

E&P

www.eandp.info

A Hart Energy Publication

May 2007

A photograph of an offshore oil rig at sunset. The rig's complex structure of towers, ladders, and pipes is silhouetted against a vibrant sky of orange, red, and purple. The sun is low on the horizon over the ocean. In the foreground, several large, insulated pipes run across the deck.

Arctic Operations

4-D Seismic
Time-lapse seismic goes mainstream

Well Planning
Techniques, tools trim uncertainty

Cementing
Alternatives build better bonds

Offshore Construction
Advanced concepts add value

Retracing our steps

Time-lapse seismic and related marine technology take us where we have gone before.

AUTHOR

Michael Tang, WesternGeco

Imagine that you are the skipper of a motorboat in a waterski-jumping competition. A skier is towed behind your boat at a fixed speed on the run toward a floating ramp. You swing the boat across to the ramp and launch the skier into the air. The skier successfully and gracefully lands far and beyond the ramp, and retains control of the ski rope without getting wet — a perfect 10!

Do it three times. How can you be sure that you can put the skier on the same spot every time before you swing away? How can you be sure that the wake will be the same? How can you be sure that you will swing at the right moment? Every little variable affects the distance and landing and, subsequently, the performance.

What if there was a technology that duplicated your experience, one that allowed you to replicate the exact conditions? A technology that took you where you went before? The key is repeatability.

Time-lapse seismic

Four-dimensional (4-D) seismic acquisition is all about repeating the vintage survey conditions so that a comparison of the two surveys will show the difference (time-lapse) signal.

The advent of 4-D seismic technology and the requirement for a high level of acquisition repeatability bring with it another level of complexity: to reduce non-repeatable noise in congested areas as well as in areas with strong and rapidly changing currents. There is a need to bridge this level of complexity. We must evolve.

Research has indicated that one of the major contributors to non-repeatable noise is the inability to exactly reposition the sources and receivers in subsequent surveys and that, even in the best case,

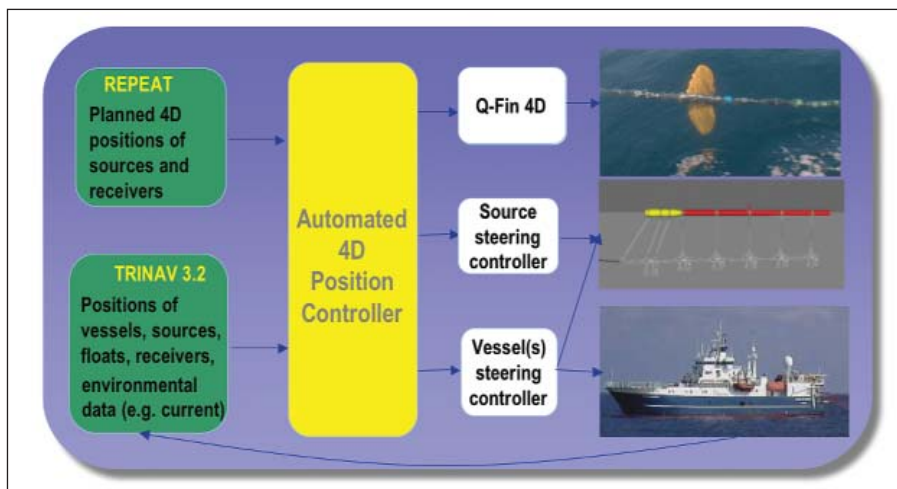


Figure 1. The concepts. (Images courtesy of WesternGeco)

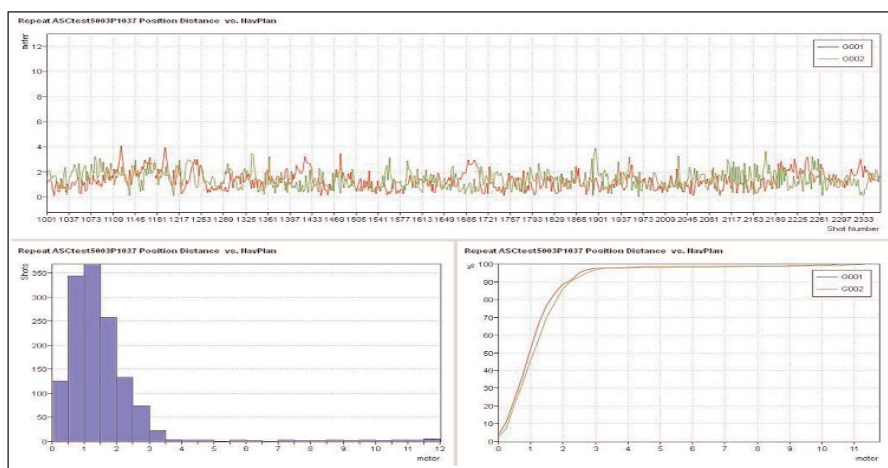


Figure 2. Results of the integrated system test showing the position difference between actual and desired shot positions.

conventional systems without streamer steering and high-accuracy streamer positioning generally do not achieve a repositioning within even tens of meters. In the worst case, positioning mismatches can be more than 330 ft (100 m). At such divergence, it is very difficult to detect any but the strongest time-lapse signals.

Research further indicates that the other limiting factor is the non-repeatable noise originating from the non-target zone such as the seismic signal energy that reverberates between the seafloor

and the sea surface, obscuring the seismic signal from the target. To reduce such non-repeatable noise, higher repeatability is required.

