Report on
the Visualization Workshop

by John L. Shanks

The Research Committee sponsored a "Scientific Visualization" workshop on Friday, September 28 following the Sixtieth Annual International Meeting and Exposition of the Society of Exploration Geophysicists. This was an all-day workshop and was unique in that it included a comprehensive display of computer equipment and visualization applications. The presentations and demonstrations came from applications both inside and outside of the exploration industry.

Approximately 300 people attended the formal presentations, which were given throughout the day in a large theater. Consistent with the topic, the presentation aids consisted of the usual slide and overhead projector devices, and in addition there was commercial quality video presentations, with sound.

Concurrently with the formal presentations the workshop provided three "breakout" rooms with demonstrations of some of the latest visualization techniques. One room, the "Visualization Theater", provided posters of projects and video tape examples. The "Geoscience Visualization" room was equipped with workstation computer equipment of the type used in visualization applications. These computers were used by the developers of these applications to demonstrate their work. The final room presented "Frontier Visualization" demonstrations with several "cutting edge" applications to give a picture of what we might expect in the future.

Formal Presentations

The formal presentations were given by eight invited speakers. The introduction to the workshop was given by H. Roice Nelson. As chairman of the workshop organizing committee, Roice expressed the enthusiasm which the committee felt about the topic, and how important it is to our business. He gave the audience a sense of history and introduced the linkage between the technology which we were about to see and business needs of the petroleum exploration community.

The keynote address was given by Georges Grinstein, from the University of Lowell. This talk captivated the audience and put the

basics of data visualization on a scientific basis. Professor Grinstein pointed out the fact that we are becoming inundated in data, and we desperately need to be able to analyze and absorb that data, or it will certainly go to waste. His team worked on presenting multidimensional data in a way which can be quickly analyzed by the viewer. This includes designing visual and audible displays of the data. Much of the work at the Institute for Visualization and Perception Research of the University of Lowell involves cognitive research, and gets at the core of the visualization problem. He also demonstrated some fascinating results and discussed the directions which his projects will most likely take in the future.

The medical profession has data visualization problems which are in many ways similar to those in petroleum exploration. Dan Wessol is with the Boron-Neutron Capture Therapy research program at the Idaho National Energy Laboratory. He showed that a three-dimensional data volume of a person's head could be obtained from Magnetic resonance images (MRI) or computer assisted tomography (CAT scan) data. The radiation oncologist interprets planar slices from the volume of data, picking control points to define the outline of a tumor. As the physician picks the control points, a curve is defined around the tumor on each slice. Continuing this process gradually defines a three dimensional surface around the tumor. By using the three dimensional structures, the clinician can maximize the tumor cell kill and minimize damage to healthy tissue. This entire procedure is analogous to the process of interpreting of 3D seismic and well data, defining the structure and stratigraphy of a field, and planning drilling and development based on reservoir modeling using the interpretation as input.

Harlen Baker, a researcher in computer vision and visualization at SRI International, presented additional examples of application of 3D visualization in medicine, paleontology and motion analysis. MRI or CAT scan data can be studied by slicing the volume and extracting geometric surfaces, much like a geophysicist interprets 3D seismic data on lines, crosslines and time-slices. Using more advanced tools, the surgeon can make an "incision" in the image of the skin and muscle tissue, and peel it away from the skull revealing the bony structures. He may cut away part of the bone to examine the structures of the brain. Such intuitive tools may lead to more precise surgical planning for delicate operations. In exploration, we have used motion to display time slices from seismic sections. These researchers are extending such concepts to include volumetric data in motion, and relative motion of various data sets.

The exploration business already has experience with using special data visualization techniques for analyzing space satellite collected data. Mr. Robert Brovey, Exxon Production Research, discussed the state of that technology. There are a number of data collection

systems in place and the United States and others are moving forward with plans for new systems. To date, this data has been used successfully to derive geologic information. The data has also been helpful in planning logistic support for exploration activities in areas which are otherwise poorly mapped, and for which information on local conditions is difficult to obtain.

A topic which has received considerable press in the computer business is that "Virtual Reality". Mr. George Zachery of VPL Research gave a presentation of their pioneering work on this topic. They have developed a "data glove" that registers finger and hand gestures to control a scene presented to the viewer by a head mounted display. The viewer is thereby given real-time dynamic control over the spatial relationship between the person and the computer generated "scene" or database. Experience has shown that a realistic degree of artificial presence can be achieved. Architects can now use these tools of artificial reality to "walk through" a plan to examine lighting, access, and scenes within a proposed building. NASA Ames Research Center is experimenting with a form that links the head mounted display to cameras and the glove to robotic arms.

Karl-Heinz Winkler, of the National Center for Supercomputer Applications, and Richard L. Phillips, from the Los Alamos National Laboratory gave papers on projects requiring more than one machine to produce the visualization. For example, in computational fluid dynamics or atmospheric modeling, extremely large amounts of computer computation time may be used to generate an image. Yet the image must be displayed on a 3D graphics device not resident on the primary computation machine. These two authors discuss the work that Los Alamos is doing in developing a very extensive network to handle their distributed visualization needs. Very often, the network is the weakest link in this type of endeavor, and Los Alamos appears to employ the very latest in state of the are networks necessary to solve this problem.

