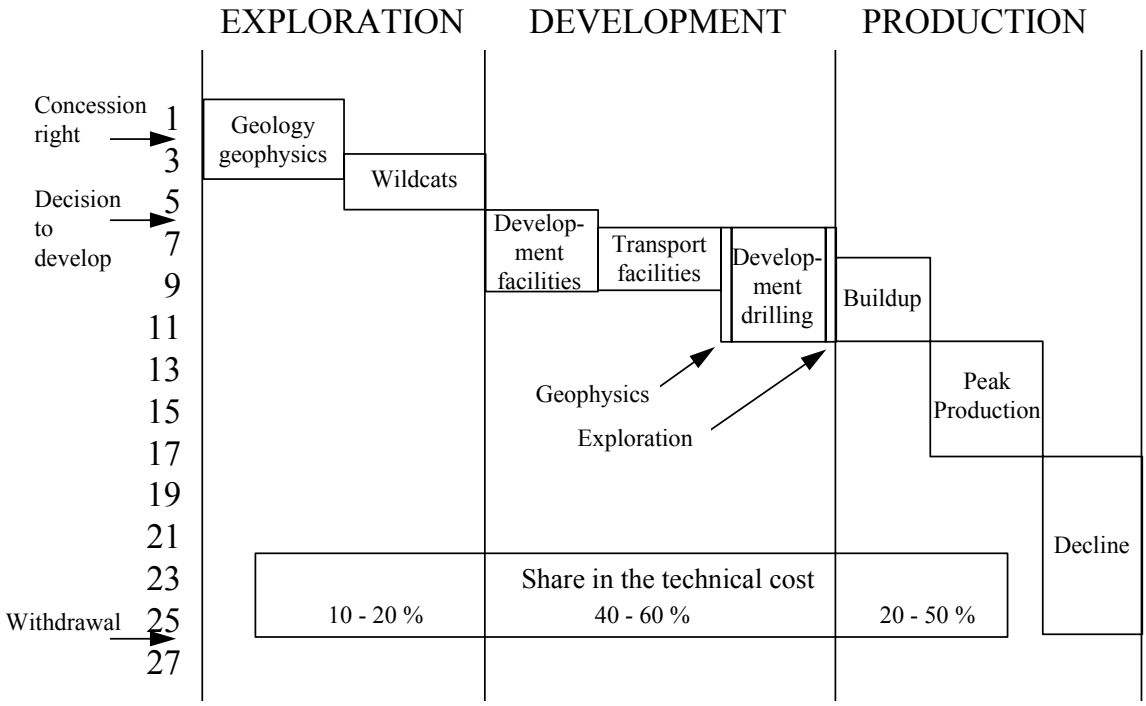
Satter, et al. (1994), represents the reservoir management process as an iterative, information intensive set of integrated processes, Figure 4. This process is best represented by the Reinforcing Process described by Senge (1990). Each step in the overall process is reinforced by the result of the previous process. Feedback loops between each set of processes provide adjustment to output of previous processes, and so forth and so on. The end result is a more effective decision.



Source: (Satter, et al., 1994)

Figure 4 - Reservoir Management Process

The technical cost of reservoir management is borne across the life-cycle of the field, Figure 5 (Masseron, 1990). At different stages of the life-cycle, different data and information dynamics are needed. To-date, much of the industry focus has been on seismic and well log data management. While this is a substantial volume of data, it is a relatively small percentage of the overall data needs of the reservoir asset team. Data and information types and needs change throughout the exploration, development, and production stages.



Source: (Masseron, 1990) p. 98

Figure 5. - Field Production Schedule

Data Management

The original focus of E&P data management has been on the G&G (Geophysical and Geological) workstation, i.e., Landmark Graphics, Geoquest. This was largely driven by the needs of the geoscience industry segment with its very large 3D seismic data sets and well logs. While this is an important element of the overall data management problem, it represents no more than 20 -30 percent of the problem. As shown in Figure 5 above, up to 20 percent of the geophysical problem is in exploration with a small geographical activity during the development phase.

