Streamers on autopilot

From steerable streamers to streamers that steer themselves, a new system targets the issues of trousering and feathering.

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Airline pilots use it to guide their airplanes. Ships' captains use it to guide their vessels. Now seismic crews can use it too — autopilot for streamers. Nautilus, Sercel's newest positioning tool for all aspects of streamer control, is now in commercial release. Among the many novel features of the system is the ability to put the streamers on "autopilot," that is, to regularize streamer shape at the touch of a button.

For years seismic crews working with multistreamer spreads have struggled with irregular streamer shapes caused by currents and other oceanographic phenomena. One common problem is "trousering," where the inner streamers form a V-shaped gap as separation between them increases toward the tails. Obtaining uniform 3-D bin coverage when suffering from trousering is impossible, leading to longer survey durations to acquire additional infill. The images in Figure 1 are from a recent test and show streamers with the trousering effect and the rapid improvement in streamer shape provided by the new system. The two images were taken within 15 minutes of each other. The regularization of streamer shape provides significant improvement in coverage, reducing the need for infill.

Once the streamers are put on autopilot, they maintain the desired separation without intervention from the operator, even during turns.

Less feathering

If needed, corrections for feathering, another common problem, can be applied to the streamers without disturbing their regular shape. Feathering corrections in excess of 3° are possible, all without any significant noise impact. The noise data in Figure 2 show the acoustic signature of Nautilus on a Sentinel solid streamer. There is no noise beyond what traditional depth controllers contribute, even with a high steering effort. Part of this is due to the careful design of the node, and part to the noise performance of Sentinel.

The system's autopilot features also extend to fully automated depth control. A fully braced acoustic network

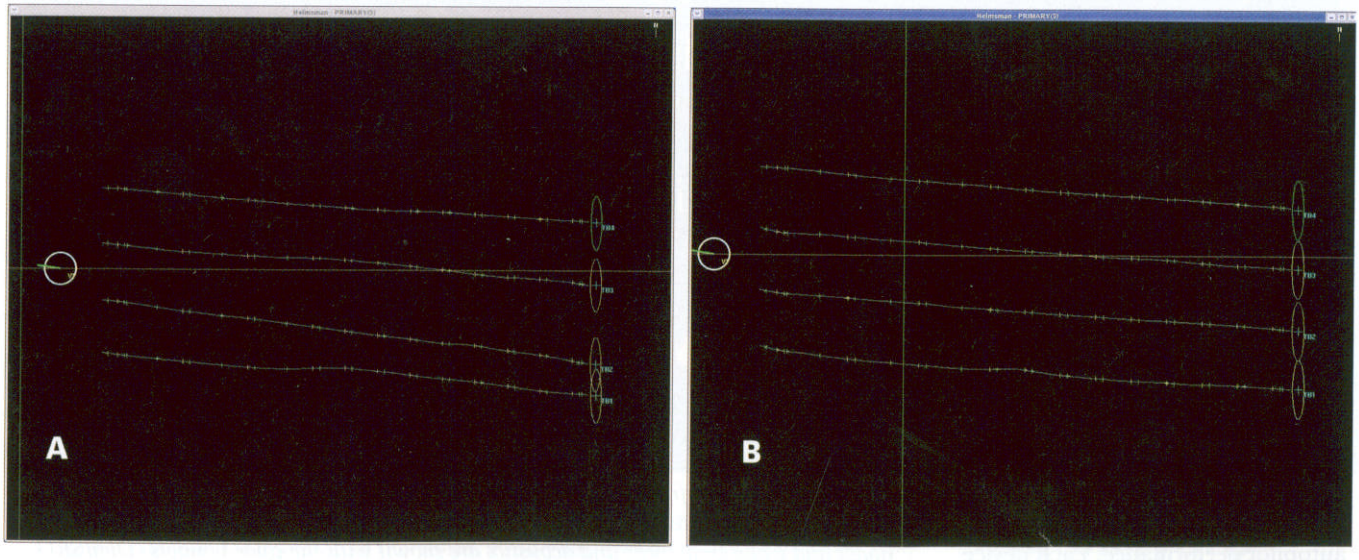

***Figure 1.** Streamers on autopilot. Figure 1A shows a four-streamer spread with pronounced trousering. Figure 1B shows the same spread 15 minutes later after spread regularization or "autopilot" has been enabled with Nautilus. Cross-line scale expanded for clarity. (Images courtesy of CGGVeritas)*

