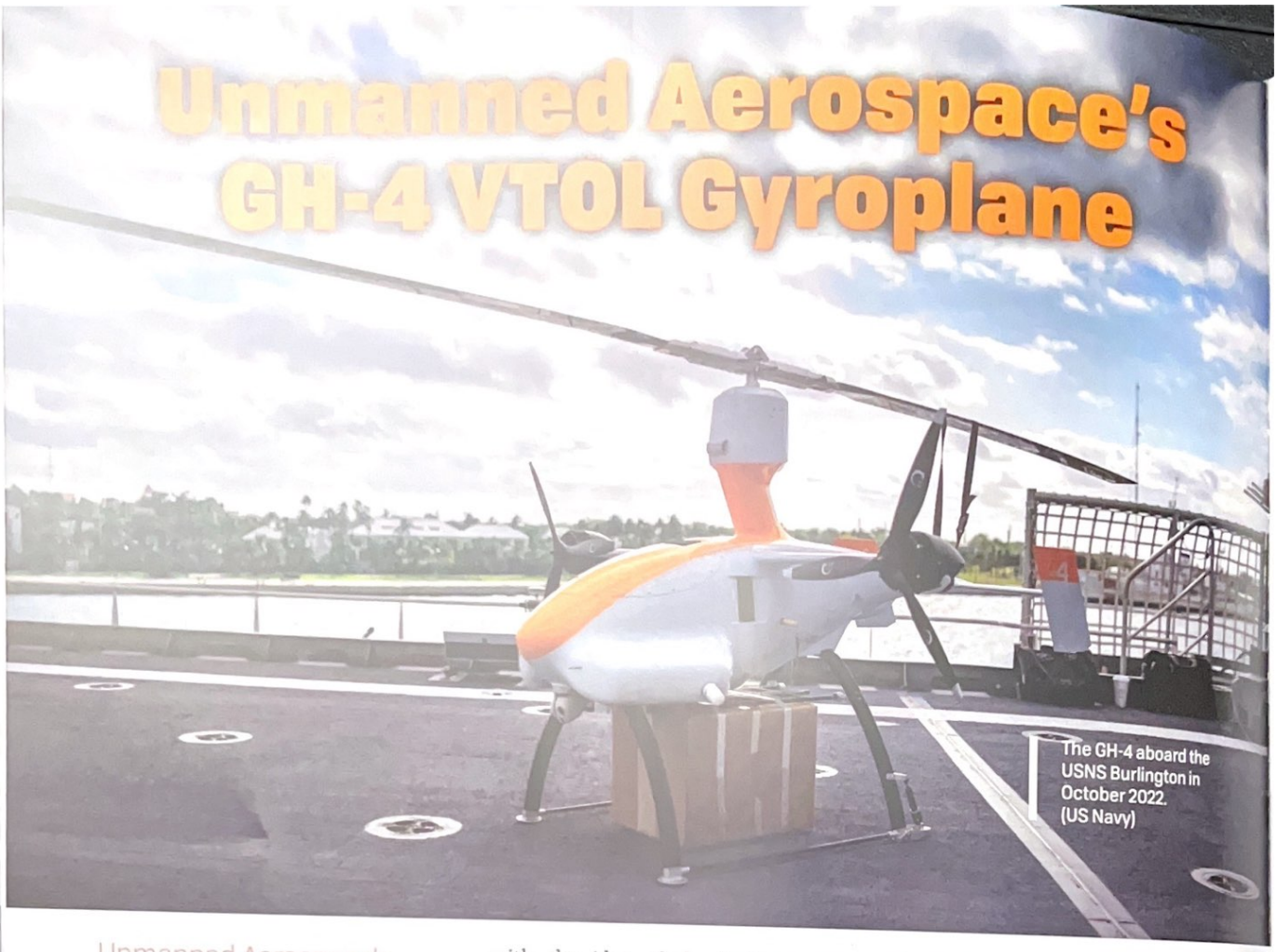
Unmanned Aerospace's GH-4 VTOL Gyroplane



The GH-4 aboard the USNS Burlington in October 2022. (US Navy)

Unmanned Aerospace's hydrogen-powered, autonomous VTOL gyroplane is gaining traction with the US Navy for low-cost logistics delivery.

By Robert W. Moorman

For some people, retirement is a welcome change after many years of toiling in the workplace. Gad Shaanan is not one of those people.

"I tried it for six months and that didn't work for me," said Shaanan, founder and CEO of San Diego, California-based Unmanned Aerospace (UA), his fifth start-up business in a noteworthy 40-plus-year career.

