Landmark History -

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European Association of Exploration Geophysicists
Utrechtseweg 62,
PO Box 298,
3700 AG Zeist,
The Netherlands

FAX: 011 31 3404 62640

Gentlemen:

This is the cover letter for a paper we are submitting for your consideration as a presentation at the 1992 EAEG Meeting and Technical Exhibition in Paris, France. We are FAXing the abstract, but will also send it by post.

The Paper is titled: "HDDV: The design of a new interactive seismic interpretation system." The authors are Venkat Viswanathan, Tim Hayes, Craig Warner, Aftab Alam and H. Roice Nelson, Jr. all of Landmark Graphics Corporation. Aftab and I are presently the only authors who active members of the EAEG. I plan to present the paper. We are not including biographies, because there was no request for them in the call for papers, but will provide them if needed. If our paper is accepted, we would like to have a projection video system available to assist in presenting part of the paper.

We thank you for your consideration, and look forward to participating in the meeting.

Best Regards,

H. Roice Nelson, Jr.

Abstract:

The massive volumes of seismic data being collected today has created a need to improve our interpretation tools. We have designed a new set of interpretation tools and procedures which have the potential to meet this need. The design is named HDVV (Horizon Detection - Volume Visualization). In this paper we will specify the reasons we feel there is a need for improving interactive interpretation tools, and then present the basic concepts behind the design of a system that has the potential to set the standard for the next generation of interactive seismic interpretation systems.

There is a tremendous increase in the acquisition of 3-D seismic data. Not only are more areas being studied with 3-D data, but the surveys are getting larger. A major oil company has shot the entire deep water Gulf of Mexico with 3-D seismic data. They are presently reshooting much of the area covered by their initial surveys. One of the large national oil companies has initiated a process they call "just in time exploration," where they will collect a 3-D survey over specific major fields every six months, with the intention of monitoring fluid movement, optimizing production, and automating hydrocarbon transportation from the well to the distribution terminal. We estimate that these activities will result in an order of magnitude increase in the amount of seismic data that needs to be interpreted. In addition to all of this data, it is a fact that interpretations need to be completed in the same length of time much smaller sized surveys were interpreted in before, and in many cases the interpretation needs to be accomplished with fewer interpreters.

Recent new developments in computer technologies are making the promise of interactive 3-D interpretation viable (Nelson, et al, 1980). One of the key developments is that computer memory is becoming much cheaper. The importance of this is recognized by studying computer latency, or that time between starting to look for a piece of data in memory and when the data element can be manipulated. Between 1982 and 1990 memory access speeds remained at about 0.1 micro-second per byte, disk latency per element was at 0.1 seconds per sample or 100,000 seconds (27 hours) per MB, and the relative price performance of compute power increased by a factor of 100. Increases in the automatic picking of seismic data by a factor of 100 in going from ZAP (the Zoned-Auto-Picker) to Turbo-ZAP were largely due to moving more data into memory rather than to the increases in compute power. Following this trend, by 1995 we anticipate high-definition television (HDTV) will be introduced. Each television will require at least 1 GB of memory (15 seconds of television). This will bring an economic revolution that will further drive down computer memory prices. To put this in perspective, in 1985 1 GB of memory cost $1,000,000 and the memory was non-volatile (you could not turn off the computer without loosing data in memory), yet by 1997 1 GB of memory will cost $1,000 and it will be volatile (Nelson and Warner, 1991). This reduction in memory cost is directly related to the present capability of being able to upgrade a scientific workstation to full color graphics for a few thousand dollars. In addition, remember HDTV is a serial application, vs working with a volume of data like we do in interpreting a 3-D seismic survey.

A process like 3-D seismic interpretation has been described as being interactive when you can remember the question once you get to an answer. Yet the interpretation of 3-D seismic surveys typically takes several weeks or months (Nelson, 1982). The HDVV design is intended to help make this process more interactive. The design is based on a concept of developing key GEMs (Geoscience Elemental Modules). Each GEM is optimized for accomplishing a specific function and is connected to other GEMs via a network protocol known as the Pointing Dispatcher (PD). The plan is that these GEMs will share data with existing interactive interpretation systems.

