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Kevin T. Biddle
Editor
American Association of Petroleum Geologists Bulletin
Exxon Production Research Co.
P.O. Box 2189
Houston, Texas 77252-2189

10 August, 1995

Dear Kevin:

Enclosed are five copies of an article being submitted for publication in the Bulletin as a Geohorizon note. The article is a summary of the recent Archie Conference on Visualization Technologies to Find and Develop More Oil and Gas. I and the co-authors hope that you find the article suitable for publication. The Conference Organizing Committee had hoped to be able to publish individual Conference papers on the Internet, but apparently AAPG publication policy prohibits this. Thus, the Geohorizon article fulfills the obligation of the Organizing Committee. A copy is also being sent to Barry Katz, Chairman of the AAPG Research Committee, in addition to editors of the other professional associations affiliated with the Conference (at least SEG and SPWLA).

I can provide the manuscript on disk or email if you find it suitable for publication in its present form.

Sincerely,

Roger M. Slatt
Professor and Head

xc. Co-authors
B. Katz

VISUALIZATION TECHNOLOGY FOR THE OIL AND GAS INDUSTRY: TODAY AND TOMORROW

Roger M. Slatt[1], M. Ray Thomasson[2], Philip Romig[3], Eric Pasternack[4], Albert Boulanger[5], Roger Anderson[5], and H. Roice Nelson, Jr.[6]

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The fifth ARCHIE Conference, titled Visualization Technology to Find and Develop More Oil and Gas, was held in Houston, Texas on May 14-18, 1995. It was hosted jointly by American Association of Petroleum Geologists (AAPG), Society of Exploration Geophysicists (SEG), Society of Professional Well Log Analysts (SPWLA), and Society of Petroleum Engineers (SPE). As the title implies, the 130 participants, mostly end-users, were treated to a variety of new, emerging, and drawing-board technologies which are already reorienting the way in which explorationists and reservoir developers conduct their daily operations.

The Conference was comprised of four day-long sessions on the topics of Visualization Methodologies (Day 1), Visualization Applications (Day 2), 4D Animations and the Future (Day 3), and Visualization demonstrations and technologies in other fields (Day 4). The fourth day session was held at Houston Advanced Research Center (HARC).

The 39 presentors during the first three days were offered the opportunity to give conventional oral presentations using 35mm slides, conventional poster presentations, or oral presentations using direct projection from a workstation. The direct projection technique was so successful that the Conference organizing committee has suggested to the professional organizations involved that similar presentation methods should begin to be made available at annual conventions.

The fourth day was devoted to keynote addresses on the evolution and application of Visualization technologies in society and non-petroleum industries, in addition to a variety of advanced software and hardware demonstrations.

Breakout group discussion sessions were held at the end of the first two days to review the day's presentations and to exchange ideas. A plenary group discussion session capped the third day of the Conference. The following summary of the Conference comprises the results of these discussion sessions, in addition to ideas that emerged during the fourth day.

What is Visualization?

Visualization, in its application to finding and developing more oil and gas, is considered a tool for characterizing and understanding subsurface phenomena. This tool can be used over a broad range of subject areas, from large-scale structures to migration of fluids through pore networks. In this sense, Visualization is not the same as modeling, for Visualization is a means of depicting and understanding a model.

Positive and negative aspects of Visualization

As a tool, Visualization allows one to think about large quantities of data, helps check data consistency and recognize data busts, provides for quicker analysis and more iterations to optimize a solution, provides a means of quality control, and perhaps most importantly, promotes integration among disciplines. Integration has grown in importance during the past few years as the petroleum industry has shifted toward integrating different disciplines into teams. Visual imaging of concepts and information is providing a means of overcoming the historical problem of verbally communicating with those in other technical disciplines. In bottom-line terms, Visualization technology was demonstrated by many presentations at the Conference to add value to petroleum exploration and development efforts (additional reserves, save time, gain new insights, etc.).

