GYROPLANES: From Novelty to Mainstream?

AutoGyro has delivered more than 2,500 gyroplanes. Shown here are its current models (right-to-left): the Calidus, MTOsport 2017, Cavalon and MTOsport 2010. (AutoGyro GmbH photo)

No longer just a fun toy for hobbyists, autorotating aircraft are poised to transition into a mainstream mode of air transportation.

By Robert W. Moorman

There's nothing like new news to re-illuminate an often overlooked aircraft sector. In this instance, the sector is the autorotating aircraft industry, aka gyroplanes. There is a renewed sense of purpose and momentum in this sector — with a shift from hobbyists to professionally-designed aircraft that provide great value, along with a return to the fundamental safety offered by autorotation that was a hallmark of early gyroplanes.

"Experimental category aircraft, including gyroplanes, continue their innovation and growth within the recreational aviation community," said Sean Elliot, the vice president of advocacy and safety at the Experimental Aircraft Association. "As EAA works with [the US Federal Aviation Administration] FAA to make it possible to engage more people in flying, there is always room for gyroplane manufacturers that can bring innovative, safe aircraft to the community and supply the customer service that meets users' needs."

Significant investments in existing aircraft and new programs are in the works, and there is a major push toward certification of various models. "The gyroplane industry is significantly improving its products with new technologies and ready to enter different markets other than leisure," observed Luca Magni, managing director of Besnate, Italy-based Magni Gyro. "We are working with FAA for Primary Category and validation of [European Union] EU certifications" for the US market.

In addition, advanced technology gyroplane companies and longtime VFS corporate members Groen Brothers Aviation and Carter Aviation Technologies have been reborn with new capital and a vision to serve all-electric urban air mobility (UAM) markets under the marques Skyworks Global and Jaunt Air Mobility, respectively. (See "Advantageous Autorotation," *Vertiflite*, July/August 2018, for more on the history of Groen Brothers and a review of Skyworks Global's current plans; see "Carter's Slowed-Rotor/Compound: Putting a New Spin on an Old Concept," *Vertiflite*, March/April 2013 for a review of Carter's developments.)

In the Beginning

Gyroplanes, which predate helicopters, were popular during the 1930s and 1940s. Spaniard Juan de la Cierva pioneered the design

Skyworks Global's subsidiary American Autogyro International, Inc., announced the restart of production of the SparrowHawk III quick-build kit in November. (Skyworks image)

of the "Autogiro." His designs were later licensed to companies in the UK, the US and elsewhere.

In the postwar years, helicopters became popular and gyroplanes were relegated to the enthusiast market.

Igor Benson's Benson Aircraft Corp. developed his line of "Gyrocopters," beginning with the B6 Gyroglider, for which he began selling plans in 1954 for home builders. Soon, customers were designing their own modifications and entrepreneurs entered the market with competing designs.

Most postwar gyroplanes have been built and flown under the FAA's Experimental Amateur Built (EAB) regulation, which requires that at least 51% of the aircraft was constructed by the owner. These rules allowed amateur gyroplane builders to freely modify the plans or kits, which led to many flawed designs and pilot training was minimal at best; accidents were very common.

Understanding the Regs

The FAA has two types of Airworthiness Certificates for aircraft: "standard" and "special" (ultralight aircraft are not certified at all). Standard certifications — like Part 23 for normal category airplanes, Part 25 for transport category airplanes, Part 27 for normal category rotorcraft and Part 29 for transport category rotorcraft — are heavily regulated and require FAA-approved designs and oversight of the production process. Standard type certifications typically require tens of millions of dollars or more in testing. There are several types of special airworthiness certificates, including primary, restricted, limited, light-sport and experimental.

In the 1950s, the Experimental Aircraft Association (EAA) was established to represent and lobby the FAA on behalf of a large community of pilots flying "homebuilt" or amateur built aircraft. According to the EAA website, amateur-built aircraft are built by individuals and licensed by the FAA as "experimental." This designation, which has been around for more than five decades, "defines aircraft that are used for non-commercial, recreational purposes such as education or personal use."

The website also notes that "Under FAA regulations, if an individual builds at least 51 percent of an aircraft, the aircraft is eligible to be registered in the amateur-built category. They are available in kits (where some of the airplane is already fabricated), or plans (where the builder purchases or manufactures all the parts and assembles them). These airplanes are also commonly known as 'homebuilts,' for the obvious reason that many individuals construct these aircraft at home, often in their garages." Nearly all gyroplanes flown in the US have been under the amateur-built category and were made using plans or kits sold by companies.

