Analyzing real data in a virtual world

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Virtual reality (VR) and immersive environments have leaped to the forefront in the energy industry, and their use by geoscientists and engineers is exploding.

At the recent SGI Visualization Summit in Galveston, eight multinational companies presented case studies on how they are using VR technology to enhance the workflow of asset teams. The unanimous bottom line: Companies are making better decisions faster with these new technologies, and dramatic changes are occurring in the way asset teams work.

Advantages. VR and immersive environments create the illusion of being in a virtual world. Individuals are surrounded by images of their data and actually feel they are part of it.

In the oil-and-gas industry, these technologies deliver a close-up look at models of the reservoir or subsurface. Members of an asset team can look at data and interpretations in great detail and understand the spatial relationships in three dimensions. The enlarged size and extent of the images in these environments allow interpreters to see details in geologic data without losing regional perspective.

An important factor to successful immersion is limiting "break-in-presence." Break-in-presence equates to a distraction, which reminds the user that the immersive environment is not reality. Examples of distractions that impact peripheral vision are flickering of screens or wearing bulky headgear.

A variety of solutions is available, and it is up to individual organizations to assess and implement the one that meets organizational and budgetary requirements. This may involve using an immersive facility on an as-needed basis rather than purchasing the technology. If this is the case, the alternatives are to lease time in a facility offering VR services or use an immersive environment that is portable (such as the VisionDome by Alternate Realities Corporation or the relocatable reality room by Trimension).

What is available? Many solutions are available that should enhance and speed up exploration, production, and drilling design workflow. Some offer the collaborative experience, some deliver the immersive experience, and others offer both (Figure 1).

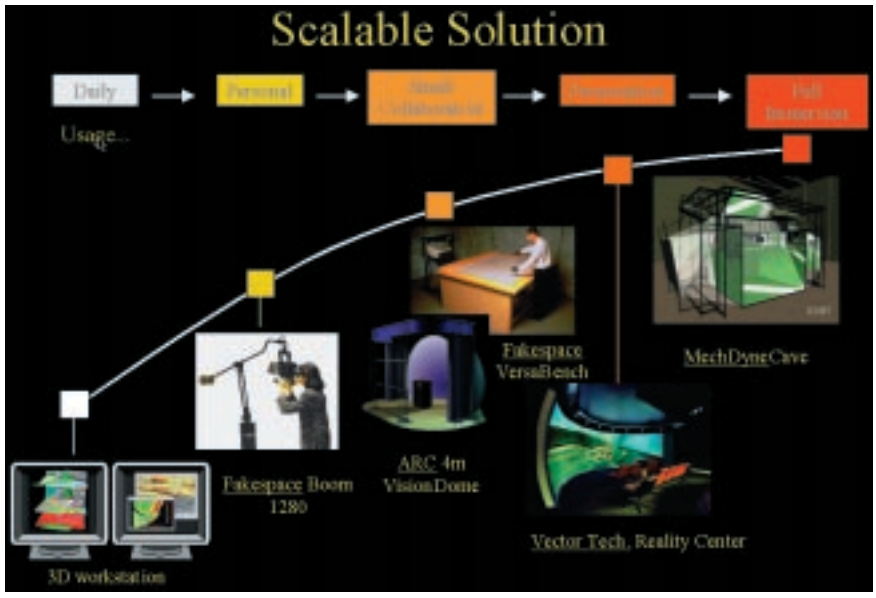

Figure 1. Available environments and their likely uses within the oil-and-gas sector.