To spark his creative juices again, the restless inventor, industrial designer and entrepreneur attended several military and industrial trade shows, with the idea of developing a new, useful and affordable aircraft. This idea morphed into a full-blown design for an uncrewed rotorcraft based on the simple gyrocopter (aka gyroplane or autogyro) but with true vertical takeoff and landing (VTOL) and hover capabilities. The resulting GH-4 is an aircraft without the weight, mechanical complexity and high direct operating and maintenance costs of a helicopter. It's a simple aircraft optimized for quiet, safe and efficient operations for the civil and military sectors.

The GH-4 eliminates around "85% of a helicopter's complexity, meaning 85% less maintenance," said Shaanan.

At present, the company is under contract with the US Navy to test the autonomous, hydrogen fuel cell-powered GH-4 aircraft, as well as a jet-fuel version, to determine the aircraft's applicability. Hydrogen is one of several alternative fuels that the Navy and other military branches are considering to power future aircraft.

The GH-4 first came to the attention of the US Naval Forces Southern Command in 2021 as a vehicle that could help deal with the narcotics threat emanating from South and Central America and the Caribbean. At that time, the company was flying a full-scale, remotely controlled, battery-powered gyroplane demonstrator (shown above).

"The design of the GH-4 gyrocopter is very novel in its flight control system," said Dr. Christopher P. Heagney, Fleet Advisor for the US Naval Forces Southern Command and the US Fourth Fleet. "The simpler, more robust and reliable an aircraft, the better. The GH-4 has incredible range and should be capable of thousands of flight hours before failure."

Heagney "discovered us," recalled Shaanan. UA, a finalist in a competition involving alternative-energy-powered aircraft, was invited to demonstrate the GH-4's technology and capabilities onboard the USNS Burlington, an

expeditionary fast transport operated by the Navy's Military Sealift Command, in October 2022. At the time, UA had not yet begun training the autopilot, so didn't fly it on the ship.

In recent years, the Navy and other military branches have begun to show interest in hydrogen and other alternative power sources. As part of the Navy project, UA plans to introduce a hydrolyzer, a machine that generates hydrogen in a 24-hour timeframe. "We plan to demonstrate to the Navy that they do not need to lug a month's worth of hydrogen onboard ships," said Shaanan. "These are relatively small machines that can generate enough hydrogen for multiple flights."

Funding for the GH-4 program comes from the Pentagon's Operational Energy – Innovation Directorate (OE-I). The military is now primarily interested in the GH-4 and other drones as low-cost surveillance and logistics delivery platforms.

With the characteristics of a simple gyrocopter and robust rotorcraft, the scalable, 120-lb GH-4 can carry a 15-lb (6.8-kg) payload presently. In time, larger variants of the GH-4, with 60-lb (28-kg) and 300-lb (135-kg) payloads, could be developed for various military roles, including an air ambulance to evacuate soldiers from the battlefield or to deliver supplies and medicine.

On the civil side, the GH-4 and larger GH-5 could provide aerial surveillance for police, deliver supplies to remote communities, inspect powerlines and monitor forests for possible fires.

The company is considering licensing its technology to a well-capitalized company that "wants us to scale up with larger passenger-carrying variants," said Shaanan, who declined to provide further details at this time.

UA's founder expects the GH-4 will be released in late 2025 for Navy evaluation use. The company hopes to go into production in 2026. Obtaining an experimental license from the US Federal Aviation Administration (FAA) for civil service will come next, followed by full certification and mass production.

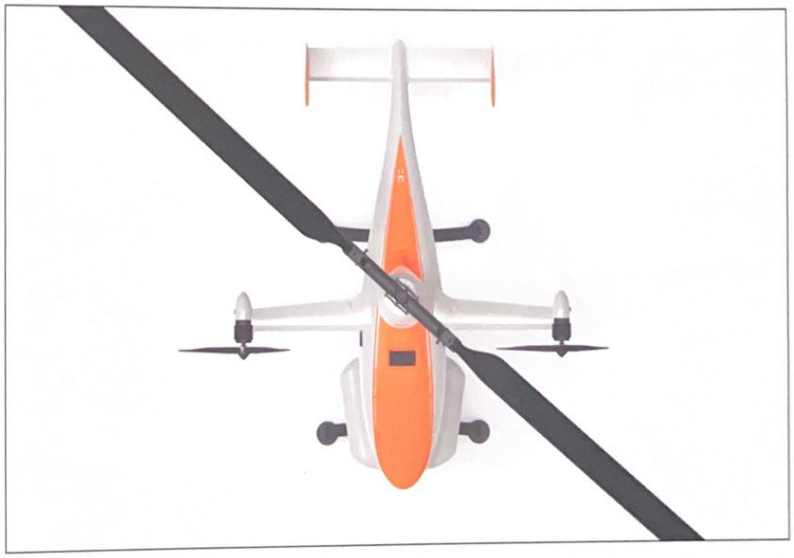
Recent testing of the battery-powered GH-4 testbed under remote control. (Unmanned Aerospace)