In the 1980s, light aircraft production in the US collapsed under the weight of product liability lawsuits. To help revive grassroots aviation, several new aircraft categories were created to accommodate factory-built aircraft that did not have a Part 23 airplane type certificate.

In 1984, the EAA and Aircraft Owners and Pilots Association (AOPA) proposed the "primary" category, which would reset certification and production approval standards for single-engine aircraft weighing 2,500 lb (1,134 kg) or less and having engines with 200 hp (150 kW) or less power. The rule governing primary category aircraft was approved by the FAA in 1993, but there was not much interest in this alternate means of certification and very few aircraft manufacturers sought approval under this category.

The aircraft industry and the FAA developed the Light-Sport Aircraft (LSA) category by partnering with ASTM International, an organization that develops industry standards by consensus.

This gave rise to the the Sport Pilot and Light-Sport Aircraft rule (14 CFR 21.190) in 2004 which opened the door for the sale of new factory-built aircraft designs, but specifically excluded gyroplanes as Special LSA (SLSA). Instead, existing gyroplanes were incorporated into the LSA rule as Experimental Light-Sport Aircraft (ELSA), which require that they continue to be built from a manufacturer's kit.

The rule allows ELSA gyroplanes to be flown by those with a sports pilot license or endorsement, which has a much lower requirement than a standard pilots' license. Gyroplanes can also be built and certified under the Experimental Amateur Built (EAB) 51% rule; this is an older exemption, but if the EAB aircraft also meets the definition of ELSA, it can be flown by sport pilots with a gyroplane sport pilot license or endorsement.

For many years, the gyroplane industry lobbied the FAA to have gyroplanes added to the SLSA category, without success. That's when gyroplane manufacturers started to take a fresh look at obtaining a primary category aircraft type certificate as a means to sell factory-assembled gyroplanes in the US to stimulate sales and acceptance.

In November 2016, the FAA issued a primary category certificate for AutoGyro USA's Calidus gyroplanes, utilizing an approval path only used for two other (fixed-wing) aircraft since 1993. This is a completely different rule that doesn't require a consensus standard.

Instead, the FAA allowed AutoGyro's gyroplanes to be certificated based on reciprocal acceptance of the British Civil Airworthiness Requirements (BCAR) gyroplane standard. AutoGyro also had to obtain an FAA-approved production certificate and establish a preventive maintenance program for the aircraft.

If maintained by an FAA-certificated mechanic or appropriately-rated repair station, a primary category aircraft may be rented for personal use as well as for flight instruction.

The Magni Gyro M24 Orion is an enclosed side-by-side gyroplane. (Magni photo)

In the 1960s and early 1970s, a few companies type-certificated their gyroplanes, including the Air & Space 18A (formerly Umbaugh Aircraft Corp.) in Kentucky; the Avian Aviation 2/180 Gyroplane in Georgetown, Ontario; and the McCulloch J-2, in Culver City, California. All had two seat-enclosed cabins, but production was limited and none of these companies saw much commercial success.

The 1980s and 1990s saw a rebirth of the gyroplane in North America, which included the Rotary Air Force RAF1000 and RAF2000. The aircraft, designed by Bernard J. Haseloh of Saskatchewan, Canada, had enclosed composite cockpits and were powered by Subaru engines.

A gyroplane renaissance began in Europe in the 2000s, thanks to advancements in design and more favorable regulations that permitted the sale of factory-completed aircraft to European customers. Now several manufacturers compete in the owner-pilot market and are producing aircraft at high rates that would astonish many helicopter makers.

Today's prominent gyroplane manufacturers — which include Skyworks Global, AutoGyro, Magni Gyro, ELA Aviación and Silverlight Aviation — seem better capitalized and capable of producing well-engineered products.

Refining the Designs

Until the late 1990s, there was very little application of rotorcraft mathematical modelling techniques or computational fluid dynamics to the study of gyroplanes that could help refine the amateur aircraft designs.

For example, gyroplane manufacturers added bigger engines and propellers, which disrupted the propeller thrust line and many of the early gyroplane designs did not include adequately sized (or any) horizontal stabilizers to provide static and dynamic stability. It is believed that both these factors contributed to numerous accidents caused by bunt overs (power push overs) or pilot-induced oscillations (which causes rotors to slow under lower g's).

By the time Groen's subsidiary — American Autogyro International, Inc. — introduced its SparrowHawk gyroplane in 2004, the homebuilt gyroplane kit industry had a poor reputation. But the SparrowHawk introduced center-line-thrust placement of the propeller and more correct alignment of the rotor thrust vector, according to the company. Competitors also made similar improvements to their products, resulting in safer gyroplanes.

