Luminati Creates Vertically Integrated VTOL Development Business

At press time, the first electric Rotorcycle had completed initial ground runs. (Luminati photo)

Daniel Preston has acquired a number of key intellectual property rights, licences and manufacturing capabilities, leveraged partnerships and cutting-edge technology, and created a rotorcraft production and development hub in upstate New York.

By Kenneth I. Swartz

In May 2019, Luminati Aerospace exhibited a vintage Gyrodyne XRON-1 Rotorcycle coaxial helicopter at the VFS Forum 75 in Philadelphia equipped with a small electric motor to power the pair of 20-ft (6-m) diameter rotor blades.

Luminati's Gyrodyne XRON-1 Rotorcycle was displayed as a work in progress at Forum 75 in May 2019. Left-to-right: Peter Stone, Daniel Preston and Alex Stone. (Author photo)

Two months later, the Little Falls, New York-based company displayed the same aircraft equipped with a new, custom computerized numerical control (CNC) machined 125-hp (100-kW) electric motor (de-rated from 185 hp/138 kW) and a sizable under-seat battery pack at the Experimental Aircraft Association (EAA) AirVenture in Oshkosh, Wisconsin. (See "Oshkosh e-AirVenture," *Vertiflite*, Sept/Oct 2019.)

In Oshkosh, Wisconsin, in July, Luminati had fitted the battery pack and electric motor to the Rotorcycle. Dr. Zucker explains the Polarix motor in the background next to a frame for the larger QH-50 rotor system. (VFS staff photo)

Ground runs in a controlled environment began in mid-December inside a large former US Air Force hangar at Griffiss International Airport in Rome, New York, which supports the development of aerospace businesses in the region.

Luminati was formed in 2015 by aviation entrepreneur Daniel Preston after he spent a number of years pursuing the development of high-altitude, solar-powered long endurance drones. Preston previously worked at Atair Aerospace, a company he founded, which worked with a number of government agencies including

DARPA on products ranging from satellite-guided parachute systems to unmanned aircraft systems (UAS).

Preston developed a business interest in vertical flight after numerous flights in a helicopter as a passenger and later as a student pilot.

"I started looking at all the technologies around rotorcraft that I was interested in and… hopscotched the country visiting companies that I thought had interesting ideas or technology [that] for one [reason] or another hasn't become mainstream," said Preston.

He was particularly interested in vertical takeoff and landing (VTOL) aircraft designs suitable for electric propulsion that have demonstrated a high level of safety and can autorotate if something goes wrong.

This led Luminati to licence rotor technology developed by Richard "Dick" DeGraw for conventional and compound gyroplanes, acquire the intellectual property rights for the Gyrodyne Company of America technology in an asset sale, and buy the Dragon Wings rotor blade factory from Ernie Boyette of Rotor Flight Dynamics, Inc.

Now Luminati has started the process of creating a vertically integrated manufacturing company focused on developing, building and selling coaxial rotor and compound helicopters and "jump takeoff" gyroplanes. In addition, the company has now started building VTOL aircraft for other aerospace companies.

Gyrodyne

Gyrodyne Company of America was the leading developer of coaxial rotorcraft for more than 50 years and produced the first drone helicopter to enter operational service, and one of the first armed UAS.

The company was founded in the late 1940s when aeronautical engineer Peter James Papadakos bought the assets of Bendix Helicopters, Inc., including the five-seat Bendix Model J coaxial helicopter, which became the basis for the Gyrodyne GCA-2B compound helicopter. (See "The Incredible Story of the QH-50 DASH — The First Unmanned Helicopter Turns 50," *Vertiflite*, Spring 2011.)

The GCA-2B had a gross weight of 5,400 lb (2,450 kg) and a pair of 48-ft (15-m) diameter main rotors powered by a 450-hp (335-kW) Pratt & Whitney R-985-B4 Wasp Junior radial engine. It became the first compound helicopter developed in the US when two 95-hp (71-kW) Continental engines were attached to each side of the airframe, each powering a propeller for forward thrust.

Early coaxial helicopters like the GCA-2 utilized differential collective and rudders for yaw control in powered flight, but this didn't provide adequate yaw control in autorotation. Gyrodyne set about to solve the problem by installing small air brakes at the tips of the rotors that used induced-drag to provide yaw control during all phases of flight.

The tip brakes were linked to the flight controls through a rod inside the rotor blades and a shaft running through the center of the rotor mast.

The single-seat Gyrodyne XRON was the first helicopter to utilize the tip brakes for yaw control. It was developed in the mid-1950s

Luminati first displayed the piston-powered Gyrodyne Rotorcycle at Oshkosh in July 2018. (Author photo)

to meet a US Marine Corps requirement for a small helicopter that it could be dropped to a downed pilot behind enemy lines. It was flown with several different engines, with the 72-hp (54 kW), four-cycle Porsche engine providing a 900-lb (408-kW) gross weight.