The HDVV interpretation process is planned to start with easy to use tools for loading 3-D

seismic surveys from standard digital seismic formats. As part of the data loading, the data can be formatted for rapid horizon tracking with a pattern discrimination filter. It is envisioned that these filters will emphasize reflection peaks, troughs, zero-crossings, as well as geologic factors like stratal continuity and reflection configuration (Simson and Nelson, 1984). Pattern discrimination filters need not be applied just at data loading, but can be used to provide alternative horizon tracking. The seismic is displayed with cultural files, well data, horizons, and fault interpretations that are made using standard interactive interpretation systems. Fault planes (Nelson and Hildebrand, 1986) act as boundaries for horizon tracking. Tools are planned for tracking horizons in overthrust sheets (O'Brien, Mastoras and Nelson, 1988), as well as for extracting amplitudes along and parallel to fault planes in order to study trapping associated with growth faults (Nick and Nelson, 1987).

The seismic displays are planned to include the ability to display variably spaced grids in cross-section (Nelson, Hildebrand and Mouton, 1984) and volumetric displays (Harris and Nelson, 1980) using color computer graphics (Massell, Winningham and Nelson, 1981). A 3-D aperture is planned to allow movement through the seismic data volume and to assist in the identification of standard geologic form. The run-time interpretation process is the horizon detection GEM. This GEM design has recursive algorithms, as well as the flexibility for allowing user implemented tracking algorithms. Rapid interpretation is expedited by reflection and stratal continuity (Macurda and Nelson, 1988). Test results of tracking algorithms that follow geologic trends, like shattered geologic sheets in a mature basin, or expanding section against a lystric fault in a passive margin will be presented.

Equally, if not more important than interactive interpretation is the design of flexible volumetric horizon editing tools. Planned editing tools include image processing features like edge detection (Denham and Nelson, 1986), as well as pseudo sun filters and pattern matching heuristics. It is intended that the tracked horizons can be manipulated with standard mathematical and logical operations, and that these operations can be strung together as a horizon spreadsheet. These horizons and the data they are derived from are planned to be displayed in standard 2-D views, as maps, time-slices and cross-sections. In addition, the design includes a full functionality cube that allows study of the visual relationship of all of the different data types that are used by geologists, geophysicists and engineers (Anderson, Cathles and Nelson, 1991). This part of the design is the volume visualization GEM. Hypermedia technology (Nelson, et al, 1991) is planned to be tied into the interpretation process so that the interpreter can make notes, capture drawings or graphics, and tie them to a particular part of the interpretation.

These tools have the potential to provide the integration of geoscience disciplines, as well as oil and gas exploration and production processes. An activity is integrated when we have all of the expertise, tools and data necessary available to help us ask the questions that lead to answers which can be validated scientifically. For instance, is there fluid movement in basins which can result in reserves that replenish during man's lifetime and not just over geologic time (Anderson and Nelson, 1991). In our industry the concepts are validated by the well bore. Volume visualization is key to optimizing the potential success of that well bore, not only the display of horizons in 3-D (Nelson, 1974), but also display of the raw data that those horizons were derived from. It is anticipated that interpretations will be greatly enhanced when the data derived from horizons (attributes like seismic amplitude) and other affiliated data (like geopressure and temperature) are simultaneously displayed to show relative spatial relationships.

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Biography

Roice Nelson moved to Houston in January of 1980 after working for Mobil Exploration and Producing Services Inc. in Dallas for 5 1/2 years. He received a B.S. in Geophysics from the University of Utah and an MBA from SMU in Dallas. Roice worked for Amoco Production Company in Denver two summers and for Applied Geophysics in Salt Lake City during his undergraduate studies. He served as a voluntary missionary for the Church of Jesus Christ of Latter-Day Saints in southeast England from 1970 to 1972.

In Houston he worked at the University of Houston's Seismic Acoustics Laboratory as a Senior Research Scientist. During his three years at the U of H, SAL sponsorship went from 33 oil companies to 42, there was a smooth transition for both new Principal Investigators of SAL, students and staff went from 17 to 65, several million dollars worth of computer equipment was installed, and the AGL (Allied Geophysical Laboratories) was formed to coordinate the research activities in computational research, image processing, field acquisition, and well log response. During this time he wrote a series of 10 articles which were later published as the book New Technologies in Exploration Geophysics.

In 1982 he participated in the founding of Landmark Graphics Corporation. He raised the initial capitalization, started manufacturing, marketing (introducing Landmark technology in Europe, Australia, Canada, China, Brazil, etc.), field service, customer support, technology transfer, advanced interpretation training, Landmark's university program, Applied Geoscience Research and is presently actively involved in long-range planning and development of advanced interpretation products at Landmark Graphics. Roice has presented many papers at professional conventions and has taught numerous SAL, IHRDC, and Landmark Graphics public and private schools; emphasizing interactive interpretation developments and techniques.

Roice married Marti Sharp on September 5th of 1974. They have 6 children: Roice III, Ben, Paul, Melanie, Sara and Robert, ages 17 to 9.

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