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New generation solutions for global petroleum data management

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Abstract: In response to continued economic uncertainty the petroleum industry is restructuring to improve its return on investment. Companies are operating all aspects of the business with fewer personnel and are emphasizing cost controls. In spite of significant investments in work stations and computer applications, as recent as 1991, it was estimated that geologists and geophysicists spend an average of 60% of their time looking for data (Lawyer, 1991). Driven by the need to manage massive data bases, particularly 3D seismic, and to improve worker productivity a new information management paradigm is emerging. Past generation organizations and information systems were function oriented and segmented to serve specific end-user disciplines (geophysicists, geologists, engineers, etc.) by serial data access. New generation organizations and information systems are process oriented and serve teams of end-users by sharing data access through networks. The new generation information management paradigm is focused on the needs of the business enterprise and productivity enhancement using a data warehouse concept. Components of the new generation solution include a relational DBMS, a standard data model and an integrated GIS that operate on workstations and PCs in a client-server environment.

INTRODUCTION

Reducing operating costs through technology and new approaches to information management is a major petroleum industry objective for the mid-1990s. The chronic excess in crude oil supplies continues to yield weak oil prices and to curtail return on investment and growth. As a result the industry continues to restructure to improve its ability to generate profits under the prevailing conditions.

In a survey of its customers, Petroleum Information Corporation identified the following information management profile:

- Companies are operating all aspects of the business with fewer personnel.
- There is continued emphasis on expense control and cost reduction. Outsourcing information management services is an example.
- Companies are implementing technology to increase professional productivity and effectiveness. Reducing the amount of time that professionals spend looking for data, estimated to average 60% of their workday (Lawyer, 1991), was cited as a prime opportunity to improve productivity.
- Other information management challenges include:
  - Maintain knowledge and use of historical data archives.
  - Preserve valuable massive corporate databases in a distributed environment.
  - Increase productivity through more effective use of data and technology.
  - Reduce risk of failure through increased use of technology and data. 3D seismic data is a primary focus here.

In order to address productivity issues companies have examined their operating and information management system organizations. In spite of significant investments in workstations and applications, past generation functionally oriented systems are too segmented to improve overall productivity. Moreover, professionals who need to share interpretations cannot get timely access to the results to complete their analyses. Lost opportunities could result from functionally oriented systems.

New generation operating structures and information management systems are process oriented and focused on the needs of the business. Professionals are teamed to solve problems and share access to enterprise data through networks. The new generation information management paradigm embraces the data warehouse concept that was described by David and Murphy (1988). A data warehouse focuses on the information needs of the business enterprise. A data warehouse is a repository for a variety of data types and media where the data are validated and mapped to a

standard data model and which responds to the queries of users throughout the enterprise.

NEW GENERATION SOLUTION

The new generation information management solution features a comprehensive integrated desktop database management system plus improved data access and delivery systems to better meet the enterprise needs. Desired capabilities of the solution include a relational DBMS with a industry standard data model and meta data model that operates on UNIX workstations and PCs in a client-server environment and allows easy-to-use access through a spatial browsing system. Four basic components of the new generation solution are shown in Figure 1. The features of these components are described below:

Data capture and archiving

Companies are increasingly aware of the need to manage all information resources as a corporate asset and to improve user access to data archives through desktop computers. The objective is to create comprehensive computerized inventories of all petroleum documents and data. Data such as reports, studies, logs, maps and seismic in all available media (hard copy, microforms, images and digital tapes) must be accounted for.

Because of their size and potential utilization, the management of seismic data files and documents is most critical. Such data can be efficiently maintained in a modern, environmentally controlled archive with user access through digital inventory systems. The digital data inventory also must be integrated with a company's master database system to maximize user benefits.

Five data capture tasks are essential to the development of new generation integrated database systems. They are:

1. **Data organization and indexing** — A modern bar coding system and a relational meta model are used to capture indexes into an inventory database. The index facilitates archive data management and provides a master identification record that corresponds with detail data that are captured in the main database.
2. **Source document accumulation** — All source documents that are to be scanned, digitized or entered into the database are assembled and quality-checked in conjunction with data indexing. Records are verified for completeness, accuracy and for consistent identification and location standards.
3. **Scanning and reconstruction** — To maximize their value, certain logs, seismic sections and maps merit scanning, vectorizing and reconstruction. Comprehensive scanning and digitizing may be included in the data capture phase. Resulting digital logs and seismic trace data are stored in a vector database and tracked through a location record in the inventory database.
4. **Cartographic digitizing** — A heads-up digitizing capability is provided to build and maintain cartographic reference maps for the system. Map attributes such as shot points and well locations also are captured and quality-checked.
5. **Digital tape quality control and transcription** — After seismic and other data tapes are indexed, they should be read to verify quality and de-multiplexed before returning to storage. A tape transcription system is provided to accommodate internal and external tape format needs and to load data into new high density tape storage systems.