Gyrodyne didn't get a USMC order, but the stable helicopter caught the attention of the US Navy, which saw an opportunity to turn the piloted XRON into a remote controlled helicopter for its Drone Anti-Submarine Helicopter (DASH) program.

The first-generation, Porsche-powered, QH-50A drone flown in 1960 had a maximum gross weight of 1,100 lb (500 kg) and was equipped with a homing torpedo.

After many tests, the US Navy ordered the QH-50C, powered by a 255-hp (190-kW) Boeing T50-4 turboshaft engine. The QH-50C, with a maximum takeoff weight of 2,285 lb (1,036 kg), was followed by the QH-50D, which had a more powerful Boeing turboshaft engine and a semi-rigid rotor incorporating fiberglass blades; notably, the blades featured a 2:1 taper ratio with a negative twist of 12 degrees and a heated de-icing system.

The unmanned QH-50 Drone Anti-Submarine Helicopter (DASH) was developed in the 1950s to find and kill enemy submarines. (Luminati photo)

The US Navy deployed 758 QH-50 drones on 165 ships in the 1960s, and when they were retired from anti-submarine warfare duties they were used as target drones and target tows until retired in 2006.

The QH-50 also served with the Japanese Maritime Self Defence Force, and Gyrodyne provided Israeli Aircraft Industries and Dornier

in Germany with QH-50 technology in the mid-1980s, which they used to develop surveillance drones with modern electronics.

With the asset purchase, Luminati obtained 40-years of Gyrodyne documents including tooling, blueprints, photographs, engineering data and government reports. "It's overwhelming," said Preston.

Electric XRON

The electric-powered XRON helicopter is a technology demonstrator, but "I can tell you performance is stellar compared to the original," said Preston.

The aircraft has been named "Record Breaker One" because Luminati aims to break the world endurance record for an electric helicopter, and "we should have no problem hovering for over 45 minutes," said Preston.

The company's partnerships with PEMS Machine and Tool and technology innovators have opened new possibilities for electric and conventional Luminati rotorcraft. (Luminati photo)

The first indoor tests inside a hangar validate the replacement of mechanical clutches with digitally controlled electric motors.

"We are performing a series of spin and flight tests to datalog the performance of our virtual slip clutches programmed into our electronic drive system and to verify the performance of the battery management system developed in-house for the helicopter with a lot of sophisticated programming," said Preston.

Dick Degraw adjusts the Rotorcycle rotor head assembly (Luminati photo)

The tests will also evaluate the integration and performance a new high-specific power electric motor technology licensed from Dr. Oved Zucker of Polarix Corp., which uses cutting-edge semiconductor technologies in a novel turn-less motor topology. The construction of the motor was engineered by Preston and his business partner Peter Stone of PEMS Machine and Tool Inc. and manufactured in-house in Little Falls.

"The engines used for bench tests are producing 22 hp per pound [36.2 kW/kg]," said Preston, which is well above current electric motors and internal combustion engines.

Once the design is validated, Luminati will apply to the US Federal Aviation Administration (FAA) for a flight permit to conduct outdoor tests at Griffiss Airport, which is also one of the seven FAA-designated UAS test sites.

The fact that the XRON started life as a manned helicopter with flight controls and can autorotate made it a natural decision to test fly the electric version with a pilot, rather than unmanned.

QH-50 Project

Luminati is also developing a larger coaxial experimental helicopter that utilizes later model QH-50 rotor and transmission dynamics system that will be powered by the Czech 241-hp (180-kW) PBS Velká Bíteš TS100 turboshaft engine, which is already installed in several new ultralight helicopter models (e.g. the Italian IRI G-250 Eagle and Curti Zefhir, and the Ukrainian Softex Aero VV-2).

"We've been following PBS for a long time… and were very impressed with the work they did," said Preston, adding that "the quality and precision is excellent and the price point is beautiful; we can buy two for the price of one Rolls-Royce [turboshaft] engine."

The Gyrodyne QH-50B was designed as a twin-engine drone but never entered production. During development, the company found that the transmission was suited for multi-engine inputs without creating external torque reaction problems, and with only a small overall weight increase per added engine.

Coaxial Opportunities

While not a fast helicopter, Preston believes the very stable hover characteristics of Gyrodyne make them suitable for a wide range of manned and unmanned applications.

One advantage of the coaxial XRON and QH-50 designs is that all the major components of the helicopter (e.g. engine, landing gear, fuel tank, flight control system, sensors etc.) are bolted directly to the transmission without the need for any additional structure, giving the helicopter a small footprint and a high power-to-weight ratio.

