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Tech Trends

Trends Driving Advancements In High-Performance Computing, Visualization

With Ever-Larger Data Volumes...

Trends Driving Advancements

In High-Performance Computing, Visualization

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By Bill Bartling
SGI

MOUNTAIN VIEW, CA.–Business drivers in the oil and gas industry are producing a variety of technology trends that will impact the next 10-20 years of exploration and production.

Larger companies have been aggressively investing in high-performance computing and visualization technologies as key to not only exploration, but as supercomputing, long-distance collaboration, networking and desktop capabilities continue to expand, key to increased production from new and existing wells. Independent and smaller major companies will see important gains in access to information and the technology to use it cost effectively. Major multinational and national oil companies are promoting the full automation of oil fields, remotely managing complex and hazardous operations through robotics, real-time data acquisition and analysis, and large-scale collaborative visualization.

But the main business driver remains consistent: the need to explore larger and larger data sets to add accuracy and precision to very expensive decisions.

One way to increase the economic productivity of oil fields is to add data derived from producing wells to the analysis and decision-making process. Consequently, the industry is now dealing with exponentially-expanding data volumes. In fact, the data volumes used to describe producing oil and gas fields have grown over the last decade from tens of megabytes to hundreds of megabytes, and to where it is now not uncommon for a geophysicist to find himself working with up to 100 gigabytes of data.

The only effective way to analyze these larger data volumes is in a large-format visual environment. Understanding 50 gigabytes-100 gigabytes of data using a spreadsheet program is very difficult, but analyzing 100 gigabytes of data in a visual format is very easy. Success rates have increased dramatically with high-performance computing and visualization technologies, especially in exploration, where success rates have gone from an average of about 10 percent for most companies not that long ago to as high as 70-80 percent in some companies today. That, obviously, is a powerful improvement.

Seismic Reprocessing

Geoscientists have learned over the years that seismic exploration data provide primary information that can be reprocessed to create different attribute fields. A number of companies are in the business of creating secondary processing systems for seismic data and creating a new seismic volume from them. They start with a seismic volume that is typically 1 gigabyte-10 gigabyte in size, but the second processing of this initial data set creates a new computational solution that increases the volume size proportionately. Creating a third attribute results in a commensurate increase in volume of information. This is currently being done using batch processing, as well as real-time analysis in visualization applications.

There is a relatively new application being used in the industry that creates a cube showing the seismic data in volumes as one navigates through them. An algorithm can be associated with a moving cube so that the volume computes another attribute, adding additional decision-relevant information with each new attribute, thus increasing the size of the overall volume of data being viewed. All of these data are stored in the memory of the computer and visualized in real time, typically in large-format, theater-type rooms.

With high-performance processing, visualization and 3-D applications, the industry has greatly advanced from just 10 years ago, when earth scientists were still making lots of assumptions about what kinds of rocks were in the earth and what types of fluids they contained. Today, actual measurements provide direct information about what the drill bit will find in the subsurface.

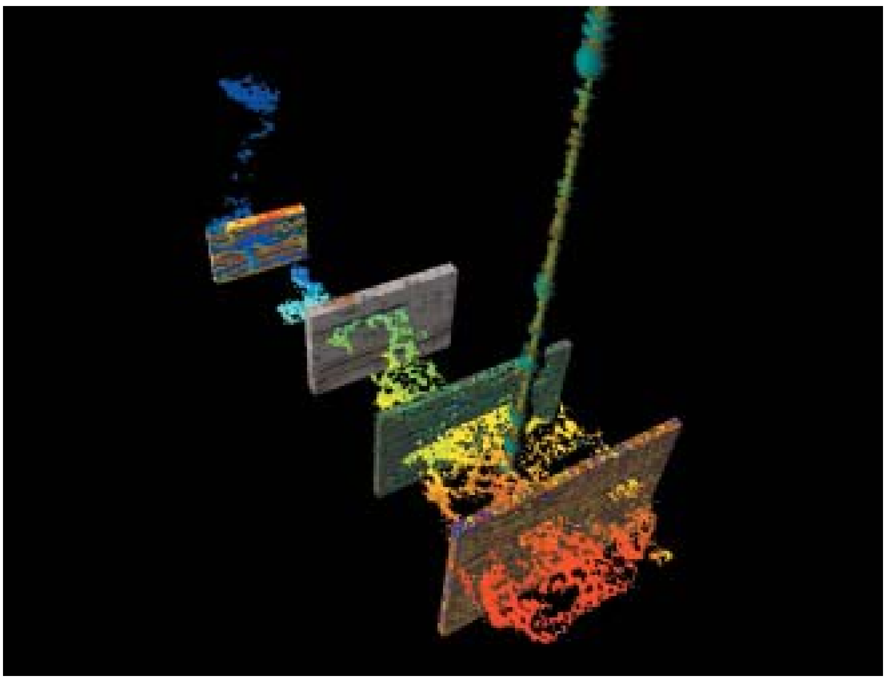
Simply put, the industry has advanced from assumption to knowledge. That knowledge leads to fewer dry holes in the exploration world and improved management of reservoirs that leads to an extra 10, 20 or even 30 percent of hydrocarbons recovered.