is also provided, with no additional devices required for mounting on the streamers. The nodes are easy to install and deploy, as shown in Figure 3. The system utilizes a dedicated, fully redundant communication link with a sophisticated telemetry protocol that allows consistent communication on streamers in excess of 39,000 ft (12,000 m). The devices can take power from any of three sources — a dedicated power link, streamer power, or a back-up battery.

Acoustic package

In addition to the full acoustic, depth and lateral steering system, Nautilus is also available in an acoustic-only package. The acoustics, in both the full package and the acoustic-only configuration, use an acoustic transducer mounted in the termination of the Sentinel section installed in front of the device. The acoustic transmission scheme is unique in using a sequence of chirps transmitted in quick succession. The individual chirps can be received and decoded independently. The number of chirps received can be compared to the number expected to generate a quality figure for the acoustic ranges. Additionally, the system exports ranges to the navigation system as soon as they are received with precise time tags rather than outputting ranges in bulk with a single time tag assigned at the end of the entire ranging cycle. Nautilus can already be interfaced to the industry-standard SPECTRA and ORCA navigation systems. Advanced functionality is planned for the system when deployed with Sercel's new SeaProNav navigation system, which is itself nearing commercial release.

Independent control

Designed from the ground up as a fully integrated system, the node system includes many unique features. One of these features is at the heart of its autopilot performance. Each device has sophisticated hardware and software built in that provides the nodes with the ability to calculate lateral separation between streamers and make any necessary steering corrections to preserve the assigned separation. This feedback loop operates autonomously without the necessity of any communications with, or feedback from, the navigation system or the controller onboard the vessel. With this unique arrangement of autonomous steering, the streamers truly are on autopilot.

Another unique feature is the elegant mechanical arrangement which controls the steering surfaces. Not only is the mechanical linkage novel, but the size, shape, and position of the wings are all carefully designed to provide maximum steering power and stability with minimum streamer noise. The autonomous in-water control loop and the mechanical design are covered by a suite of US and international patents.

In addition to improving data quality by regularizing 3-D and 4-D coverage, the system delivers on other fronts as well. Health, safety, and environment (HSE) exposure is reduced by taking power from the streamer. There are no lithium batteries to store and handle, and no workboat deployments to replace them. There is also a greater margin of safety when working around obstructions in the presence of variable currents. Beyond HSE, the efficiency of seismic crews using the system will improve due to shorter line change times and less time for infill acquisition, as well as by reducing tangles when deploying and recovering streamers.

Sercel used a unique development approach to design the system. In this approach, major portions of the project were distributed to Sercel subsidiaries working with a networked communication structure and building to a carefully detailed design specification. To further accelerate the delivery, the company integrated manufacturing engineers into the development teams with the aim of shortening the time to get from prototype to production tooling. This efficient development strategy was coupled with exhaustive qualifica-