Visualization Demonstrations

Visualization Theater

Two of the university posters treated techniques to display geophysical data. The video presentations covered a wide range of data visualization problems, including the display of numerically modeled physical systems such as storm systems and fluid flow. The general topic of volume visualization was also presented.

Geoscience Visualization

The "Geoscience Visualization Breakout Room" included sixteen such demonstrations devoted to the area of Geology and Geophysics. Some of the highlights included:

Visualization, construction, and modification of 3D Geological models can be achieved much more easily with the aid of real time 3D graphics to manipulate the 3D images. The animation of 3D objects achieves a breakthrough in helping the human to perceive that third dimension.

Volume visualization of 3D seismic data, discretized 3D geological models, etc., is proving to be a very useful aid in helping an explorationist to view and understand large 3D data volumes.

Borehole televiewer data can be displayed in a 3D form more readily understood than the conventional 2D displays. This is achieved by display travel times or amplitudes on a borehole displayed in 3D, and allowing the interpreter to rotate, zoom in or out, and even travel into the borehole column.

Frontier Visualization

This room gave the attendees an opportunity to see results of very new projects in visualization. These projects were not directly related to petroleum exploration, but showed new ways to look at data which may well lead to revolutionary applications in our industry.

The University of Lowell presentation extended the keynote presentation given by Georges Grinstein. The viewer had the opportunity to see and hear in more detail the variety of data presentations with which they have experimented. Especially revolutionary was the use of sound to help analyze and scan large data sets.

The "Virtual Reality" presentation by VPL Research gave the attendees a hands-on look at this technology. Workshop delegates were allowed to put on the helmet viewer and "data glove" and move around visually in a computer generated 3D scene. The program allowed one a certain amount of interaction with the scene and the subject could pick up various "objects" in the scene and move them.

The demonstration by Dan Wessol of the Idaho National Energy Laboratory covered the subject of his talk. With his system, he showed how the oncologist could view the MRI and CAT scans, both slices and

3D volumes. The application allowed him to interactively pick boundaries in the images and define volume areas.

Another frontier technology was that of "Frame Rate Image Processing" by Doug Rickman, et al, of the Wilmer Eye Institute. This system is being developed by NASA for the visually impaired and actually appeared as a poster in the Visualization Theater.

Summary

This workshop was very well received by its audience. Attendance was good during the whole day and the demonstration presenters were kept busy talking to interested viewers. Just as important as allowing the uninitiated to see this new work was some of the interaction between the presenters. The workers of the University of Lowell and VPL were overheard discussing how they might be able to merge their technologies to the benefit of both.

We only received four critiques after the meeting. However, all were strongly positive. To the question "Was it worthwhile?", the answers were "yes", "most certainly", "definitely!", and "clearly so!". Furthermore, of the four, two of the respondents offered to help with future workshops.

This workshop definitely required more time and resources than the normal workshop. However, the response of the audience was so strongly positive that we should consider a similar format for some future topic.

Addendum Handout for workshop attendees

Society of Exploration Geophysicists
Sixtieth Annual International Meeting and Exposition

"Scientific Visualization" Research Workshop
Sponsored by the SEG Research Committee

September 28, 1990
Mariott Hotel, San Francisco

ORGANIZERS: H. Roice Nelson, Jr. (Landmark), Tracy J. Stark (Exxon), Kay Dautenhahn Wyatt (Phillips), Geoffrey A. Dorn (Arco), Richard A. Ottolini (Stanford), Wulf F. Massell (HARC), Paul E. Sovelius (Visual Science Corp). John L. Shanks (Amoco)

PROGRAM: This "Scientific Visualization" Research Workshop is designed to provide to the Geophysical Community exposure to the latest developments in visualization technology. Formal presentations are given by eight invited speakers, who are recognized experts in their fields (such as molecular modeling, computational fluid dynamics, medical imaging, space borne imaging, virtual reality) who will describe their use of scientific visualization technology.

In addition to the formal presentations, a "Visualization Theater" for poster papers and video tape presentations has been arranged. The posters and videos may be viewed by attendees before, during, and after the formal presentations.

In order to provide to the attendees "hands-on" exposure to the latest in visualization tools, two breakout rooms have been set aside to allow demonstrations of hardware and software showing the latest in scientific visualization technology. The first breakout room is dedicated to "Non-Geoscience and Frontier Technologies". The second breakout room is dedicated to "Geoscience Visualization". These demonstrations may be viewed by attendees before, during, and after the formal presentations.

The "Visualization Theater" and both breakout rooms will run from 8:00 a.m. to 4:00 p.m. There will be sandwich carts in the area of the breakout rooms so people can eat a quick lunch and still participate.