While recent industry activities are integrating geophysical data acquisition, processing, and interpretation into the development and production phases, e.g. 4D

seismic, this is still an area of 'data chaos'. Data chaos is defined as the current, normal, random state of scientific and engineering data in the industry today.

Most often, the computer industry defines data as various forms of digital media and cataloged 'hard copy' or paper based media which will ultimately be transformed into an electronic format. This is most certainly the case in the oil and gas industry today.

Most definitions of data management focus on the processes of administering and storing low level electronic and other media. Today, E&P data management is focused on the process of adding value through each step of the value chain from the point of acquisition throughout all oilfield decision processes. This approach is a significant departure from the traditional concept of data management. With a locus on adding value, E&P data management has been redefined.

No longer is data management an information technology problem (Keen, 1991). Now it is a fundamental process of the core business of E&P organizations and very important to the success of projects (Thakur, 1996). This re-definition of the data management enigma is a structural dynamic (Shemwell, 1996) approach towards reducing the overall costs, and increasing productivity (value add).

Structural dynamics is a concept which suggests that the underlying structure of an industry or organization is not static. Rather, in much the way the earth is composed of a series of tectonic plates whose movement is generally unobserved and is only noticeable to the lay person during earthquakes. Over time, data management has emerged not as an enabler, but as a driver of total cost management and asset optimization.

Asset managers are also interested in moving data from the point of acquisition or storage to wherever and to whoever needs it, Figure 6. The industry is using all available communication technologies available, i.e., the AIRES high bandwidth satellite project, and the Internet. This field is changing rapidly. Where once it was necessary to fly seismic tapes from the field to processing centers, now it is possible to transmit 2D seismic data directly from the boat by satellite to anywhere in the world. Additionally, well logs and other data types are routinely transmitted over the Internet.

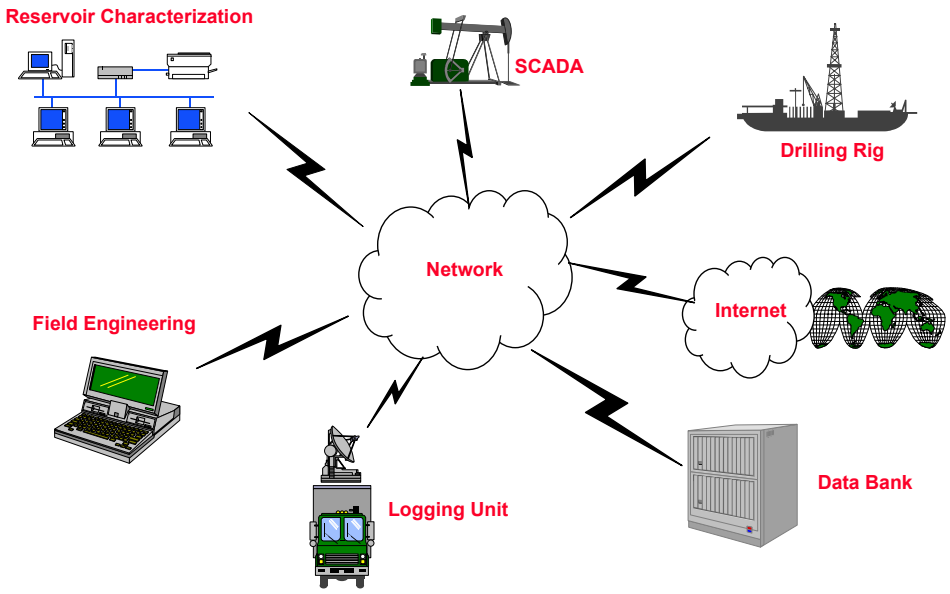


Figure 6. - Data Movement

The concept of the databank is new; previously data was archived in various formats, i.e, paper, magnetic tape, mylar, etc. The E&P databank is the computerized repository of technical data necessary to manage the oil and gas business. Databanks are usually large, in the order of 100 or more terabytes (2^{40} or 1,099,511,627,766 bytes equals one terabyte). To put this into perceptive, the current gigabyte disk drive on today's personal computers is one billion bytes or 2^{9}.