Later model QH-50D drones carried a weapon load of up to 1,140 lb (517 kg) and had a combat radius of about 40 nm (74 km) with four-hour loiter capability at a cruise speed of 80 kt (148 km/h).

The electric XRON and turbine QH-50 will probably be marketed as experimental category kit helicopters and for unmanned military missions, with newly manufactured aircraft to be placarded at a maximum cruise speed of 120 kt (222 km/h). However, further development of the QH-50 for commercial passenger use would require a type certification program, which Preston estimated would cost at least $100M, even with leveraging more than 40 years of engineering data.

Luminati is also open to the idea of suppling the Gyrodyne's

coaxial rotor and transmission as a modular "core" to other VTOL developers requiring such technology.

Compound Gyrocopters

Luminati's licensing agreement with DeGraw is focused on making hybrid-electric compound gyrocopters with increased speed or endurance.

A self-taught machinist, welder, designer, builder and test pilot, DeGraw designed and built the RDX1091 Hummingbird synchropter (N5275Y), powered by a Volkswagen engine. It first flew in November 1984 and won the Outstanding New Design (Rotorcraft) Award at EAA AirVenture that year. DeGraw has designed, built and test flown several gyroplanes, one of which is the Gyrhino that won the $20,000 prize at the Popular Rotorcraft Association's first ever "jump" takeoff competition.

Videos of Gyrhino 1, Gyrhino 2 and the streamlined LFINO — "Leap Flight In Normal Operations" and pronounced as "'ell if I know" — proof of concept aircraft developed with Ernie Boyette show the aircraft doing vertical jump takeoffs and quickly transitioning to forward flight.

Luminati to licence rotor technology developed by Richard "Dick" DeGraw for the Gyrhino 2, shown here at Oshkosh in 1999, as well as other conventional and compound gyroplanes. (Courtesy of Luminati)

Aircraft using DeGraw's three-bladed, fully articulated rotor can perform zero roll takeoff and landings, enabling operations in tightly confined areas usually accessible only by more expensive helicopters. A partially powered rotor system also minimizes drag by the rotor system, allowing for an increased cruising speed and additional range.

The Gyrhino uses an automatic transmission with compound planetary sets to produce torque splits with about 10% of the power going to the rotor. A differential eliminates a hard connection between the rotor and the engine to improve control in flight.

The concept of a partially powered rotor is well known and has been used on rotorcraft as diverse as the Lockheed AH-56 Cheyanne and the CarterCopter, which was test flown by a team of experienced autogyro pilots, including DeGraw.

Luminati believes that DeGraw's three-bladed rotorhead is ripe for use on a hybrid-electric "jump" gyroplane that has an electric-powered rotor for lift and a piston engine to power a pusher propeller, as well as an alternator to produce electricity for the rotor and a battery pack.

"We are talking about a next-generation rotorhead that can sense what the aircraft is doing in a millisecond and a thousand times per revolution," said Preston, who envisions building a two- to three-seat gyroplane in the 2,600-lb (1,180-kg) weight class.

Luminati has also licensed DeGraw's four-blade, soft-in-plane rotorhead where the pitch changes are fed through a gyroscopic stabilizing flywheel.

Preston said the four-blade rotorhead was designed for a high-speed compound gyroplane and he believes using an electric-powered rotorhead will make it easier to reduce the rotor-induced drag for a given airspeed during wingborne flight.

Luminati has contracted Barnaby Wainfan — a technical fellow for aerodynamics at Northrop Grumman, an adjunct professor of aeronautical engineering at the University of Michigan and a well-known light aircraft designer — to develop non-military, low-drag, lift-generating, carbon monocoque cabins for both compound gyroplanes.

Manufacturing

Preston bought a heritage house in Little Falls, New York, as a retreat in 2017, then decided to relocate his business to the scenic town that lies between the Catskill and Adirondack mountain ranges.

Then just over a year ago, he met Peter and Isabella Stone, owners of PEMS Machine and Tool, Inc. in Little Falls and they became partners in Preston's plans to create a vertically integrated VTOL manufacturing company.

Peter Stone started working as a machinist in the early 1980s and gradually built PEMS into a busy ISO 9100 certified machine shop with more than 30 CNC milling/turning machine tools that produce precision-milled machine parts for the aerospace, automotive and firearm manufacturing industries.

PEMS has ongoing contracts to machine driveshafts for the UH-60 Black Hawk and AH-64 Apache and is a long-time parts supplier to the Remington Arms Company located in nearby Ilion, New York.

The production of Dragon Wings rotor blades kicked off VTOL manufacturing work in Little Falls. Luminati bought all the blade maker's production tooling and shop equipment and shipped it from Wimauma, Florida, to the PEMS facility. Production began in mid-2019 and 14 blade sets were completed by December.