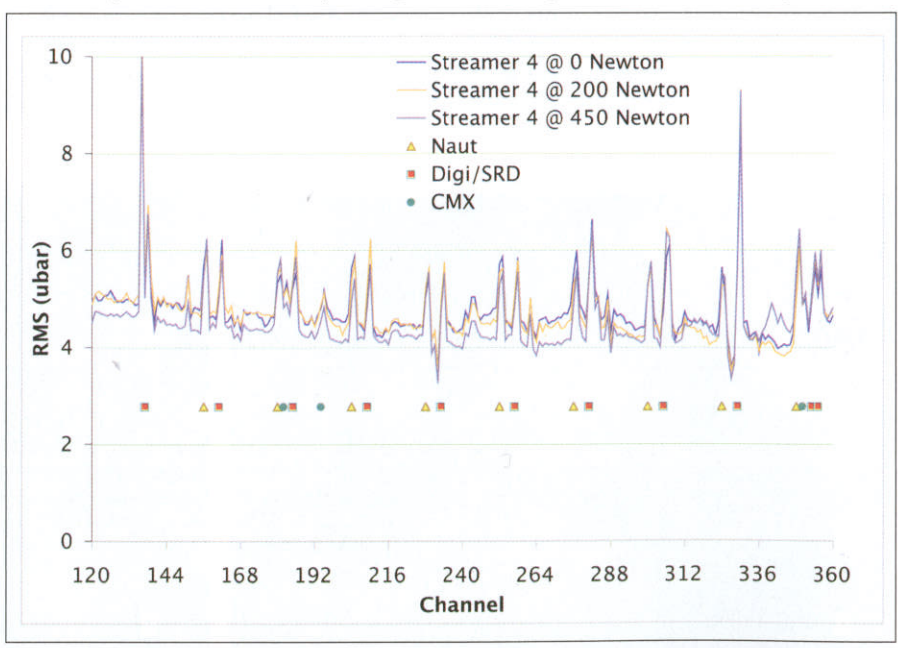

Figure 2. Noise data from a recent Nautilus test. Data calculated with a 3 Hz low cut filter. Streamer 4 was steered with various levels of steering force. The positions of Nautilus nodes and traditional birds and acoustics are shown with the color symbols (Digi/SRD refers to a standard depth controller and streamer recovery device; CMX refers to a standalone acoustic pod). Overall noise levels do not vary with steering force. The noise at Nautilus devices is indistinguishable from that produced by traditional devices.

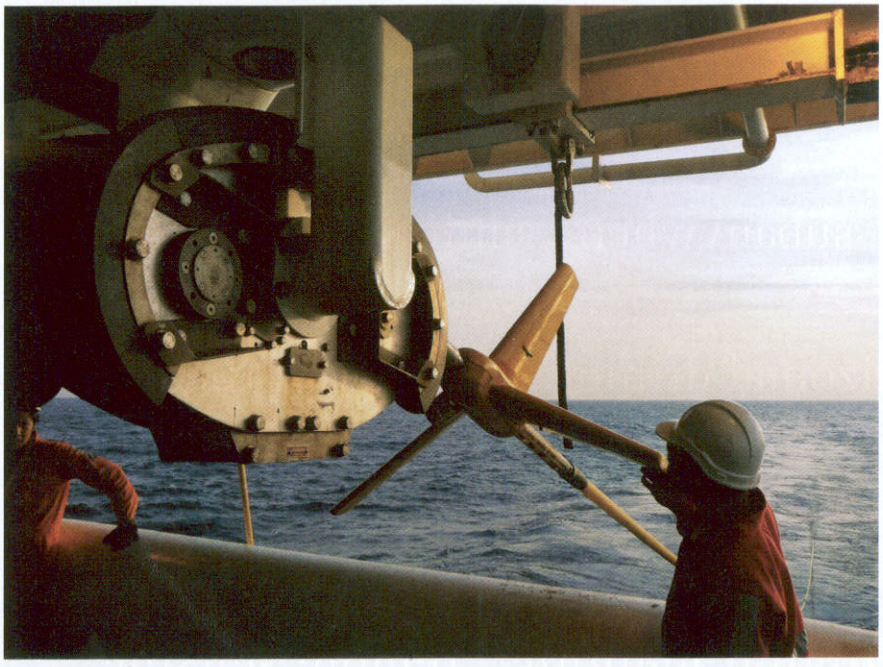

Figure 3. With present-day streamer handling systems, Nautilus goes over the stern easily.

tion, thorough testing, and careful attention to detail. To prepare for the commercial launch, a team of customer support engineers has been assembled with specialized training and Nautilus field experience.

A far-ranging roadmap for implementation of additional data quality and efficiency improvements is in place with a steady stream of enhancements planned for the coming years. For example, there are possibilities in 4-D acquisition for deliberately introducing "pre-steering" artifacts in cable shape to mimic a baseline survey.

The first commercial deployments of Nautilus will be on two CGGVeritas high-capacity 3-D vessels, one with an acoustic-only system, the other with the full steering, depth control, and acoustic system. Further deployments are planned beyond these first two systems. E&P