

E&P DATA MANAGEMENT TRENDS IN OIL AND GAS COMPANIES**By****P.V.S.Bhanu Murty, ONGC, IOGPT, Panvel-410221, INDIA****ABSTRACT**

To succeed in a climate of increasing global competitiveness, oil and gas companies are challenging themselves to double their productivity. Increasing levels of productivity will require significant changes in process, culture as well as leveraging emerging technologies. As oil and gas companies strive for greater efficiency, there is a push for better utilization of data- its quality, accessibility and timely introduction into the reservoir management process. Today the widespread availability of database management techniques is ushering in new approaches of managing data and improving productivity. Data centre models including national data repositories are being introduced to ease the burden of exploration and production data management. To improve productivity - multi-disciplinary team approach, long term oil field alliances and shared databases are expected to dominate upstream industry in future. The current paper outlines the trends of E&P data management, approaches of data integration and emerging scenario in this direction.

1. INTRODUCTION

The oil industry has moved into an era in which competitiveness is measured by asset-related knowledge, not just reserves in the ground. To increase companies' competitiveness and shareholders value, the challenge lies in finding and successfully implementing latest appropriate technologies - both that decrease operating and administrative costs, and those that increase the production. This requires optimization of production process, decrease in costs and improvement in the efficiency of data movement throughout the organization. The profitability can be improved by ensuring that the valuable production information is accurate, timely, and easily accessible by all the concerned both in field and in office.

In oil and gas companies, great volumes of data are obtained regularly, which must be gathered, documented and analyzed. Such data are instrumental in a fast and effective technical and operational decision-making process. One of the most difficult and most important tasks is finding and assembling all the relevant data into forms suitable for interpretation. The increasing use of computers and software systems to assist in the interpretation task has led to storage of data in digital form, and to the introduction of database techniques to manage the digitally stored data. As the trend toward integrated interpretation of data has increased, the problem of access, by different interpretation programs, to data stored in different formats, in different databases, and in different systems, has intensified. In a situation of declining crude revenues, the selective use of electronic data processing for the optimization of operations has become a high-priority objective.

Data management assumes greater significance in view of the following factors:

- **Data storage and management Costs:** now-a-days, a survey ship fills an 18-track tape every two minutes. Oil companies must deal with the costs of storage, copying, administration, retrieval, loading, quality control and other activities. As a result, the lifetime costs are approximately 30 times the cost of the original blank tape. The average geoscientist today is dealing with 100-1000 times more digital data than 10 years ago. The typical interpreter is overloaded with data. Seismic vessels churn out more and more seismic data in more efficient ways. Clearly, unless oil & gas industry find better ways to extract unambiguous and cost effective oil and gas prospects from these mountains of data, the economic underpinning of the hydrocarbons business will disappear.
- **Data duplication:** The explosion in the amount of data collected is compounded by the problem of data duplication. Oil companies exploring a common area may have the same information on various tracts within their databases as the result of data exchange for cross-licensing or other purposes. Single companies may have bought the same seismic specifications and all the data more than once.
- **Data Quality:** Data quality begins to deteriorate from the moment tapes are exposed to the heat, cold, humidity and salt air aboard marine survey ships. In some cases, these data tapes are more than 20 years old, and have been adversely affected by poor storage environments (in India, to address this problem, a special data archival project has been taken up). In some cases, formats and media may be incompatible with today's technologies. Poor indexing or cataloguing techniques may also complicate the task of finding required data.

- **Incompatible technologies:** Even within the same organization differing platforms may make data inaccessible without extensive reformatting. This problem is compounded by data exchange among multiple oil companies, each with differing IT infrastructures. Standards and integration are critical in this context.

DATA MANAGEMENT & PRODUCTIVITY

The most important component, which affects the productivity in the petroleum industry, is the engineers and decision-makers time spent on searching and analyzing the right data. It is estimated that geophysicists and geologists spend approximately 50-60% of their time searching for the right data and only 15-20% in productive data analysis. A percentage time distribution on this activity is presented in Figure No.1 [7].

In today's fast-paced, high-tech industry, the emphasis of top management is on generating successful workovers to increase field production and revenue. While geologists and engineers waste precious time searching for the needed tools to develop a field, a true understanding of the field's status is rarely reached because the most important element in the process i.e. the data is not properly handled.

Over the last decade, oil producers have been confronted with variable and often low oil prices. This has caused many companies to reduce staffing levels. Also, the industry is experiencing a significant number of mergers and acquisitions of both companies and producing properties. These changes often result in disorganized well files and poor tracking of well histories and related costs. Absence of a well-organized exploration and production database adversely affects production optimization and trouble shooting tasks.