Powerplant

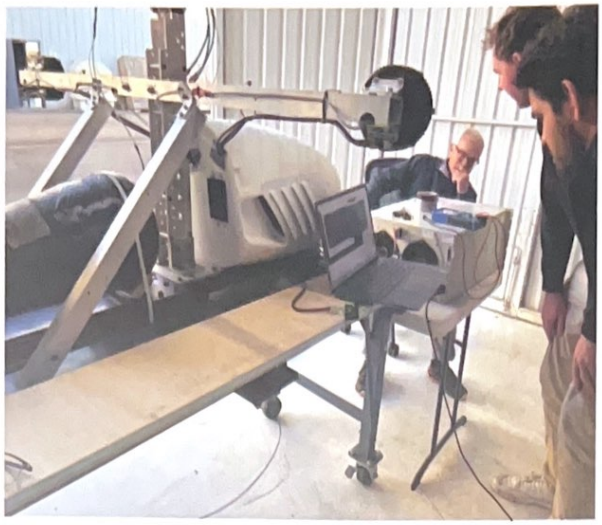
UA's story began a few years ago when Shaanan and his small staff, working in a converted hangar near San Diego, assembled the GH-4.

Most hydrogen fuel cell-powered VTOL aircraft need additional batteries for the peak power demands for vertical flight and hover. The GH-4 is equipped with two booster batteries on the landing skids. This location was selected because it offers easy access to install and replace the batteries, has better center-of-gravity balance and for safety — keeping the batteries away from the hydrogen fuel cells reduces the chance of a fire onboard the aircraft.

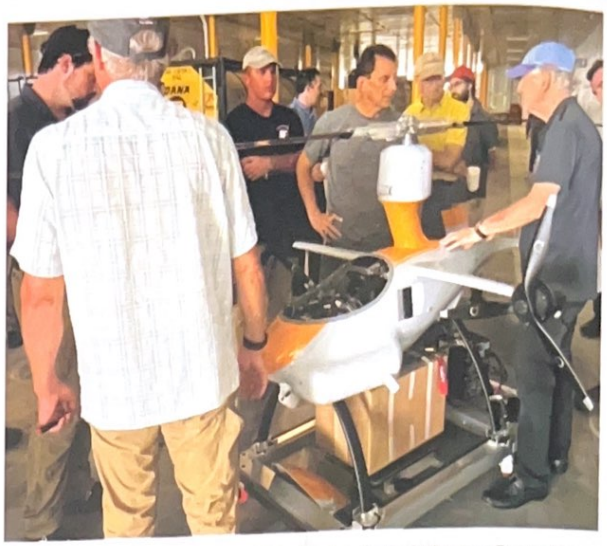
Shaanan was asked why he chose hydrogen over lithium-ion batteries, the power source for numerous electric VTOL aircraft currently being developed. "In general terms, batteries are not efficient from a weight-to-power ratio," he said, "whereas hydrogen fuel cells offer several compelling advantages for aviation, including higher energy density, longer range, faster refueling as well as environmental benefits."



The GH-4 can be used as a platform for logistics and other missions. (Unmanned Aerospace)



Testing the hydrogen-electric powertrain as part of an iron bird. (Unmanned Aerospace)



The GH-4 aboard the USNS Burlington in logistics configuration. (US Navy)

The military's use of small, hydrogen-powered autonomous aircraft to support the air fleet is no longer a back-burner topic. The US Department of Defense (DoD) is actively looking at smaller, affordable aircraft to fill a mission gap for the warfighter. Shaanan said that the narrative at DoD now is: Why use a large expensive helicopter or fixed-wing aircraft for moving small packages when a small drone will suffice?

Proponents of hydrogen power got a boost in May 2023 when DoD's Operational Energy Capability Improvement Fund (OECIF) approved the use of alternative energy options to meet the needs of various aircraft of the military. The advanced technology fund, initiated by Congress in 2012, focuses on first-of-their-kind innovations. OECIF has also been funding Unmanned Aerospace.