The data inventory/index meta model is an integrated component of the master database. The data inventory system, nevertheless, could be implemented as a stand-alone function.

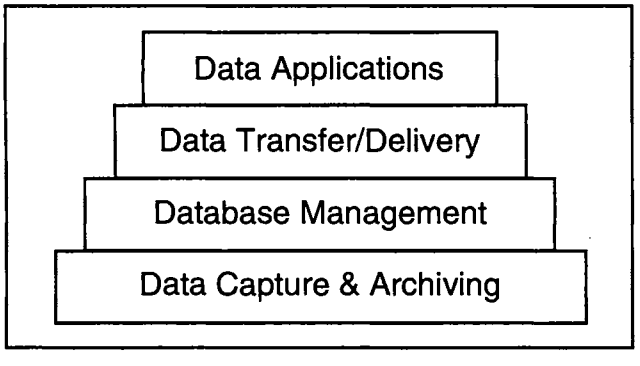

Figure 1. New generation solution components.

Data management

The database management system is the core of the new generation solution. The database system provides the linkage and functional controls for all data that are captured, generated and applied in a petroleum enterprise.

The data management phase includes the database development and maintenance tasks for both spatial and attribute data and facilitates the user's interface to the database and applications. The new generation system consists of database management and GIS spatial data management components that are linked to an industry standard relational data model. Data management system components are shown in Figure 2.

Standards are critical to the new generation database solution. The system must comply with computing and petroleum industry standards for

operating systems, user interfaces, database management, telecommunications, data models and data exchange formats, such as those published by ANSI, OSF, API, AAPG and POSC.

The data model

An industry standard data model is the foundation for the new generation database system. The Public Petroleum Data Model (PPDM) is the most widely used public relational data model standard and its support is growing. More than 80 operating companies and vendors participate in the advisory committee. The PPDM model currently encompasses well and production histories, seismic attributes and lease/license data. In a recent initiative, PPDM and POSC (Petrotechnical Open Software Corporation) agreed to merge their data models to develop a new industry standard relational model that would be endorsed by both organizations. Substantial evaluation must be completed before the commerciality of the merge model is determined. Meanwhile, utilization of the PPDM model is expected to expand as more operating companies and vendors use it in current system implementations.

Data management system

The database management system must address data entry and editing, file maintenance and security, user queries and report generation, data imports and exports, spatial data browsing and mapping.

- **Data entry and editing** — Standard, pre-formatted data entry screens and interactive edits facilitate data quality. Screens should be modifiable to meet specific user needs and new screens with edits added in accord with data model expansions.
- **File maintenance** — Updates and data field modifications required for database maintenance also must be addressed by the system.
- **Security** — Multiple security levels are required. Each user must have a valid signon and authorization level to access the database. Appropriate security levels are assigned so that data entry technicians can modify data. Users would be limited to queries of the master database but, would be allowed to modify their project files.
- **Queries/Report generation** — In addition to spatial queries through maps multiple data query styles are required. A variety of standard reports, standard application export formats and a custom report builder round out the query capabilities.
- **Data imports** — A variety of commercial and industry standard formats, such as for logs and seismic data, must be imported to the database. The data management system must serve as a master repository that interfaces with the inventory model and a wide variety of commercial and proprietary data, including massive raster and vector files.

- Industry standard relational data model. Well, production, geology, lease, seismic.
- Integrated GIS
- Interfaces to applications
- Installation, training & maintenance

Allows you to:

- Build
- Import
- Edit
- Report
- Export
- Browse
- Map

Figure 2. Data management system components.

Geographic Information System (GIS)

A unique aspect of the new generation database management solution is the integration of a GIS graphics data browsing and mapping system with the data model and data management components. User interface to the database is greatly enhanced through spatial data browsing. Data selections from multiple sectors of the data model can be displayed and analyzed in integrated GIS maps. A GIS tool kit also addresses map digitizing and editing, map project file management and generation of standard maps using simple function keys.