2. DATA MANAGEMENT TRENDS

The oil and gas industry has become a highly technical industry using new technologies to find, produce, maintain, monitor and control wells and pipelines. The ability to access real-time data quickly and easily from wells and facilities from any point in the corporate network can provide a huge advantage in the production, transportation, and sales of oil and gas. This ability has traditionally been accomplished by continually upgrading to more powerful computers and bigger data transmission lines. Significant changes affecting data management trends in petroleum industry for improved productivity are database technology, shared databases and integration issues.

2.1 TECHNOLOGY

Initially data in oil and gas companies was stored in diverse, disjointed pockets. Also, technology was developed piecemeal with acquisition/storage/use of new data compartmentalized. Business was segmented in terms of exploration, production, engineering etc. through part of same life cycle. There was lack of lateral integration.

The exploration data used to include - seismic tapes (raw & processed), seismic sections (raw & interpreted), survey (navigation) reports, location maps & other paper documents, digital interpreted seismic data, digital well logs (raw & processed), paper logs (raw & interpreted), paper maps, digital maps, geological, geophysical reports & regional studies, gravity, magnetic, electrical data, drilling reports, well completion reports, engineering data etc.

The production data used to include - well testing (DST, RFT, pressure, flow etc.), production figures, field modeling & simulation, EOR program data (water injection, steam flooding, gas injection, chemical agents, biological agents), reservoir monitoring programs, pipeline & flow optimization, engineering facilities etc.

Limitation of this type of data management include

1. Data in disjointed form e.g. all seismic acquisition activities not necessarily related, interpretation results not used for simulation & field development
2. Data has confined use and not used as a corporate asset
3. Uniform data security not enforceable
4. Huge library spaces with massive infrastructure costs etc.

RELATIONAL DATABASE TECHNOLOGY

Oil and gas companies have adopted relational database management systems (RDBMS) with structured query language (SQL) tools. A key concept has been the need of a master database and a project database. The master database holds the master copy of all data. This includes data for all wells, seismic lines, reservoirs, facilities, plans and more including raw data, processed data, interpreted data and reports. Database administrators (DBA) control changes to this master data. The project database contains data selected from master database and includes geographically or thematically selected data such as wells, seismic lines, interpretation in progress and other intermediate data.

The primary difference between project data stores and the master data store is volatility. Project stores will usually contain many versions, as the team reinterprets the data, applies new theories and algorithms, and attempts to optimize the model based on new inputs. When interpretations reach a certain level of completion (i.e., the reservoir top has been agreed upon, and approved by the team leader or selected manager), project data are stored into the master for use later on by another team.

OBJECT TECHNOLOGY

Object oriented technology has become talk of the day in petroleum industry too. Object-oriented databases offers some special features like rich data modeling, versioning, navigational querying, large objects to store different/ varying data types like tubing/ casing size, well completion details, reservoir parameters, PVT properties, artificial lift details, logging data etc., required for oil & gas industry. Some researchers are currently exploring the possibility of describing and managing complex exploration and production (E&P) data with the help of object oriented databases [1].

IMMERSIVE TECHNOLOGY

The science of immersive realization [4] brings to the oil and gas industry comprehensive working environment and software solutions which will enhance users' current software investments, not replace them. Immersive technology will offer a suite of commonly used interpretation and geotechnical tools coupled to a full multi-sensory visualization and collaborative environment. Managers can 'fly' through their fields, interrogating recognizable objects to determine production rates, temperatures, pressures, flow, and other engineering data. This visual database sits on top of the existing digital databases and is the portal to the immersive environment. In near future, the immersive environment and its perceptual computing interface will enable users to efficiently explore terabytes of data to discover the embedded knowledge trapped within. The new immersive technologies, coupled with more natural computer interfaces and a new set of analytical tools, designed and built to be optimized for the new environments, promise a solution to the current interpretation, data integration, and decision-making bottleneck.

FIBRE CHANNEL INTERCONNECTING TECHNOLOGY

The need for oil exploration companies to acquire, process and interpret seismic data has been one of the main drivers of IT in the upstream oil and gas sector. Until recently however, the methods of transferring or sharing these data sets amongst various workgroups were cost-prohibitive to all but the largest oil companies. Now, with new developments in shared storage and networking capabilities, innovative and more affordable approaches to asset and data management are close at hand.

With the promise of better performance and connectivity options, Fibre Channel based Storage Area Networks (SANs) are emerging as the cure-all means of managing large volumes of seismic data [3, 8]. SANs are emerging as an alternative to traditional client-server environments, giving users on network attached workstations direct access to industry-leading high bandwidth storage subsystems.

Basically, a SAN approach involves using interconnecting technologies such as Fibre Channel to link client workstations directly to shared storage devices, Fibre Channel provides a 1 GB/sec interface, which equals 100 MB/sec burst data transfer speeds, enough to provide the bandwidth demanded for visualizing and interpreting uncompressed seismic data. Fibre Channel can ultimately provide multiple, independent FC connections, each sustaining up to 100 MB/Sec. The result is unprecedented performance capabilities between the client and the data residing on the external storage subsystems.