However, Visualization is not the pot of gold at the end of the rainbow. For example, use of 3D and 4D Visualization technology requires a paradigm

shift for an industry historically conditioned by 2D information displays. An important negative aspect is that the beauty of a display can sometimes overshadow the significance or accuracy of the information being displayed. In this regard, there is danger that Visualization can create a false reality if it is applied too zealously to sell a prospect or complete a reservoir simulation. It is possible for Visualization itself to become the end-product rather than the tool for solving a real problem. Finally, some geologic phenomena, and datasets, are still too complex to understand, and should not be overly simplified by Visualization technology.

Standards--are they necessary and desireable now?

There was much discussion at the Conference concerning current lack of standards, the need and desire for standards, and when they should be introduced. Standardization would facilitate communication and data exchange, but at the expense of flexibility and the possible loss of a competitive advantage. There was consensus that every Visualization project should include information on how the Visualization was built, a frame of reference (legend, etc.), and that it would be useful to have a common format for transfer of data between applications. However, beyond these ideas, there was a sense that Visualization technology is in such a state of infancy, and growing so rapidly, that trying to impose industry standards at this time could be counterproductive.

One clear observation made at the Conference is that no single software package meets all of the needs in Visualization. As a result, data exchange between packages is often a stumbling block. It would be useful for end-users to communicate their needs to hardware and software vendors as well as internal company developers, so that perhaps common formats for data interchange can someday emerge. Conferences such as this one can provide developers with a sense of commonly desired features.

Hardware and software issues

A number of hardware and software issues were extensively discussed at the Conference. Perhaps foremost was the desire by many for PC-based Visualization tools, so that Visualization technology can reach the larger market of consultants and independents who have neither the desire nor the resources to maintain a workstation environment.

Another major concern was for bigger bandwidth capabilities to drive faster, more powerful machines. There is the need for larger high-resolution display devices with truer 3D representation (such as caves, holograms, virtual reality, and stereoviewing), better means of handling larger grids interactively, and improved data transfer capabilities.

A demonstration of a cave during the fourth day session highlighted the potential application of more powerful computing capabilities to the oil and gas industry. A cave is a space where data in stereo are projected onto one or more walls that make up the space, placing the viewer inside the data. Head tracking and a 3-dimensional input device, called a wand, provide a means for the viewer to coordinate selection and movement within the data. The impressive example presented was a one-walled version of a geological structure surface from a 3D seismic dataset.

End-use technical issues

The main end-use issue that emerged during the Conference was the need for understanding and displaying uncertainty in Visualizations. Sensitivity analysis must be included in Visualization iterations to test the accuracy and quality of the subject portrayed. Even though a single answer is often preferred, the value of bracketing an answer may be both useful and ultimately more preferable. Perhaps developing Visualizations of suitable outcrops, where stratigraphic and structural architecture can be quantified, is one approach toward ground-truthing and measuring uncertainty in visualizations of subsurface analogs. Improvements in accuracy of Visualization technology will drive improvements in accuracy and resolution of data-gathering technologies (seismic, well logs, well bore images, etc.).

Rigorous treatment of fault topologies and stratigraphic geometries were noted as particularly important by Conference participants. It was also noted that uncertainty of a portrayal will vary with scale, so scale should be considered in any attempt at uncertainly definition. The same is true for spatial resolution between wells. These are key areas in which geostatistics can be integrated with Visualization technologies to reduce uncertainty, and as such, are topics for further research.

It was generally felt that Visualization technology can provide a relatively simple means of incorporating more diverse types of data than normally would be attempted, in order to develop a consistent and reliable portrayal of subsurface phenomena. For example, in addition to integrating 3D seismic and well log stratigraphy into a model, petrophysical properties, pore geometries, borehole images, permeability, fluids, gravity, magnetics, radar imagery, etc. can be built into a model for more complete characterization and more comprehensive attribute visualization.

At the Conference, the potential applications of 4D Visualization were amply demonstrated, both at the exploration scale (e.g. temporal and spatial hydrocarbon migration along faults) and reservoir scale (e.g. temporal and spatial flow of natural and artificial fluids through a reservoir). Such Visualization, when portrayed accurately, offers significant opportunities to improve understanding of natural and artificial phenomena.

As demonstrated by some specific presentations, the ability to visualize multiple models, and complete numerous realizations of many attributes quickly and cheaply can offer tremendous bottom-line impact.