The obvious advantage is that companies can make a lot more money for the same investment. For example, if a company drills 10 wells in a year that cost $10 million each, and is successful only once, it has spent $90 million on dry holes. That one successful well had better be a good one! But if that same company could improve its drilling success to eight-of-10 wells, it would spend only $20 million on dry holes. If a 1 billion-barrel oil field is discovered with that $10 million per-well investment, the return would span 30 years, at least. If the company spent $10 million on the exploration well, it would not be unreasonable to expect it would spend $100 million on evaluation wells and perhaps $1 billion on the platform, the pipelines and everything else that goes into creating a producing facility.

Improving Recovery

When an oil and gas company does find a billion-barrel field, historic averages indicate that it typically recovers only about 30 percent of original in-place reserves. So, in this case, when the company walks away from the project, it will leave 70 percent (700 million barrels) of the original oil in the ground, unrecovered. Should the company be able to recover even 10 percent more oil (100 million barrels) from the field with limited incremental additional capital investment, the majority of the resulting revenue would fall directly to the bottom line as profit.

There are documented cases, such as an example from Mobil that was pub-



This typical seismic analysis image depicts four spatially synchronous seismic attributes, along with a well attribute, from which a geobody or oil reservoir can be derived.
Source: Rock Solid Images utilizing GeoProbe™ software from Magic Earth.

lished in a technical paper, where the company was able to achieve 14 percent additional oil recovery with reservoir monitoring and frequent analysis. Applying a 14 percent incremental recovery increase to a field with 1 billion barrels in place would deliver 140 million more barrels, which at a price of $20 a barrel, would equate to the better part of $3 billion in additional revenue–from a field where the bulk of the major capital investments have already been made and depreciated!

High-performance computing and visualization can help operators capitalize on opportunities to achieve incremental recovery gains and generate additional revenues by providing the infrastructure for rapid model updates, analysis and sharing of results, which leads to more effective decisions on how to invest capital resources in oil and field management.

Perhaps a less obvious advantage of using high-performance computing and visualization technology for decision management is the preservation of the environment, or more specifically, the ability to drill fewer wells, yet get more oil. And the events of the last few months underscore the strategic advantages and security that would come from being able to extract more oil from domestic wells and become less dependent on foreign sources in less stable parts of the world.

Robotics And Automation

Automation, including having robotic equipment on platforms remotely managing oil fields–especially in hazardous environments–offers a number of advantages. Automation takes humans out of harm's way, but more importantly, allows oil fields to be managed in a much more real-time manner using "live" data and modifying the behavior of the fields over feedback loops to robotic equipment.

While it is true that this is largely still a dream today, it is a dream of many large multinational and national oil companies, and step by step, it is slowly becoming reality. For instance, one key direction in the area of robotics and automation technology is toward mechanized, fully-automated systems that can drill wells without placing personnel on the rig or platform. Many companies envision that, perhaps 10 years out, most wells will be drilled this way.

In a remote command-and-control world, digital video cameras and digital sensors will provide views and acquire information that will be handled by high-performance computing and large-scale visualization technology, allowing remote management and operation as new information is acquired. Sensors and some of the communications structures are still bottlenecks, but robotics and remote operations are among the most important evolving trends.

Moore's Law, which predicts that the power of technology will double every 18 months, has held true. As a result, some remarkable capabilities are emerging on the desktop and in the computer room. In addition, and principally based on technological developments made in computer gaming, the industry is beginning to see impressive advances in graphics technologies, focused principally on fast polygon computation and rendering.

In parallel, supercomputing in the mainframe business continues to go strong. Companies such as SGI, IBM, Hewlett Packard, Compaq and Sun all continue to work very hard in the high-end business, particularly in the areas of supercomputers and high-end computational servers and graphics machines.

Mission-Critical Computing

While the low-end CAD/CAM world moves to these commodity desktops, the scientific, technical and engineering markets–where special, mission-critical activities are commonplace–still rely on very high-performance machines for two reasons. First, the quality of the graphics, especially in regard to image realism, is superior. Second, the performance of the machine, both in speed and in the amount of memory used to produce full-motion models, is untouchable by any desktop machine.

Achieving capabilities of supercomputers on desktops is inevitable, according to Moore's Law, but Moore's Law also applies to supercomputing. Supercomputers are doubling their capacity every 18 months as well, so the desktop, no matter how fast and how good it gets, will never be as good as a supercomputer at running graphics.

Nevertheless, users would still like to have as much capability as they can on the desktop, which means moving into graphics-serving systems that provide a robust fashion by which to attach a desktop system to a graphics supercomputer and serve those images across either a broadband, local-area network or wide-area network to the desktop. This strategy, being promoted by a number of companies, basically gives the PC or UNIX® desktop workstation user more performance capabilities than anything these machines could actually do on their own.