As with most data and information driven processes in the E&P industry, databanks were initially developed for seismic and well log data types. Future databanks will incorporate all exploration and development data types. Databanks which contain most and eventually all the data an asset team needs will be tightly integrated to the asset team project databases.

Once this integration is accomplished, data and information will seamlessly move around the globe on high speed communications wide area networks (WANs), Figure 6, and the industry will realize the vision of the *right data, at the right place, at the right time*.

Managing Reservoir Engineering Data

Production, drilling, and operations data are the most important data types to the engineering community. Production data is in many different formats, including e-mail, and is customarily manually keyed in daily production databases. Daily production reports are usually in a spread-sheet format which are forwarded throughout the organization to various financial and engineering groups. This process is prone to error and variations among data sets used by these different organizational functions are common. The end result is that each group is using its

own figures. Frequently, these figures cannot be reconciled and contribute to the sub-optimal decision making processes.

Drilling data must be the input of the daily drilling reports, sent by satellite from the rigs to operator's and/or energy service companies' operation centers. Many operators archive daily drilling reports in in-house software or commercial software, however, these reports are not recorded in a databank

Surface production engineering and operation, covering the onshore and offshore production facilities, their engineering, the construction and installation projects, their operation and maintenance are another broad range of data types. The integration of these processes using information technology with the subsurface engineering processes will contribute dramatically to the dual problem of reducing total costs of operation and optimally producing the reservoir.

E&P companies, their service providers, and alliance partners are becoming more and more interested in detailed CAPEX and OPEX data. Detailed field development costs and also cost data on engineering, project management, consumables, overhead, and services all contribute to better reservoir management.

Probabilistic Decision Making

The drilling engineering community is comfortable with 'process' wells which are drilled in a known environment with standard programs, in a deterministic mode. The 'project' well (a wildcat) is a risky operation which leads the engineers to embark on the most reliable, i.e., the most expensive programs, in order to minimize the probable risks. Drilling, production and structural engineering decision processes are still deterministic sciences and are not yet as probabilistic as the geosciences.

Probabilistic decision making tools such as advanced new software will depend on sophisticated and well populated (large volume) databases. The development of these databases will require collaborative efforts on the part of E&P companies and their service providers. The new sophisticated software will take advantage of emerging information technology such as the World Wide Web and be available to a wide variety of users.

The engineering community is far more fragmented than the geoscience community. Geologists, geophysicists, and new venture groups are mostly based in head and branch offices which constitute altogether a limited amount of work sites where it is feasible to install Data Base Management Systems (DBMS) on central computer servers. Engineers work not only in head and branch offices but also on project sites, construction yards, platforms, rigs, etc.; a multitude of locations. Each of these locations would have a use for the data from an engineering DBMS; data should be delivered via the Information Super Highway.

The Information Exchange Loop

Geoscience and engineering data are obtained from a variety of sources:

- Data which are in the public domain and that can be obtained from governments and private agencies;
- Operator proprietary data;
- Data acquired as the result of wellsite data acquisition systems or completion services;
- SCADA or continuous production data (pressure, temperature, flow, etc.) obtained from the reservoir on an on-going basis.

The quality of the data, its format, validity, etc. are not strictly under the control of the E&P organization. It must rely on others as it meets all of its data needs. These interdependencies are in some cases long-standing, i.e., data brokers, data acquisition service companies, and have been a fundamental building block in the industry's drive towards data standards (POSC, PPDM, and others). These historical processes and relationships will be enhanced and invigorated as organizations continue to develop closer working arrangements and alliances.

Not only are multiple parties involved in the acquisition, processing, and storage of data, the industry reengineering efforts are changing the relationships between E&P companies and service providers. Service companies are routinely being asked to perform tasks that only recently operators considered proprietary and the source of competitive advantage. The industry is recognizing that competitive advantage for each participant is now a function of the synergistic effect of partnerships and strategic alliances. Inherent in these types of relationships is trust.

