Wernli's Law of More — *Robert L. Wernli Sr.*

Robert L. Wernli Sr. retired in 2005 from his first career in underwater vehicle technology with the Space and Naval Warfare Systems Center, San Diego, California. As president of First Centurion Enterprises, he has begun his second career as a writer and consultant on underwater systems.

I have written several technical papers about commercial autonomous underwater vehicles (AUVs) with the theme "who is leading the pack now?" However, the real question is "who will be leading the pack in 2020?"

The answer begins with Moore's Law—the law where the number of transistors per given area on a chip will double about every 18 months. As a mechanical engineer, the analogous Law of More began to form. What is the Law of More and how does it apply to AUVs and the ocean?

Six years ago, the AUV market projected exponential growth due to their cost savings over towed systems. After all, the offshore market was booming, especially in route surveys for telecommunication cables. However, this growth would not continue, and the cries of irrational exuberance by a few icons in the U.S. stock market were ignored. Eventually, the market collapse would also take the telecommunication industry with it. Ultimately, the optimists' other projections were right. These new AUVs could reduce the cost of offshore surveys from 50 percent to 80 percent. The efficiency and success of these vehicles (such as C & C Technology Inc.'s (Lafayette, Louisiana) C-Surveyor™) has resulted in many large AUVs left waiting at the dock for the next job.

In the 1960s and 1970s, manned submersibles ruled offshore. Nearly every major company involved in the oceans and/or defense were building the next great submersible. Unfortunately, most ended up displayed at the entrance to their respective companies. There were too many (and they were too costly), and the remotely operated vehicle (ROV) was knocking at the door. These robotic intruders—underwater eyeballs that would never replace manned submersibles, nor divers—rose in popularity in the 1980s, and were assimilated offshore in the 1990s as companies pushed into deeper waters.

Eventually, the dominant players (like Houston, Texas-based Oceaneering International Inc.) began to corner the market for offshore ROVs working worldwide.

Will history repeat itself? Today, AUVs are strutting in from stage right, but their optimistic projections have not yet been realized, and the military is still trying to squeeze a ton of technology out of a 21-inch tube. Many countries are successfully integrating AUVs on mine countermeasure surface ships, however, the high cost of military vehicles leaves them few and far behind.

Are these missed projections another example of irrational exuberance? And, what became of the Law of More? The answers are found in small, low-cost AUVs (such as Hydroid LLC's (Pocasset, Massachusetts) REMUS and Bluefin Robotics Corp's (Cambridge, Massachusetts) nine-inch-diameter vehicle). What do they have in common? The companies' initial vehicles began as spin-offs from academia, where vehicles were put together in an environment of meager budgets and inexpensive labor. They were developed to work and return, because the students could not afford to lose them.

In several of my past AUV papers, I have ended with the battle cry "now is the time to lose some AUVs." Blasphemy? Not necessarily. If you have plenty of inexpensive vehicles, then you will not lose sleep if one is occasionally lost. Torpedoes, cruise missiles and, now, unmanned air vehicles are expendable. They are not cheap, but compared to the benefits (and potential alternatives without them), the loss is acceptable.

Where is this leading? The sad fact is that we know more about the other side of the moon than the underwater world of our own planet. We are missing the knowledge that is critical for the maintenance of mankind itself. What is the solution?

My projection is, by the year 2020, that the academic community's commercial spin-offs of AUV technology will be the ocean's version of Microsoft. They were there first, with a vision of how to cost-effectively solve a problem, and how to build the infrastructure to do so. I believe that the small, low-cost AUV will grow exponentially from now into the future. Moore's Law foretells miniaturization—smaller sensors, more efficient energy sources and, ultimately, that smaller, cheaper AUVs will be developed.

By the year 2020, Wernli's Law of More will become apparent. More AUVs being built and used will cause acceptance, acceptance will increase usage, increased usage will result in the loss of some vehicles, losses will require that more AUVs be built, more AUVs will be built and so on.

There is money to be made by mass producing these excellent machines, and someone will lead the pack. AUVs will go far, deep and operate from shore or small boat. They will live for years in remote sites where they will suckle their energy from arrays (such as that envisioned by the Project Northeast Pacific Time-Series Undersea Networked Experiments), conduct investigations and periodically dump data into the Internet. These small vehicles will not pose a threat to shipping. Running over one would be no worse than the ship hitting some ever-present flotsam. The vehicle will sink and, if properly designed, biodegrade into the benthic ooze.

Eventually, the military will jump on the bandwagon and abandon their multi-million dollar behemoths. These vehicles will perform the mission, feed back data and disappear into the environment. Military AUVs need to become more like toothpaste: a small, expendable amount squeezed out of a tube will quickly do a satisfactory job, leaving the user with a big, bright smile. By the year 2020, thousands of small AUVs will be working the world's oceans. For proof of this vision, do not miss my soapbox article in the June 2020 issue of *Sea Technology* magazine: "The Law of More—More Than a Theory." Now is the time to start losing some AUVs. /st/