SCIENTIFIC VISUALIZATION -- Formal Presentations

8:30 a.m.	Introductions
8:45 a.m.	Georges Grinstein, University of Lowell, "Exploratory Scientific Data Visualization"
9:45 a.m.	Description of Break-out rooms
10:00 a.m.	John Spurlino, Howard Hughes Medical Institute - "Molecular Modeling"
10:30 a.m.	Dan Wessol (INEL), Jim Cobb (U. of Utah), Floyd Wheeler (INEL), Elaine Cohen (U. of Utah), Beth Cobb (U. of Utah), David Barber (INEL) "Interactive Generation of 3-D B-Spline Objects from Planar Image Data for Multidimensional Analysis"
11:00 a.m.	Harlin Baker, SRI International - "Computation, Display, and Manipulation of Surfaces from 3-D data"
11:30 a.m.	Robert L. Brovey, Exxon Production Research - "Space Borne Visualization"
12:00 a.m.	Lunch
1:00 p.m.	Jaron Lanier, VPL Research - "Virtual Reality"
1:30 p.m.	Karl-Heinz A. Winkler, NCSA, "Visualization and Computational Fluid Dynamics"
2:00 p.m.	Richard L. Phillips, Los Alamos National Laboratory - "Distributed Visualization at Los Alamos National Labatory"
2:30 p.m.	Panel Discussion

GEOSCIENCE VISUALIZATION

"GOCAD Project: Geological Model Building", Jean-Laurent Mallet, Fondation Scientifique De La Geologie Et De Ses Applications

"Seismic Volume Visualization", Christian Tourenne, Vital Images, Inc.

"SEDSIM: SEDimentary Basin SIMulation", John W. Harbaugh, Dept. of Applied Earth Sciences, Stanford University

"Geologic Surface Interpretation", Steve Thomas, SciVision, Corp.

"3-D Geological Modeling", Larry E. Denver, Stratamodel Inc.

"IVM: Interactive Volume Modeling", Carl Kurz, Dynamic Graphics, Inc.

"3-D Geological Modeling", Victor Pereyra, Weidlinger Associates

"IREX: Interactive 3-D Reservoir Modeling", Tom Lasseter, Tech-Logic, Inc.

"Borehole Image Analysis", C. A. Barton, Dept. of Geophysics, Stanford

University

"The MAC as a Tool for Geophysical Visualization", R. Burnet Oliveros, Texaco Exploration and Production Technology Division

"Imaging to Visualize and Quantify Micro-Geometric Properties of Petroleum Sandstones", Doug Rickman, NASA Science and Technology Lab

"PHIL: Interactive Sequence Stratigraphic Studies", Scott A. Bowman, Dept. of Geology and Geophysics, Rice University

"Visualization of Prestack Migrations for Fault Structure in Southern California", John N. Louie, Dept. of Geosciences, The Pennsylvania State University

"Interactive 3-D Examination of Borehole Televiewer and Formation Micro-Scanner Images", Lee B. Metrick, Schlumberger

VISUALIZATION THEATER (Posters and Videos)

VIDEOS:

"EXVIS: The Perceptualization of Scientific Data", Georges Grinstein, University of Lowell

"Study of a Numerically Modeled Severe Storm", Robert Wilhelmson, National Center for Supercomputing Applications

"Volume Visualization", Christian Touranna, Vital Images, Inc.

"Visualization in Scientific Computing -- Issues 50, 49, 43, and 42", SIGGRAPH videotape (Special Interest Group in GRAPHics of the ACM - Association of Computing Machinery)

"Visualization of the Dynamic Forces Driving Fluid Flow in the Subsurface of Offshore Louisiana", Roger N. Anderson (Columbia University), Lawrence M. Cathles (Cornell University), Wayne Lytle and Bruce Land (Cornell University)

"Visualization of Numerical Forward Modeling", Ole' Vilmann (Odegaard Danneskiold Samsoe ApS), Peter Gerstoft and Henrik Schmidt (MIT)

"Visualization of Prestack Migrations for Fault Structure in Southern California", John N. Louie, Pennsylvania State University

"Understanding Current Channeling by Volume Visualization of a Transient Electromagnetic Sounding in a Three-dimensional Earth", Louise Pellerin (U. of Utah), T. Todd Elvins (San Diego Supercomputer Center), Gerald W. Hohmann (U. of Utah)

POSTERS:

"Use of the Landmark to Understand Groundwater Flow", Laurel Alexander and Stacey Ricci (Cornell University)

"Improving Groundwater Contamination Modeling by Visualization of Shallow Soil Layers with Ground Penetrating Radar and a Landmark Workstation", Jan Boll (Cornell University), K. Samuel Kung (U. of Wisconsin), Tammo S. Steenhuis, and Lawrence M. Cathels (Cornell University)

FRONTIER VISUALIZATION

"Interactive Generation of 3-D B-Spline Objects from Planar Image Data for Multidimensional Analysis", Dan Wessol, INEL

"Virtual Reality", Jaron Lanier, VPL Research

"Exploratory Visualization", Georges Grinstein, University of Lowell

"Frame Rate Image Processing", Doug Rickman (NASA), Robert Massoff (Wilmer Eye Institute of The Johns Hopkins University), Leigh Abts (TRIAD) (Poster Paper)