Notable Innovations

Among Shaanan's design innovations on the GH-4 is the new collective dubbed the Automatic Pitch System (APS).

"Think of it as an automatic transmission in cars," explained Shaanan. "The pitch of the blades goes from gyro mode to helicopter mode by turning on the rotor motor. We gain and reduce altitude by increasing or decreasing the rotor RPM. We use the centrifugal force of the blades at a higher RPM than a gyrocopter would fly at, to open up the collective, and close again when returning to gyro mode."

The rotor rpm automatically changes the collective pitch; there is no cyclic control. Tilt angle of the rotor shaft affects the aircraft pitch and roll, while the two propeller thrusters are used for yaw and forward thrust.

UA has obtained multiple patents for the APS in the US, Japan, Israel and Germany. Patents are pending in other countries.

Gyroplanes produce less drag in forward flight than a helicopter rotor. The GH-4's teetering rotor provides thrust for vertical flight and hover, but converts to autorotation in forward flight. The GH-4 requires 40% of the energy in forward flight of a conventional helicopter, and the fuel cell system recharges the booster batteries in flight.

"Unlike a fixed-wing aircraft, the GH-4 cannot stall and can tolerate much stronger winds," said Shaanan. Weighted blade tips produce a much higher inertia rotor system, which cuts through turbulence better than a conventional helicopter, according to UA.

Meanwhile, UA continues testing the maneuverability of the GH-4, as well as the use of a tweaked Veronte autopilot from Embention; the Spanish company specializes in autonomous control for uncrewed aircraft systems (UAS). "What we are doing now is teaching the autopilot how to fly our aircraft," said Shaanan. He said the flight testing has completed about 70% of the autopilot programming to be capable of flying autonomously.

Among the key characteristics of the GH-4 is a projected range of 140 nm (260 km), a 4.5-hour flight time and a 120-lb (54-kg) gross weight. The all-electric system powers two wingtip-mounted, three-bladed propellers; the aircraft also uses two position servos to move the rotor shaft forward and aft. One of the propellers provides counter-torque during vertical and hover flight.

The GH-4 might be described as a hybrid helicopter and gyrocopter. Gyrocopters have excellent low-speed and low-altitude capabilities. And they cost far less to make and operate than a comparable helicopter but cannot hover, takeoff or land vertically. Gyrocopter rotors are not typically powered; instead, they autorotate and provide lift only because of the forward flight. In contrast, the GH-4 has a rotor drive that engages only during vertical flight, hover and transition operations — a cost-saving feature compared to a helicopter. Unlike a helicopter, the GH-4 is not equipped with a swashplate and related linkages, using rotor head tilt.

UA has nearly 50 hours of total flight time to date, and the company continues to improve its proof-of-concept GH-4. Looking to the future, Shaanan said that the GH-5 will weigh about 320 lb (145 kg), with a 60-lb (27-kg) payload and a total flight time of five hours or about 350 miles (560 km) at 70 mph (113 km/h). The aircraft will be reconfigurable between logistics and other missions, and will be ruggedized for land and sea operations. It folds to a minimum footprint and is deployable in minutes. Like with the GH-5, UA is planning to have the option to use a hydrogen fuel cell or an internal combustion engine burning jet fuel.

About the Author
Robert W. Moorman is a freelance writer specializing in various facets of the fixed-wing and rotary-wing air transportation business. With more than 30 years of experience, his writing clients include several of the leading aviation magazines targeting the civil and military markets. He can be reached at **rwmassoc325@gmail.com.**

Founder Focus: Gad Shaanan

Gad Shaanan's professional history is noteworthy. He spent three years in the Israeli Army and fought during the 1973 Yom Kippur War. Following military service, he worked and consulted for numerous companies, including Bombardier/Canadair, CAE, General Electric, Kyocera, Motorola, Qualcomm, Siemens and other businesses.

Shaanan's other inventions are not to be forgotten. For California-based SmartCup, he invented a new way of brewing American-style coffee, one cup at a time. For lubricant maker WD-40, Shaanan and his team invented the Smart Straw that sprays lubricants in two ways. In 2015, the UA founder invented an integrated blood glucose meter with lancets and test strips. The device connected through a cellular network so a caregiver could track a person's performance and results worldwide.

Shaanan is an adherent of the "keep it simple, stupid" (KISS) principle as it relates to his novel aircraft. "I have dedicated my life to developing simple solutions, and the GH-4 exemplifies that idea. The simpler the product, the more time you must devote to keeping it simple."