Mutual trust is the heart of data and information exchange between partners. Joint teams working on the same problem require access to the full range of expertise, data, information, knowledge, and wisdom of their partner(s). From an information prospective this means not only the free sharing of data, but possibly the sharing of in-house processes and in-house software among the parties. Joint and cross licensing of technologies, software, intellectual property, and third party data will be required as well.

The purpose of this paper is not to address the overall changes on-going in the industry, but only to suggest that as part of this overall effort, the data and information relationship among E&P actors is changing. This is a significant event and will require the commitment of senior management if this change in information management roles is to be successfully undertaken.

'Change management' has been commonly defined as the joint management of social and technical change (Davenport, 1993). Changes in the role and ownership of information is a difficult (knowledge is power) social change in the midst of a

technological revolution (Tapscott, 1996). When these changes in information management are coupled to the hypercompetitive dynamic environment (D'Aveni, 1994) in which all participants find themselves competing with global and innovative combatants, the opportunities for success or failure appear boundless.

Success in this arena will be to those who capitalize on the strengths of their partners and suppliers. A key to success will the joint participation in the information value chain and its associated feedback loop by both the E&P companies and energy services companies with their affiliated suppliers of data and other information technologies.

Conclusion and Summary

Not too many years ago it was difficult if not impossible to measure the result of investment in information technology. The promise of this technology was yet to be delivered (Strassmann, 1990). Like most technologies (the electric light for example) infrastructure and knowledge of usefulness and limitations had to be developed before the real value could be realized.

Data and information management have reached this crossroads in the E&P industry. These technologies and processes have moved far beyond what was envisioned for them only a few years ago (Hammer & Champy, 1993) and are no longer the enablers of change, but the very cause of it. To secure and maintain competitive advantage in the hypercompetitive arena, organizations and industries must have the foresight and insight to capitalize not only on their own capability, but the capabilities of the partners and suppliers.

The concept of the feedback loop is well established in engineering. No refinery could function without it. However, this concept is poorly developed in reengineering literature. Senge (1990) builds upon the work of Roberts (1978) and his predecessors which supports the benefits to an organization of formalized managerial feedback systems. The combination of mature information technologies and business reengineering principles open the door for organizations to develop competitive advantage through 'Total Cost' management and oil and gas asset optimization.

By jointly closing the data and information feedback loop E&P organizations, large energy service companies, and affiliated suppliers can significantly contribute to the cost effective, productive management of oil and natural gas fields while adding value to the bottom line performance of all participants.

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Biographies

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General management experience leading integrated computer hardware and software organizations in the development of worldwide business opportunities. Over the past 20 years, directly responsible for managing many aspects of a global enterprise. In addition to authoring and implementing strategic plans for penetrating new markets on 6 continents, directly responsible for development of several new business ventures. Responsible for development and implementation of the organization, standards, methodology, policy, and infrastructure necessary to capture, organize, and provide access to the information technology generated by Halliburton as it delivers its products and services to the industry.

Education

Doctor of Business Administration, (D.B.A.), Nova Southeastern University
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Management of Oil and Gas Exploration and Production overseas branches of International Independents, management of the Production Engineering and Production Operation Divisions of these companies at the head office. Held various top managerial positions with contractors in North America, Europe, Africa, Near and Middle-East. With Petroconsultants S.A. since 1986, Geneva, Switzerland, his home country, audited oil and gas fields around the world and worked with National Oil Corporations of Albania, Algeria, Cameroon, Equatorial Guinea, Ethiopia, Indonesia, and Nigeria; World Bank and UNDP. Editor of 'Catalogue of EOR Projects in CIS'. In charge of the Asian Development Bank project 'Safety and Environment Management of ONGCL' activities, India and of the Petroconsultants project 'IRIS for Engineers, a Drilling, Production, and Reservoir Engineering Database Management System'. Organization and chairmanship of conferences, seminars, and workshops on exploration and production technologies such as 3D seismic, horizontal drilling, slim hole, and coiled tubing drilling.

Education

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