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Let's make some noise

Proponents of simultaneous sources are banking on newer, better processing techniques to take advantage of the cost-savings this technique enables.

By RHONDA DUEY, Senior Editor

Noise. It is the bane of geophysicists. For years, processors have developed filters to suppress it, remove it, or somehow work around it to find the signal amongst all that noise. So anyone who acquired a seismic survey that intentionally introduced more noise would have to be crazy, right?

Not necessarily. The concept of firing sources simultaneously, rather than letting the vibrations of one source fade away before firing the next, has recently been embraced in large land seismic surveys with impressive results. Mostly these are efficiency gains, reducing the cost of these surveys considerably. But the unexpected consequence is that the data are more densely sampled — always a good thing in a seismic survey.

What about shooting simultaneous sources in the marine environment? Here, several challenges present themselves. First of all, marine seismic surveys rely on airguns rather than vibrators. This takes away the sweep effect. Also, multiple sources means multiple source boats, which, until recently, was not particularly feasible.

But attitudes about marine simultaneous sources are beginning to change. Leading that charge is Craig Beasley, chief geophysicist for WesternGeco.

Lying fallow

In an abstract describing his talk for the Society of Exploration Geophysicists (SEG) Distinguished Lecturer series, Beasley noted that this idea was originally posited in the late 1990s, but it has "lain fallow" until recent changes in marine seismic surveying. To go even further back in time, his introduction to a special section on simultaneous sources delivered at last year's annual SEG meeting outlines studies that have nothing to do with seismic surveys but which suggest that removing the noise from this method might not be impossible.

Modern wide-azimuth acquisition typically utilizes four or more vessels. (Images courtesy of WesternGeco)

First of all are studies done in the 1950s on the "cocktail party effect," relating to the fact that it is possible to hold — and concentrate on — a conversation with one person in a noisy, crowded environment. It is equally possible to tune out a conversation that does not interest you. This has led to technology in speech recognition as well as work in air traffic control centers.

The second bit of interesting research was done at Bell Labs in the late 1990s. Here the goal was to overcome conventional relationships between frequency bandwidth and information content by using multiple antennae and exploiting propagation differences to separate the signals.

"These developments are mentioned not only for their novelty and similarity to current developments in geophysics but also because of the impact these new paradigms had in their respective sciences and businesses," Beasley wrote. "The [cocktail party effect] work … certainly paved the way for speech analysis and recognition and could be considered seminal in the understanding of human communication theory in general. The work at Bell Labs … could be said to have revolutionized the wireless communications industry. It is possible that simultaneous sources could have a similar effect in our domain."

In the 1980s, a paper was published looking at the issue of crew interference — two or more boats shooting in the same area. One of the conclusions,

Beasley said, is that if the timing of the shots on the different boats is not synchronized, then the data can be sorted where the interfering data are randomized. While this paper did not discuss simultaneous sources, it is easy to see where a carry-over might apply.

In 1997 his company, then Western Geophysical, did a simple 2-D study using simultaneous marine sources, primarily motivated by illumination deficiencies in conventional marine acquisition. While the experiment was a success, uptake was hampered by the need for additional boats — not common practice in those days — and the terminal-velocity drop in oil prices.

"Around 2004 or 2005, we started to shoot wide-azimuth surveys, and the setup was perfect," he said. "We already had multiple boats on the prospect. We didn't have to convince anyone to put another boat on the prospect."

With that major hurdle out of the way, other companies also began to take interest. But marine simultaneous source adoption still lagged behind land.

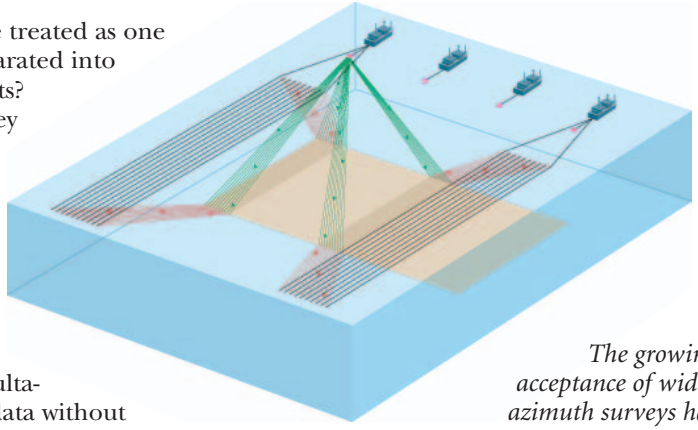
Making the value case

That is starting to change. The efficiency gains offered by simultaneous sources are enormous. "This is the reason that it was attractive to people in the first place," Beasley said. "If you are successful at suppressing interfering shots, if you are successful at separating them, then you can save a lot of money."

As experiments have continued, operators are also pleased at the fact that by doing the survey more efficiently, they end up with better spatial sampling.

However, the challenges are also numerous, and they lie primarily in the processing domain. Like multicomponent surveys, simultaneous source surveys provide much more data than a traditional survey. The question is what to do with those data. Should they be treated as one dataset, or separated into discrete datasets?

Currently they are typically separated. "In practical terms, nobody is very comfortable with trying to process simultaneous source data without separating it," he said. "Most people would prefer to apply some separation process so the shots look just like they would without interference. Then you would have the normal processing sequence."



The growing acceptance of wide-azimuth surveys has made marine simultaneous source surveying more practical.

But certain existing processes — like migration — seem to be applicable to the entire dataset without separating. "What we envision is improving this filtering technique to its maximum capability, and this is the topic of heavy research right now — just how well can we do on that step?" Beasley said. "If you look at the results qualitatively, the judgment most people make is for structural imaging and stratigraphic interpretation. Then you have the full power of filtering plus migration to eliminate interference."

Other processes might not lend themselves well to this approach. Amplitude vs. offset, for instance, is sensitive to very small amounts of noise, and 4-D seismic studies require the extraction of very delicate changes in the seismic signal.

To examine that issue, WesternGeco did a simulation of a two-boat undershoot around a fixed platform using existing data. The resulting dataset would have had a slightly higher background random noise element, he said, but other unintended benefits emerged. By shooting simultaneously, the boats would be able to travel faster in the undershoot area. This means better streamer control, which means a safer operation as well as better coverage in the obstruction zone (which, most likely, lies directly over the field).

"It's a detailed analysis, and it turns out that in that case it would have saved money," Beasley said. "There is a trade-off. There would be this low level of added noise, not enough, we think, to have affected a 4-D analysis. But right where the field is, where the obstructions are, you get better coverage, and you get better 4-D.

"This was a simulation, but it did answer the question — yes, it's possible to lower the costs and increase the safety profile. These are important things as well."

Beasley's delight at the SEG granting a special section to simultaneous sources is palpable in his presentation. "Although it is clear that the roots are deep and the subject is not new, it seems that we have reached a tipping point, or point of critical mass, that is necessary to introduce a new paradigm," he wrote. "The potential benefits of increased acquisition efficiency are of such a magnitude that we must investigate this opportunity. In response, we see rapidly growing research efforts in simultaneous sources. For these reasons, I conclude that the time has come for simultaneous sources in geophysics." E&P