2.2 SHARED DATABASES

A variety of shared databases are developing in oil and gas industry. These include individual client, multiple client, industry-sponsored, multiple client, commercially sponsored, national data repositories and combinations of these [5,6].

- **Individual client:** Amerada Hess installed commercial data management and reservoir characterization systems at company operations in London, Aberdeen and Copenhagen. Vastar Houston is another example of a single client centre. The company currently has a corporate data store with 2,600,000 wells, over 100,000 seismic lines, 50,000,000 3D seismic points serving over 200 users. The database is updated every month from commercial data sources.
- **Multiple clients industry-sponsored:** The common data access (CDA) initiative in UK is a prime example of a successful multi-client data centre. Many companies were spending more than \$250,000 per year simply on these data. Co-operation between 32 members of CDA resulted in the creation of 6000 well database, which is accessible by all members at their site.
- **Multiple-client, commercially sponsored:** The GeoQuest LogSafe Centre in Sedalia, Colorado places logs from any vendor in a relational database, storing them in their original format. Clients have access only to their own data, and receive a catalogue of their data and quarterly statements of holdings. The service functions as an off-line log archival system that costs less than an internal database, yet can deliver logs over phone or network lines in a few hours. The LogSafe system now serves over 130 oil companies and archives more than 100,000 wells representing six terabytes of log data.
- **National data repositories:** Repositories for countrywide oil & gas assets are receiving increased attention. The primary drivers for establishment of these national data repositories include - preserve national assets, better utilization of national assets, attract foreign investment, support more cost-effective E&P activities. An important part of the national data centre is data presentation and interpretation area, where the client can visualize and interpret data sets, generally with the assistance of experts furnished by the offering government. This allows potential customers added flexibility in data access, at significantly lower cost.

2.3 INTEGRATION

Historically, there has been a lack of integration of the various disciplines in the exploration and production environments within the oil industry, due to the lack of communication among tools used in respective geological, geophysical, and engineering applications. A successful operation relies on all data types and sources being accessible. Advances in personal computer technology, both in hardware and software, make the computer environment a cost-effective platform for integrating disciplines and operations to stimulate cost efficiency. Integrated, multi-vendor approaches give users ready access to the best tools available for each task in the exploration and production cycle.

MULTI-DISCIPLINARY TEAM APPROACH

Many oil & gas companies responded quickly when interpretation software vendors started talking in terms of asset teams, re-organizing their traditional discipline centric departments in to teams that could share and leverage the data in a company database. The multi-disciplinary team approach is a concept that is now well accepted in petroleum industry. The typical upstream team consists of geologists, geophysicists, reservoir and production engineers, finance personnel, construction & maintenance engineers, safety & environment experts. The integration of mixed disciplines creates the need to integrate data applications.

Individual disciplines utilize different sets of tools, which can include word processors, spreadsheets, and graphical and specialty programs such as log analysis, seismic interpretation, and reservoir modeling. Petroleum data sets usually consist of cartographic features and database tables. Database tables must be designed to relate to one another. Cartographic map features must be designed to link to data in the database tables. For a multi-disciplinary team to function efficiently and effectively, databases and software applications need to be integrated. Today, inter-disciplinary uses of oil field information are changing the face of petroleum data management. To minimize the cost of exploration and to improve upon the success ratio, integration of multi-disciplinary data is well recognized. The need for optimal reservoir exploitation has been driving a trend toward integrated exploration and production activities and related software [2].

SOFTWARE INTEGRATION

Geology and geophysics software applications are being integrated with drilling and engineering software packages, which are about 5 years behind in maturity. These integrated programs are being further integrated with window's business applications, SAP and other nonscientific information technologies for

enterprise-wide solutions. Some oil & gas companies are working with different vendors to obtain solutions that best match their needs. For example, Mobil selected Landmark and Geoquest to provide an integrated platform for both applications and the Master data store.

In 1998, Prism Tech Corporation (Prism Tech) has announced [9] the launch of the Open Spirit E&P Component Framework (Open Spirit), an application-independent software platform enabling the 'plug-and-play' integration of E&P software applications and data stores. Open Spirit is a collaborative development project between Prism Tech and the Open Spirit Alliance (Alliance). The Alliance is a partnership of oil companies and E&P software vendors including Shell, Elf Aquitaine, Statoil, Chevron, BG plc, CGG Petrosystem, Shared Earth Technology, Jason Geosystems, de Groot Bril Earth Sciences, Foster Findlay Associates and IFP. Focused initially at the subsurface interpretation domain (but designed to embrace the full E&P lifecycle) Open Spirit provides generic E&P data and visualization components, which facilitate the development of inter-operable applications. Open Spirit also provides standardized data access to a variety of popular E&P data stores. Open Spirit supports distributed applications, utilizes OMG/CORBA standards, and supports new application development in C++, Java and with Microsoft development tools. By enabling 'plug and play' integration, Open Spirit introduces new and powerful capabilities for both users and developers of E&P applications.