Precise repeatability

Repeatability needs to be taken to a higher level of precision and accuracy. The synergy between man and machine is necessary to achieve the required level. First and foremost, the way forward is automation; it is not possible for an operator to accurately predict the

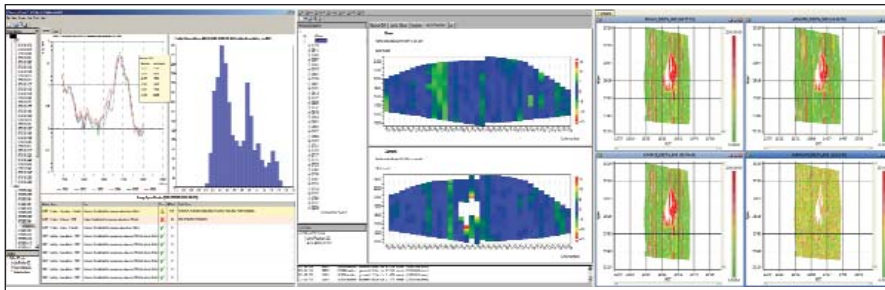


Figure 3. Displays of statistical analysis and 4-D attributes.

behavior of the towed spread and vessel in a dynamic marine environment.

Next, to achieve very tight source repeatability specifications, there is a need for intelligent independent source steering. Tests have shown that it is generally not possible to achieve very tight source position specifications with vessel steering alone. The ability to position the source independently in an intelligent manner means that the vessel must be steered positioning the front of the streamer, which subsequently improves receiver repeatability.

Finally, to be prepared is only half the battle. It cannot be overstressed that successful 4-D projects start with good strategic planning. The information obtained must be:

- **Relevant.** It must change your beliefs about another uncertainty.
- **Material:** The information must have the ability to change decisions.
- **Economical:** The cost of the information must be less than its value.

Synergy

With these requirements in mind, WesternGeco has developed Q-Marine 4-D technology (summarized in Figure 1). The navigation plan created in this module, REPEAT, contains the desired source and receiver positions based on the data from the vintage survey or surveys. The information in the navigation plan is also used to control the source firing for accurate inline position control. The same application is also be used to evaluate and analyze the 4-D results.

The intelligent automated steering controller (Q-Pilot) is the heart of the system, and it automatically steers the vessel, sources and streamers to achieve the best possible 4-D match. Both the navigation plan and the real-time positions are fed into the steering controller, where the system evaluates the scenario and sends the necessary information to the streamer steering devices, source steering and vessel steering controllers. The system is designed with relevant intelligent con-

trollers for constant positioning improvements.

The first test of the fully integrated system was carried out on the Q-Marine vessel *Western Regent* in the Moray Firth area offshore Scotland at the end of 2006. Initial results showed a very good match between the actual and the desired shot positions. The test results are illustrated in Figure 2.

As with any other system, there is a need to tie all of the results together in near-real time to enable fast decisions regarding 4-D acceptability. This integrated module minimizes data handling and management risk.

The planning and quality evaluation module allows the user to evaluate all 4-D acquisition strategies. Using this module in conjunction with the Q-Xpress tool, a proprietary integrated data acquisition and processing workflow for near real-time data analysis, operators can evaluate the 4-D quality in both the shot and common mid-point domains. In addition, the module provides statistical analysis and flexible displays of all relevant 4-D attributes. Examples of screen shots are given in Figure 3.

Composite reports are automatically published to WesternGeco's Internet-based remote viewing and monitoring system between offshore and onshore, which allows remote project monitoring from design to delivery. It supports onshore teams who can make rapid decisions from remote locations at any time, thereby controlling the 4-D project cost and quality by monitoring up-to-date information. Figure 4 shows examples of composite reports viewed through the SuperVision remote viewing and monitoring system for offshore and onshore.

Conclusions

Seismic surveys can be repeated accurately through integrated automated proactive steering of vessels, sources and streamers. With intelligent planning and quality control tools, 4-D seismic challenges can be met with advanced applications and technology. **ENP**

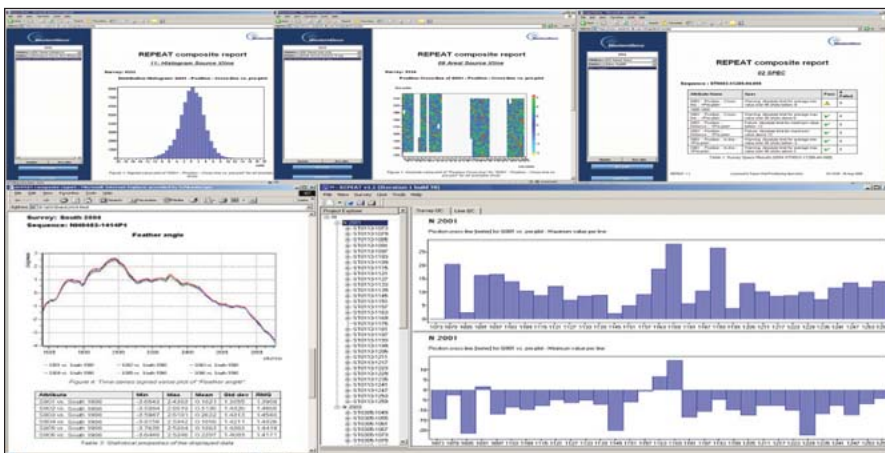


Figure 4. Composite reports generated by REPEAT and published through SuperVision.