TIDAL SHIFT

Zivko's smart-towed vehicles enable accurate data gathering while avoiding wave hazards

For both climate modeling and effective radar detection of ships, aircraft, and incoming missiles, it's often necessary to take low-altitude oceanic air samples. But the ocean's surface isn't always amenable to data collection. Rogue or "monster" waves with heights of up to 100 feet can sometimes appear without warning. Until recently, effective data gathering was limited by how close to the ocean's surface research aircraft could safely collect samples.

After experiencing several rouge waves, the U.S. Navy recognized the need to fly manned research aircraft at higher altitudes, reducing personnel safety risks, but they still needed the ability to collect useful data close to sea level.

In 1996, the Department of Defense (DoD) issued a request via its Small Business Innovation Research (SBIR) program for a towed research device. Zivko Aeronautics, Inc. (ZAI)—a woman-owned, Guthrie, Oklahoma-based small business—set to work on finding a solution.

The result is the Controlled-Towed Vehicle (CTV)—a durable, smart enclosure into which research instruments, such as thermometers, hygrometers, and Global Positioning System/Inertial Navigation System (GPS/INS), can be placed. Towed by a specialized aircraft flying above potentially dangerous waves, the CTV is capable of being lowered over the ocean while maintaining a specified altitude. The stabilized platform is designed so that it travels below any wake turbulence produced by the main research aircraft, thus providing "clean" air data samples. The system is designed to fly in the 10-meter (32-feet) zone above the ocean—the area most known for atmospheric gradients.

Eric Zivko, ZAI President, said, "The SBIR award allowed us to design, manufacture, and test the vehicle using a Twin Otter aircraft at a government site in Monterey, California.

"We did a significant amount of engineering and development," he added. "The CTV is self-powered, self-contained, and wireless. It is lowered from the host aircraft using an electrically powered, regeneratively braked cable winch designed to be installed in the fuselage of a Twin Otter aircraft."

Initial testing was fairly uneventful. A few minor problem areas were identified but, overall, the system operated exceptionally well. The biggest hurdle was the communication link between the CTV and the system operator, located approximately 5,000 feet away. ZAI eventually settled on a commercial-off-the-shelf (COTS) autopilot solution to make communication and controllability of the CTV acceptable.

"Ultimately, work on several SBIR projects helped catapult Zivko Aeronautics into becoming an industry leader for composite instrument enclosure design and manufacturing."

Eric Zivko and Katherine Lindley

The company transitioned the technology to the Navy, which continues to use it today in conjunction with university scientists. The CTV is regularly deployed to measure flux, or exchange rates, between the air and sea boundary layers. The collected data is invaluable for climate prediction and radar propagation models, both of which have national security implications.

Dr. Haflidi (Haf) Jonsson, Chief Scientist and Research professor at the Naval Postgraduate School in Monterey (NPS), said, "The purpose of the CTV was to measure exchange rates of heat, momentum, and water vapor between the ocean and the atmosphere. Ideally, you measure these rates right on the water surface, because there may be features above the surface that alter the flow of these properties. The further away from the surface, the more likely it is that you are not measuring the surface rates. On the water, you usually are stuck with measurements in one place, or on a slowly moving ship over a small area. From an airplane, we can cover a wider area, but the compromise is the distance from the surface. To protect the pilot, our airplane is allowed to fly no lower than 30 meters above the water. The need to get closer was addressed by the CTV, which we can tow as low as 10 meters."

The flux determination is needed to measure wind, vertical wind, temperature, and water vapor density. "All parameters have to be measured at high rates (40 times per second), which can be challenging," Jonsson explained. "The exchange rates we measure influence the temperature of the overlying air, which

Photos courtesy Zivko Aeronautics

Zivko's controlled-towed vehicle (CTV) seated under its plane.

influences the weather. These rates also influence the temperature and humidity distribution in the boundary layer, which ultimately influences the transmissivity of light, radio, and radar signals in the air. This temperature and humidity distribution can greatly affect the radars' range and can also lead to radar 'dead zones' where nothing can be detected."

The CTV system not only enhanced the NPS's Twin Otter platform, it enabled data collection that has increased the Navy Research Program's potential mission capabilities.

Capitalizing on Zivko's experience, the Navy awarded the company a separate SBIR contract to develop a four-dimensional atmospheric and oceanographic instrumentation manufacturing process—something previously difficult, if not impossible, to achieve. Zivko leveraged the learning acquired from the development of the CTV to perfect a process that rapidly builds lightweight, accurate, and strong enclosures.

The Navy reports that Zivko's process, "permits rapid development of suitable molds. Their method enables the manufacture of affordable, closetolerance composite structures for high performance aircraft and offers a solution to a perennial problem in instrumentation: packaging multiple instruments together in a way that permits each instrument its necessary inputs."

The standard process involves applying fiberglass to foam, and then carving it into shape—a time and labor intensive process. Zivko does the opposite. They machine the foam into shape and then add the fiberglass coating. The novel manufacturing technique significantly reduces costs and allows the company to quickly respond to changing customer needs. As a result, the Navy is now able to collect timely meteorological and oceanographic data.

Katherine Lindley, Zivko's vice president of contracts said, "That SBIR contract indirectly led to additional work for ZAI. Ultimately, work on several SBIR projects helped catapult Zivko Aeronautics into becoming an industry leader for composite instrument enclosure design and manufacturing. Today, we work with commercial and government customers, creating user-friendly enclosures that are mounted to a variety of manned and unmanned aircraft."

Zivko Aeronautics, Inc.

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