ERP SOLUTIONS

Oil companies round the world are seeking ways to leverage capital assets and inventory investments, increase responsiveness to customers and decrease logistics costs. A comprehensive ERP solution for the oil and gas industry helps in managing operations with integrated planning, scheduling, procurement, manufacturing, inventory, sales, and transportation systems. It permits precise, cost effective product measurement and movement for both bulk and packaged products. Such a solution would help the company to provide personalized sales and service to customers with easy-to-maintain rules for customer preference, buying patterns, delivery and invoices. Essentially this means that all activities that are part of a process should be integrated. Therefore the use of an ERP which inherently guarantees this integration of processes across the organization is being looked upon as an information technology solution to achieve this objective in oil & gas companies.

STANDARDS ON E&P DATA

The need for optimal reservoir characterization has been driving a trend toward integrated exploration and production activities. Now, a way to arrive at an integrated E&P interpretation environment using existing computing tools is available. Specifically, a common data exchange standard suited to all types of scientific data has been introduced to geoscientific software developers and a group of oil and gas operators. Specifics of the standard, which is fully hardware- and software- independent, are being widely published to encourage maximum industry participation. POSC's (Petro-technical Open Software Corporation) standards for data sharing and interoperability are poised to become the models for petroleum industry. What is significant about POSC is that it is a global organization developing global standards, and the breadth of its efforts is evident in the richness of its standards.

A project is under way [10] to build data-loading tools and create an integrated oil and gas production database using specifications developed by the POSC. The Industry Pilot Project (IPP) Phase I is a collaborative effort between 7 oil companies: ARCO Oil & Gas Co., British Petroleum Co., Elf Aquitaine Inc., Mobil Oil Co., Oryx Energy Co., Repsol S.A., and Shell Oil Co. The participating oil companies have provided a large set of data from a producing North American oil and gas field. Many companies have already streamlined their in-fill drilling processes and receive significant incremental benefits. This project sets out to prove how POSC specifications can help reduce the cost and time for developing a field, improve the quality of the decision-making process, minimize the number of communication barriers and, most importantly, change technology from a hurdle to a seamless step. The project demonstrates that POSC specifications are an enabling technology that can dramatically improve the way oil companies and suppliers operate.

NETWORKING IN INDIAN E&P INDUSTRY

The premier National oil company of the country (ONGC) is setting up a company wide E&P data management and information networking (EPINET) in the shape of a project to bring out the subsurface exploration models to near perfection through IT and Data base applications in order to

- Fine tune hydrocarbon prospectively
- Enhance success ratio and EDI through integrated E&P solutions
- Reduce exploration risk and cost.

The salient features of the EPINET project include - client server computing environment, open system

architecture, POSC compliant data model, user friendly database application software, extensive GUI capabilities, fast data communication network, concurrent data accessibility, multi-level data security, integration with seismic & Electro log archive and asset database.

3. CONCLUSIONS

The development of an oil field requires a synthesis of information technology from several disciplines to allow these disciplines to work together for more efficient operations. Oil and gas companies must be constantly looking for ways to do business more efficiently, including gathering and reporting accurate production data and regulatory information in a way that improves time utilization of both field and office personnel.

Over the last 20 years, the quest for more cost-effective management of oil and gas developments has been dominated by efforts to cut production costs. A number of options are available to maximize efficiency and profitability. These include closer ties between oil companies and the service sector, shared project responsibility, and changes in tendering practice. Developing basic technology through industry-wide cooperation would derive additional benefits. When the mutual benefits are clear, many companies are willing to enter joint ventures and long-term alliances. This cooperation allows leading oil and service companies to tackle projects in partnership. In some countries, new national petroleum databases are being introduced for nonproprietary data. These will help to ease the burden of exploration and production data management.

Integration, combined with advanced information technology, will be the lever that moves exploration and production companies to their next level of productivity and profitability. Integration is enabling petroleum industry to shift its focus from simple structural interpretation to complex 3-D and even 4-D reservoir characterization and simulation to better model both rock and fluid properties of whole stratigraphic intervals. This shift marks a major leap in technology-based productivity by the oil and gas companies. Very soon, however, a much more dramatic productivity leap will begin. The most visionary companies that adopt technology early are looking beyond integrated reservoir characterization and simulation to the next long-term business advantage: leveraging knowledge.

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**Fig No.1 Percentage time spent
on looking for data**