Preston said that the most popular rotor is an all-aluminum bonded blade that has a chord of 7 inches (18 cm) and a diameter of 22–28 ft (6.7–8.5 m), including the teetering rotor hub. The leading edges are made of an extruded and CNC machined 6061-T6-aluminum section and upper and lower aluminum skins that are chemically etched prior to being attached using an expensive bonding agent and cured in special ovens. Then, "the blades are polished just shy of a mirror finish to make sure there are no cracks that can propagate," explained Preston.

The company also makes an 8.5-inch (21.6-cm) cord blade in up to 32-ft (9.8-m) diameter, and recently bid on contract to make a 58-ft (17.7-m) diameter rotor.

Smaller cord blades are typically used on one- to three-place, ultralight and experimental class gyroplanes and helicopters, and the wider cord blades for heavier aircraft.

A lot of manufacturers of ultralight and experimental class rotorcraft are Dragon Wings customers and the blades are also purchased by individuals building kit aircraft or their own rotorcraft designs.

In mid-2019, Luminati trucked two composite manufacturing machines to Little Falls that it already owned. These are custom LIBA Max 3 and LIBA 150 multiaxial stitchbonding machines made in Germany that robotically make non-woven composite fabric used in the production of carbon fibre reinforced composites.

To accommodate all the manufacturing equipment, in mid-2019 Luminati bought a 410,000-ft² (38,090-m²) manufacturing facility on Hansen Island in the middle of the Mohawk River in Little Falls.

Skyworks Connection

After seeing the Luminati XRON-1 helicopter at the VFS Forum 75 in May 2019, Don Woodbury and Ashish Bagai from Skyworks Global, Inc. visited Little Falls to see Luminati and PEMS to learn more about their blade manufacturing capability.

Skyworks Global was created when Groen Aeronautics Corporation (GAC), a long-time designer of gyroplanes, was acquired and re-branded in April 2017 as Skyworks Global Inc. with the goal of bringing a portfolio of gyroplanes and gyrodynes to the commercial markets. (For more on Skyworks Global, see "Advantageous Autorotation, *Vertiflite*, July/Aug 2018 and "Gyroplanes: From Novelty to Mainstream?" *Vertiflite*, March/April 2019.)

In 2018, Skyworks decided to relaunch production of kits for the two-seat SparrowHawk III gyroplane, which its subsidiary, American Autogyro Inc. (AAI), had stopped building in 2007.

Luminati is building 10 sets of parts for the Skyworks Global SparrowHawk III autogyro. (Skyworks Global)

Customers had been showing interest in the little gyroplane, but for the past 11 years Skyworks and its predecessor had been focused on bringing larger aircraft to market — such as its runway-independent five seat Hawk 5 and its 400 mph (348 kt / 644 km/h) 8–12 passenger VertiJet design, which leverages technology from the Fairey Rotodyne and the DARPA Heliplane program.

Skyworks awarded the Little Falls company a contract to build its new SparrowHawk IIIs and signed an agreement for 10 kits.

Woodbury, Skyworks' Chief Technology Advisor, told Preston that the Luminati shop was very well equipped for precision machining, composite materials, and rotor blade fabrication.

Skyworks and Luminati are also planning to collaborate to demonstrate an electric SparrowHawk technology demonstrator.

Skyworks and Luminati are planning to collaborate on an electric SparrowHawk technology demonstrator. (Skyworks Global)

Conclusion

Luminati Aerospace is a relatively small company when compared to many of today's electric VTOL startups, but it has a big head start thanks its "toolbox" of proven rotorcraft technologies — such as the Gyrodyne, which served with the US military for 40 years before its recent revival.

Unexpected Setback

The electric Rotorcycle demonstrator underwent several days of tethered ground testing at Griffiss Airport and a site in near Little Falls in mid-December with retired New York police helicopter pilot Gregory Semendinger at the controls. The electric clutch software was tested over a wide range of power settings while monitored by a safety officer; all three wheels briefly left the ground but there was no intention of making a flight.

On Dec. 16, the helicopter was driven back to the PEMS facility in a trailer so the test data could be downloaded and the aircraft inspected. During the inspection, one of the batteries unexpectedly caught fire and then there was an explosion. Nobody was injured in the blast, but it triggered a fire that destroyed part of the PEMS factory, the helicopter, some CNC machines and parts awaiting shipment to customers.

PEMS expects to be back in business on Jan. 2 running double shifts, with no impact on its contracts to make rotor blades and CNC machine parts for the SparrowHawk and Gyrodyne.

About the Author

Ken Swartz runs the agency Aeromedia Communications in Toronto, Canada. He specializes in aerospace marketing and corporate communications. He's worked in the regional airline, commercial helicopter and aircraft manufacturing industries for 25+ years and has reported on vertical flight since 1978. In 2010, he received the Helicopter Association International's "Communicator of the Year" award. He can be reached at ***kennethswartz@me.com***.