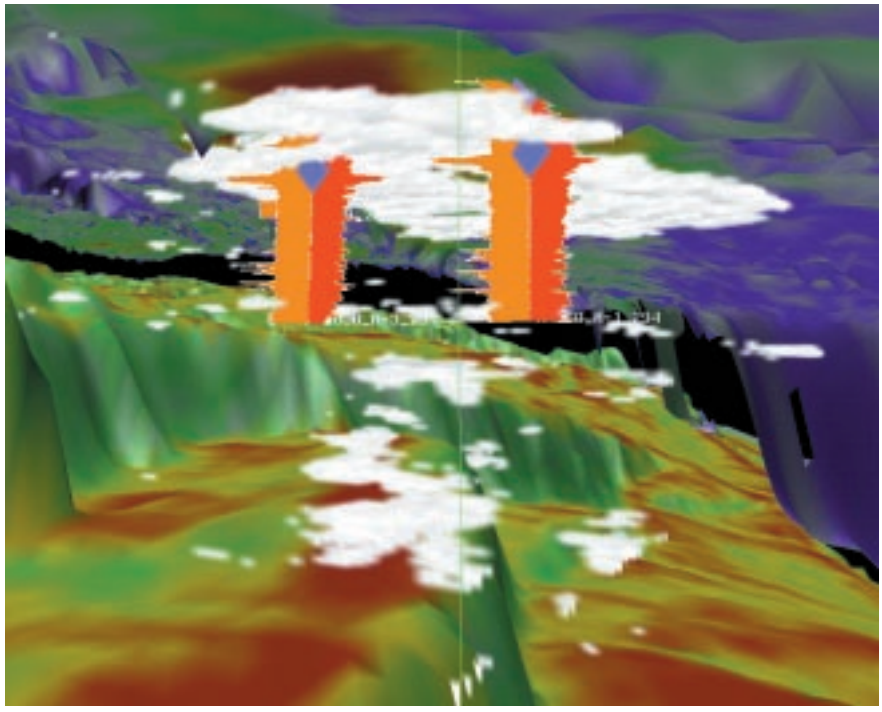

Figure 2. GeoViz image showing top and base of the reservoir unit, wells and key logs. To identify the most prospective area, the interpreter has chosen to view only the highest amplitude values of the seismic trace data, as shown in white.

Personal display devices include Fakespace's Boom and Fakespace's Push3c. These offer a high degree of immersion—but for only a single user, and interaction with the data is difficult. In many cases they do not offer significant advantages over a workstation and commercial software in stereo mode.

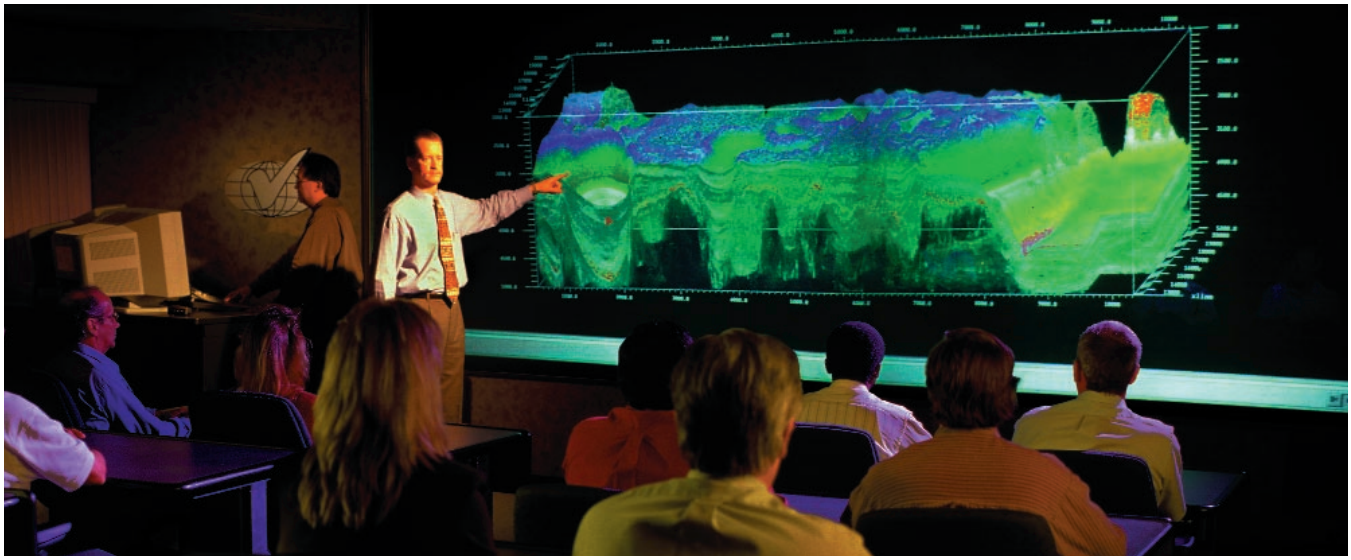

Figure 3. Veritas Visualization Center.

