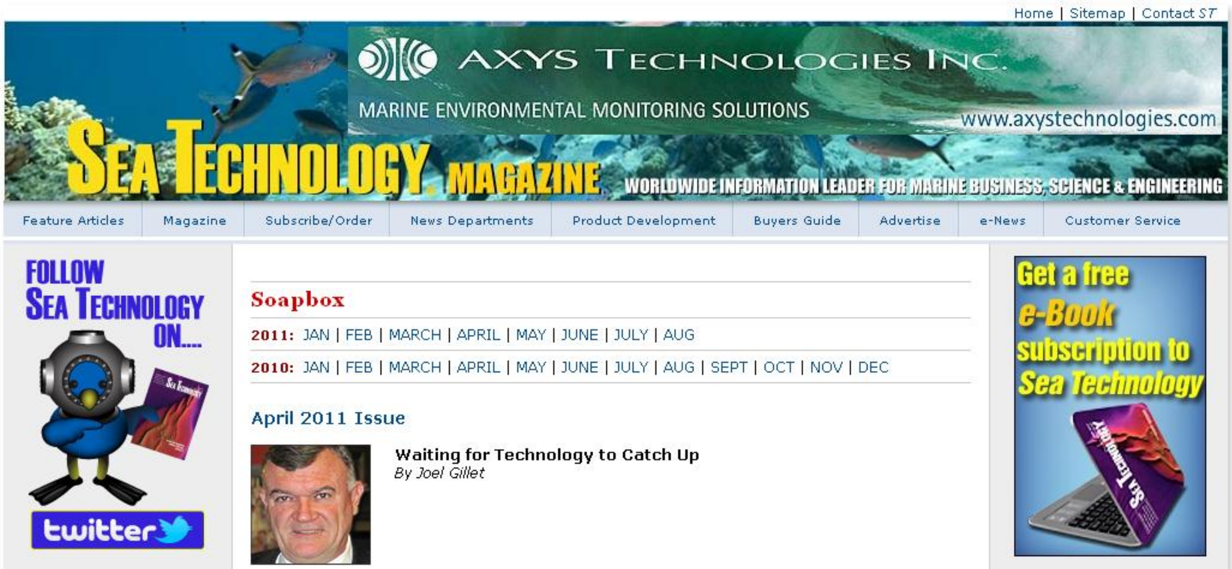

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Waiting for Technology to Catch Up

By Joel Gillet

Applications for inertial navigation systems (INS) offshore, particularly with subsea applications, have seen tremendous growth in the past decade. These applications include dynamic positioning for surface vessels; orientation for multibeam and side scan sonars, as well as laser and 3D cameras underwater; and positioning and orientation of instruments at depth, not to mention the complete navigation of all submarine vehicles.

But one thing we tend to forget is that all the methods and procedures behind INS metrology were studied and tested more than three decades ago. The only thing it had been waiting for since the 1970s was for a new form of INS implementation to become available: strapdown INS. And, of course, the end of the Cold War.

An INS, which is typically housed in a sealed box, uses three accelerometers and three gyroscopes mounted perpendicularly in order to capture all motions in a 3D space. It comes with a powerful processing chip running very high rate navigation software and elaborate Kalman filters.

The principle and methodology for INS metrology were first detailed and published in 1977 in an Offshore Technology Conference paper given by Alain Stankoff, of Intersub Developpement, and R.A.R. Tait, of Ferranti Ltd., The authors explained that the system is independent of acoustic and subsea interferences, writing that "a new tool is now available to the offshore industry to simplify and/or improve the efficiency and the accuracy of underwater jobs such as tie-ins, measurement of flow-line position and length, pipeline surveys, installation of platforms, sea bottom profiling, navigation in acoustically disturbed environment, etc."

Stankoff and Tait also indicated how to repeat the measurements, how to compensate errors—it was all in their paper given in May 1977 in Houston. Around the same time of the presentation, the theory was tested on the FRIGG line on a Total Oil Marine and Compagnie Francaise des Petroles project. Their accuracy was already very good, although INS metrology accuracy has improved to be better than 50 millimeters with today's instruments.

When Stankoff and Tait presented that paper, some of us were wearing bell-bottom pants, Chairman Mao was holding his little red book and Elvis was still alive. So why did it take more than three decades for the inertial metrology method to finally catch on and for it to be widely used offshore.

For one thing, it was the Cold War. Civilians and the public at large only had access to large gimbaled inertial systems, even though military developers started working on new generations of INS that did not have to be mechanically oriented vertically or toward north and therefore did not have the huge size and power requirement of the gimbals. These new INSs were simply "strapped down" on the vehicle and could handle and compute every single motion, thanks to powerful processors and very accurate (and smaller) types of nonmoving gyroscopes, such as ring laser gyroscopes.

Once the Cold War came to an end, the military allowed industrial contractors in the mid-1990s to share the strapdown INS technology with the public, but the method of Stankoff and Tait detailed for subsea metrology didn't change: Align on a known location for about one hour (the well head is a good location to start from). During the alignment, the sensors will estimate gravity and Earth rotation and precisely "orient" the instrument in reference to north and east-west vectors within a fraction of a degree. When the INS is ready to navigate, survey between two points and stop on each for a period of "reset" of biases named zero-velocity updates. A "reset of bias" is a static period during which the information from each sensor can be separated into signal and noise for the simple reason that the signal is "zero." This is also called grounding the error and allows a full estimation of the evolution of the biases between stops.

Jumper metrology is just one example of a modern INS application. This is simply the survey of the location and orientation of two hubs (one at the wellhead and one at the manifold) that will accept the future jumper or spool piece in an oil or gas field. The piece of pipe or "jumper" that will connect the pipeline system to the wellhead needs to be prefabricated at the surface and carefully lowered and locked into place before the fossil fuel coming out of the well will be distributed through manifolds to the pipeline and on to onshore facilities.

Needless to say, the length of the jumper and the orientation of both hubs have to be measured extremely precisely, and this can be done in a two- to three-hour dive by an INS tool handled by a remotely operated vehicle. This "new" method, first commercially deployed in 2008, is a dramatic improvement over traditional long baseline acoustic metrologies, which often require an entire day in simple line-of-sight situations or three to four days for more complicated situations, such as network acoustics.

This means that for nearly three decades, a viable, tested technology that could provide major advantages was not being used commercially. All that was missing at the time of those sea trials was the end of the Cold War and the distribution of strapdown inertial systems to civilians. The engineers who designed the method for INS metrology 30 years ago were simply ahead of their time.

Big companies that have the means to test new ideas offshore are not always forward thinking, instead focusing on the technologies of yesterday. As seen with INS technology, it is not enough for engineers to build a better mousetrap. If we want to avoid major delays in bringing technology to market, it will take some major player to test and pursue new ideas until they are commercially viable.

Joel Gillet, vice president of IPOZ Systems LLC, is a land survey and navigation specialist. Since the mid-1990s, he has been involved in the development and usage of inertial navigation system instruments for land survey and offshore work, ranging from surface applications, such as the orientation of survey vessels and dynamic positioning, to seabed applications like jumper metrologies.