The cost structure of the compute environment is driving this in many ways. Information technology managers are reluctant to pay the premiums for extraordinarily high-end graphics machines for every desktop, in spite of the fact that their engineers and scientists require them to do their work. The ultimate strategy, where the situation merits, is to concentrate the graphics capability in the computer room and provide images to the desktop on an as-needed basis.

The trend at the moment is to work inside of a building to deliver those graphics. But the environment is very rapidly evolving toward long-distance delivery of graphics, as well. Those of us in the data visualization business are always asked questions like, "Can we send these images from Houston to Kuala Lumpur?" Invariably, the answer we give today is, "Yes, but not very fast." But this is more of a network bandwidth limitation than it is a computational limitation. As bandwidth expands, new possibilities will emerge.

There are a number of reasons why companies are wanting to connect their personnel using distributed graphic-serving methodology. One is the fact that, because of industry consolidations over the past few years, there are fewer experts in the workforce, and those experts who are key to the decision-making process are distributed across long distances in such remote areas as Baku, Lagos and Jakarta. Airplanes and long-distance travel is expensive (and in today's environment, perceived to be dangerous in many parts of the world). More importantly from the corporate perspective, a valuable expert is taken "out of production" during the time it takes him to travel from Point A to Point B and back again, and that can be very disruptive to work calendars and project schedules. Real-time collaboration and visualization is bringing people together across long distances and proving highly desirable and cost effective for many companies.

Accessing High-Tech Solutions

How can independent oil and gas producers, who typically do not have the capital to purchase supercomputers or hire full-time experts, take advantage of ultra high-tech solutions that are so profitable for giant companies? The evolving applications service provider (ASP) and data service provider (DSP) models could hold the answers.

Three years ago, the whole concept of a "pay-for-use," third-party software provider was novel and unproven, and there were only a couple struggling ASPs active in the oil and gas business. A year or two later, there were hundreds. Today, there are again only a handful. Most ASPs/DSPs went out of business because they were unable to provide the bandwidth needed for 3-D solutions at both technical levels and price points that made sense. In addition, they had little content to provide along with the applications (data) and could not manage the installation and support of these applications remotely.

Graphics serving provides very high-end supercomputing applications and data views to independents on a time-fee basis. A number of large ASPs are building facilities that will house supercomputers. Soon, a small company will be able to remotely log on to an ASP's computers, use the needed computational resources and technical applications for a period of time, pay a fee, and then log off.

In addition, ASPs provide access to a substantial amount of data that are relevant to the oil and gas fields that companies are managing either directly or as portals to data providers. The providers of applications and the providers of data will be offering the ability to view those data on a pay-per-view basis for a low fee. These kinds of models provide small companies with limited capital the ability to compete in a big-company game without having to lay out big-company capital. In many cases, even big companies will prefer to adopt this model to preserve their capital or pay lower prices for reconnaissance projects.

Halliburton and Schlumberger, among others, have strategies underway to provide their customers with both data and applications in an ASP/DSP format. Their intentions, of course, are to cater not only to smaller producers, but also to large multinational and national oil companies. The independents can ride their coattails and get the same benefits.

ASPs may also have networks of consultants, often professionals with years of major oil company experience and substantial skill sets. These skills will be made available through the Internet to provide services to oil and gas companies on an as-needed basis. This is yet another vehicle that takes advantage of the fact that data and applications are online, leveraging the Internet to bring experts into these companies and allow them to operate for the benefit of independents and majors alike.

The People Problem

One of the net impacts of the consolidation and downsizing in the oil industry is that fewer university students are majoring in petroleum engineering and earth sciences. With fewer qualified candidates coming out of the universities, the demographics of the work force are becoming highly skewed. In fact, the average age of an oil company scientist is now the mid- to late 40s.

Oil and gas companies are seeing that the majority of their workforce–the most skilled and experienced experts–are about to exit the industry, and there is very little to back-fill behind them as they depart. Understandably, this is causing a lot of stress in corporate boardrooms. How are these companies going to remain capable, technical-based organizations in 15 years, after the bulk of their talent has retired?

In response, companies are increasingly using computers to capture the current work process and experience base so they can apply them to future processes. In the old days, the employee worried about being replaced by a computer, but now it is the employer that is worried about whether it can figure out a way to use a computer to replace these workers as they retire. The reality is that, in the near future, companies are going to find it unavoidable. Companies need to begin modernizing technology infrastructures to prepare for the day when they can no longer hire enough quality people, because they are simply not available.

High-performance computing and visualization is the future of oil and gas companies. The technology enables the collection of increasingly precise information from wells, communicating that new information back to the office, assimilating that new information into the decision-making process, visualizing that new information in a large-visualization format, and conferencing collaboratively (including long-distance, real-time collaboration) with other experts to make the best decisions from those data. ❒

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