Small collaborative environments (e.g., the Fakespace VersaBench and Workbench and the four-meter VisionDome) offer a portable immersive and collaborative environment for a small number of users, such as an asset team.

Presentation environments (such as reality centers offered by Trimension, Tan, and Vector Tech) and the Fakespace WorkWall are effective for displaying data, give high resolution, and accommodate large audiences. These environments have proved the most popular to date. But they are costly and require considerable maintenance.

A CAVE environment (in which images are projected on 4-5 walls) offers the closest thing to complete immersion.

Of course none of these works in isolation. They require sophisticated hardware and software to produce the images. Typically they are hooked up to terabytes of disk space. Only a couple of the systems mentioned can run on lower-end machines. These include the VisionDome and Fakespace Boom 1280.

Commercially available software is also keeping pace with the changing face of interpretation. For example, GeoQuest's GeoViz enables an interpreter to visualize and interpret multiple volumes of data by manipulating voxel properties independently (Figure 2). Another example is stereo image rendering, now widely available in three-dimensional packages.

Interpretation. A major benefit of VR or immersive environments is the ability to interpret within them before the presentation stage. Users say that spatial relationships and structural complexities can be understood much more quickly than in the standard workstation environment thanks to the ability to see the detail and the regional context simultaneously.

Off-the-shelf three-dimensional applications can, when run in these environments, offer full interpretation capability. Many oil and gas companies have developed proprietary software with very specific interpretation functionality. However, developing your own in-house environment is costly and hard to justify in the current economic environment. As a result, many companies are turning to the commercial software development companies for VR and immersive technology.

When selecting software, a key factor is how easily a base package will scale from the workstation to the VR environment the company uses. To ensure effective and efficient use of these VR and immersive environments, users need to easily access the relevant information. Impediments (such as data reformatting or learning a new interface) will degrade the time-saving benefits offered by these environments.

With an immersive environment, a group of interpreters (geologists, geophysicists, and petrophysicists) can discuss and interpret the data as one—leveraging true collaborative power. Interpreter bias is eliminated and consensus is achieved at an early stage. Traditionally, interpreters develop interpretations from the data for their discipline. At the prospect-generation stage, interpretations from the various disciplines were combined to form a coherent picture. When interpretations differed, it was often necessary to go back and check or regenerate an interpretation. By working collaboratively, at the interpretation stage, conflict can be avoided and prospects generated more quickly and accurately.

A great example of this approach is the one that Veritas has taken at its Visualization Center in Houston. To provide nonexclusive 3-D depth imaging/processing services for deepwater Gulf of Mexico data, it needed to rapidly interpret huge volumes of complex 3-D seismic data.

By combining best-in-class software applications with an Onyx2 and an 18 × 7 ft screen, they did just that. The center provides the means for clients to collaborate on seismic interpretations and their associated velocity models (Figure 3).

With large amounts of data loaded and efficient picking algorithms, they were able to pick the seabed reflection over 60 blocks in 90 s, which freed up an immense amount of time to really study the salt and pick that more accurately. They were able to get consensus on the interpretation from participants and a better depth model.

Also during the interpretation process, unusual aspects of a data set may be uncovered (e.g., a salt wall with unusual structural controls or channel sands with unexpected variations in porosity). The collaborative approach to interpretation affords the freedom to expand the asset team to include experts for their input to the problem. Their valuable knowledge can be used effectively in an immersive setting. It is well known that "two

heads are better than one"; therefore, problems are understood and solved much more quickly by a group.