The new generation database management system enables users to capture, edit, query and display the full range of data encountered in E&P operations and interface them with comprehensive applications.

Data transfer/delivery

Transfer of data to end users and applications is provided by several means in new generation systems. To reduce expenses, operators are migrating from costly mainframes and outsourcing parts of their database management. For example, a commercial client server provides access to US and Canadian active and historical well and production data bases through a high-speed wide area network. Users reduce mainframe processing costs and can import project files to their workstations in ready-to-use relational tables in a variety of proprietary and industry standard data models.

Data transfer functions in desktop systems also are important. Several levels of application

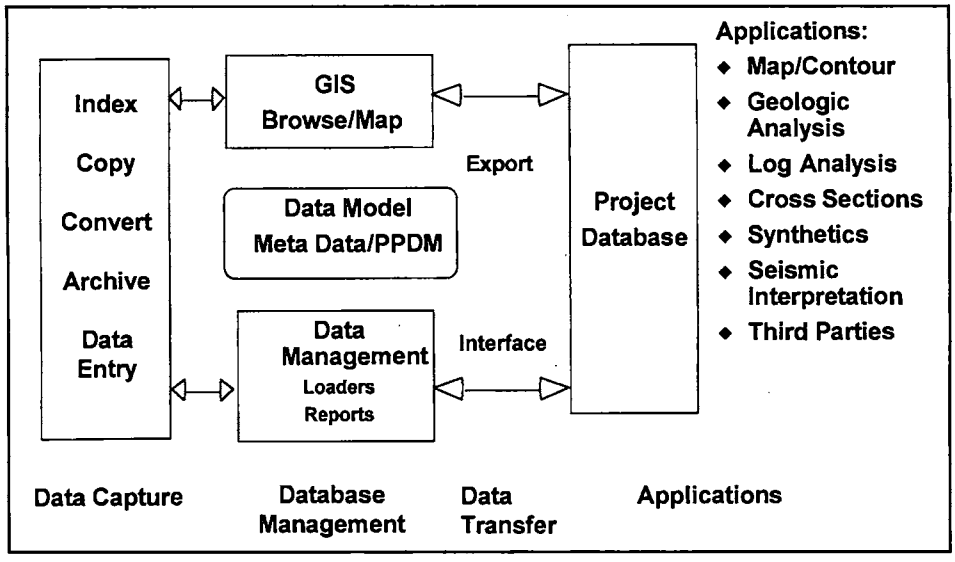

Figure 3. New generation integrated workstation database system components.

interfaces should be supported from an export module. Exports of standard commercial well and production download formats, for instance, are compatible with applications from more than 50 vendors. The ability to generate *ad hoc* exports to proprietary applications also must be accommodated. Custom seamless interfaces would be appropriate for critical high-use applications.

Applications

Tight integration of the database management system with leading application systems is a major new generation feature. Landmark Graphics Corporation, for example, is interfacing its Open Works project database with PI's PPDM data model implementations. The potential spectrum of integrated capabilities from this integration is shown in Figure 3.

Architecture

Through compliance with industry standards, a variety of configurations can be supported. Market leading components such as relational management systems, UNIX workstations, Motif, MS Windows, ethernet and Novell networks would be accommodated. Such components would ensure wide industry compatibility and acceptance.

Implementation

Several implementation options for the new generation database solution should be considered. US operating companies may adopt the integrated workstation solution as part of their migration from mainframe databases. Some countries may choose to launch a comprehensive effort to implement an integrated database system in a single project. Others may wish to implement an integrated database system on a modular basis.

Regardless of the implementation approach, to assure success users must commit to:

- A process oriented operating structure.
- The concept of building an integrated database system.
- The training of staff in new data management technologies.

CONCLUSION

New generation information system solutions address important industry data management problems that have resulted in the "80/20 rule". That is, users spend 80 percent of their time finding and organizing data and only 20 percent of their time analyzing data. The capabilities described in this paper for new integrated database systems should help industry to improve productivity by reducing data handling and increasing time spent on applications. Lower costs also may be achieved by shifting database processing from mainframe to desktop computers. Risk of failure also may be reduced by providing access to all of the enterprise data that should be analyzed for investment decisions.

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