Integration, communication, and people issues

Clearly, Visualization offers the means of improving communication among the geological, geophysical, petrophysical, and engineering disciplines. However, people still control the machines, and are the essential ingredient for any successful multidisciplinary effort. Several examples were presented in individual Conference presentations, but there is a sense that truly efficient, friendly teamwork in the workplace is still evolving. It is widely viewed that management cannot merely assign a team and expect interaction; there must be something that draws team members together on a common ground. The hardware and software of Visualization can become the significant element for successful interaction.

Some of the specific issues that emerged from the Conference include: (a) different languages spoken and read by different disciplines (including 'computerese'); (b) feedback loops between engineers and geoscientists, sometimes made difficult by use of different hardware and software

systems; (c) differences in the scale to which a phenomenon is viewed and studied; (d) application of 4D visualization to quality control history-matches; (e) integration forces a consistency to models; (f) ease of integration by all parties is necessary for it to proceed; (g) the need for smart, well-trained users; and (h) the fear that machines will replace people.

Technology transfer and economic issues

These two issues are grouped together because without effective technology transfer, there will not be economic gain, and Visualization technology will fail. The Conference illustrated that major petroleum companies span the range of effort in developing Visualization capabilities. Some companies clearly see Visualization technology as more important than others, and have provided resources for research accordingly. Similarly, only a handful of academic institutions seem to be at the forefront in Visualization technology research, owing in part to the major financial committment necessary to create and maintain such a program. Some government agencies blessed with relatively large budgets to develop highly-sophisticated Visualization technologies now need to translate their technologies into user-friendly, inexpensive, and applicable systems for widespread public use.

Much of the public (in the petroleum field, and more globally) receives its information on Visualization technologies from commercial vendors who's goal it is to develop specific hardware and software for specific applications. There is a desire from the technical community to make Visualization technologies more accessible through the Internet, but there are many technical, economic, and social factors to be negotiated before this becomes a reality.

It is difficult to quantify the success of current Visualization technology in the petroleum industry. Individual success stories were conveyed in presentations and private discussions at the Conference, offering great hope and promise for the future. To be economically successful, Visualization technologies must be made cost-effective and user-accessible, and not require substantial outlays of hardware and manpower. Also, both technical and management people must be comfortable that the Visualization technology is accurate, as well as useful to solving real problems in a timely fashion.

It appears that we are in the early stages of evolution of a technology where documentation of success and failure is important if advancements are to be made. Thus, more examples of both success and failure need to be presented at scientific meetings and in the various scientific journals. Continued transfer and application are necessary to discourage the thought that Visualization technology might represent a form of 'play-for-pay'. Buy-in by all potential users in an organization is essential.

Visualization in other industries

Keynote presentations and demonstrations on the fourth day of the Conference indicated other industries-- including medical, communications, biological and chemical--are actively developing sophisticated Visualization applications and capabilities. Applications center around the need and practicum of visualizing abstract data. Capabilities abound, and the human mind is quickly becoming the bottleneck in Visualization. Innovative visualizations have the potential of overwhelming humans. The application of touch and sound for improved visualization seem to be emerging areas for fruitful research. Many of the examples from other industries are applicable to the oil and gas industry, and the industry could profit by seeking input from other industries.

Practical messages from the Conference

Participants at the Conference were presented with many new and futuristic ways of accomplishing their goal of finding and developing more oil and gas. Useful practical messages from the Conference, as stated by particpants, include:

- Visualization technology will only provide value if it is used as an interpretation tool, rather than a sales tool;
- Visualization technology is still in its infancy, and applications must be documented and demonstrated in order to convince people of its potential, thus allowing for continued growth;
- Visualization technology will become more widespread when applied to the PC environment;
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- The future of widespread Visualization application is through networking, and the World Wide Web is currently the best way to communicate;

- 3D Visualization is currently most applicable at the field scale;
- Companies and institutions value Visualization technology to varying degrees, yet have common problems to which the technology can be applied;
- Competitive advantage is in the use of the Visualization technology, not in its development;
- Standards do not currently exist;
- Education and training are essential to upgrade end-use technical people and management in Visualization methods and applications;
- Exploration and development teams will accomplish faster and better integration by exploiting Visualization technology;
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