An additional benefit to problem solving in a group is that people from different disciplines have varying perspectives of a problem. For instance, a geophysicist looking at a drilling problem may be able to think "out of the box" to come up with an innovative solution.

Scanning through data sets. Most immersive environments need a large graphics engine. This typically translates to immense computing power and available memory. Interpreters have long dreamed of being able to see the entire data set in three dimensions, and now this is a reality.

By loading the whole 3-D survey into memory, an entire play can be seen and interpreted rather than a subsection. For example, a high-amplitude channel sand may be discriminated using voxel techniques on a workstation. With the entire data set over a large area viewed in an immersive environment, one can see whether that channel is part of a braided system or if it is the feeder channel of a delta. This increases confidence in the interpretation and reduces the play-generation time.

Importantly, a group can scan through large quantities of data very quickly to high-grade and low-grade areas in hours. One senior research scientist at a major oil and gas company noted that using the company's visualization center had helped interpreters identify 15 plays in a day.

Quality control of data. A key component of the service that Veritas offers to clients at its Visualization Center is the opportunity to check the processing steps as the work is ongoing.

One technique involves rendering of discriminated amplitudes on large 3-D volumes. This approach allows the processing team to work closely with the client to identify and correct even the most subtle processing problems early in the stream, avoiding costly rework and delays. In the case of depth processing, the seismic data and the velocity model are corendered so the group working in the center can see how the velocity model overlays on the seismic data, and what impact it has on the result. Any problems can be quickly identified and adjusted accordingly.

In addition to the confidence that such a QC process can bring, the simple ability to more rapidly change interpretations and try different scenarios helps to build a more robust model, and, ultimately, a better product.

Dale Bowering, vice president of Business Development at Veritas, says, "Viewing the data in the Visualization Center has become an integral part of processing and QC, which will inevitably increase the quality of the final product."

Another way clients use the center is to analyze the big picture of their data sets before carving them up into smaller pieces for individual detailed interpretation.

Presentation. VR is without a doubt an excellent presentation tool. Images are large, crisp, and in three dimensions, so they illustrate earth models very effectively. Nontechnical investors can be shown prospects in real world images creating an understanding of the data, which cannot be generated by words.

Immersive environments can even be hooked up to facilitate long-distance decision-making and presentations so an audience does not even have to be on the same continent to view the presentation.

Training and orientation. In the oil-and-gas industry, drilling rigs, offshore installations, and refineries can be dangerous places, and safety is of paramount importance. With the aid of sophisticated graphics and an immersive environment, potentially hazardous sites can be recreated in the office, where training and orientation can be carried out for a fraction of the cost of a site visit. In addition, with the click of a button, a user can switch between sites to compare facilities. Lastly, more people can be trained using a virtual environment in a shorter time frame than with actual site visits. In this case, it is not the collaborative nature of the environment that is being utilized; instead the focus is immersion. A number of international oil and service companies are using this technology effectively to train staff for offshore installations.

Immersive environments also are useful for training new employees. Interpretation techniques, especially in 3-D, have evolved rapidly in the last five years, and these new processes can be passed on effectively and efficiently in a collaborative setting.

The future. A few companies already have embraced virtual reality and immersive environments and are reaping benefits. It will not be long before there is a rapid rise in its use.

Massive computing power is becoming more and more accessible, and there is a trend toward making higher-powered machines available on the desktop. While some immersive environments such as the VisionDome can utilize PCs, Sun Microsystems solutions, and the desktop Octane from SGI, the majority still require an SGI Onyx.

There are currently many different ways of manipulating data in immersive environments, from the standard 2-D mouse to boxes that are held and gloves with sensors on the finger pads. Soon these will be consolidated into a few control devices that are effective but do not fatigue the user.

The industry has moved a long way from the days of paper sections, logs on which interpretation was done with colored pencils and digitizers.

Certainly, workstations have increased productivity tremendously. Now the industry is experiencing another shift where the potential of individuals is harnessed, and they are given tools to work as a group in a simulated environment that allows free exchange of ideas and views, delivering another step change in productivity and efficiency. TLE

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