In the 1990s, Besnate, Italy-based Magni Gyro entered the market with a horizontal stabilizer-equipped gyroplane; so too did AutoGyro GmbH in Germany and ELA Aviación in Spain. This seemed to demonstrate to European regulators that the horizontal stabilizer was a key addition to flying gyroplanes safely.

Today, Magni Gyro produces the open cockpit M16 tandem trainer; the M22 Voyager (similar to the M16, but with baggage pods and no rear-seat controls); and the top-line M24 Orion, a fully enclosed side-by-side, twin-seat gyroplane. The Austrian-made BRP-Rotax 915 iS engine is available for all models.

Gunskirchen, Austria-based Rotax-Werk AG — today Bombardier Recreational Products' subsidiary BRP-Rotax GmbH & Co KG — started making engines in 1962 for the original Bombardier Ski-Doo snowmobiles produced in Canada; it was acquired by Bombardier in 1970. More than 175,000 Rotax aircraft engines have been sold since 1973. Of this number, 50,000 have been 4-stroke engines from the well-known 912/914 series. All Rotax aircraft engines are approved for operation with automobile fuel, E10 ethanol-blend, and aviation gasoline (AVGAS).

Gyroplane manufacturers describe the new, higher power 141 hp (105 kW) Rotax 915 iS as a "game changer" because it shortens takeoff rolls, provides a better climb rate and increases the gyroplane's maximum cruise speed. The 915 iS is a four-cylinder four-stroke, horizontally-opposed, turbocharged, electronically

The ELA Aviación ELA 10 Eclipse is a two-place gyroplane introduced at the in 2014. (VFS photo by Ken Swartz. See more gyroplane photos from EAA AirVenture 2018 in the Vertical Flight Gallery at www.gallery.vtol.org.)

fuel-injected, air and liquid-cooled, gasoline engine that was type certificated in Europe in December 2017.

Magni Gyro is partnering with Karnardia on engine management systems and digital airspeed and altimeter options, all of which can communicate information with each other over the controller area network databus; this makes it easier to relay information to additional instruments, such as the instructor's instruments in the back seat of a tandem gyro.

Magni also offers TRIG radios with full Automatic Dependent Surveillance-Broadcast (ADS-B) "In" and "Out" equipment for flying in controlled airspace. As an option, Magni offers the Garmin 660 GPS unit with an Air Gizmos panel, which increases situational awareness of traffic and obstacles with visual and audible warnings integrated with the radio, according to the company.

The speedy AutoGyro Cavalon can stay aloft for five hours and sales are brisk for AutoGyro USA. (AutoGyro photo)

Magni announced in March 2018 that it had completed its 1,100th gyroplane.

Magni is now developing an enclosed tandem model, which will incorporate many of the features on previous models. "They haven't announced a firm date when customer orders will be allowed for the new model, but we are hopeful that it will be very soon," said Dayton A. Dabbs, president of Lone Star Magni Gyro, Inc., a major Magni dealership in Taylor, Texas.

While early design problems on gyroplanes appear resolved, there remains a major challenge for manufacturers in the US particularly: certification.

Gyroplane manufacturers believe an easier, less cumbersome path to FAA certification is the key to market acceptance and sales.

"I believe that gyroplanes are on the verge of a [sales] explosion in the US," said Greg Gremminger, an official with Magni USA LLC. "But until FAA allows factory built, non-experimental gyroplanes, we don't expect the market to explode to the levels experienced in Europe."

What's to be done? One solution is for the FAA to approve factory-built light sport aircraft (LSA) Gyroplanes, a plan the agency rejected in the early-2000s. "It's been a struggle ever since to get the FAA to change that rule," said Gremminger, who served on an industry committee for years.

The second FAA-approved route that is showing more promise is to certify gyroplanes under the little-used and optional primary category aircraft certification; though not as difficult as a standard type certification (e.g. FAR Part 27 for light helicopters), it is still a rather expensive and time-consuming process that could raise unit costs of gyroplanes.

The AutoGyro Calidus was the first gyroplane to be certified under the primary category and other manufacturers like Magni are pursuing this path as well.

Elsewhere, gyroplanes have been certified in a number of countries using the UK's Civil Aviation Authority standard. In fact, the FAA uses the UK's Civil Aviation Authority's BCAR Section T standard as the basis for gyroplane primary certification.

Safety advocates agree that today's gyroplanes are safer, but better training would help, as would a universal plan to improve safety overall in this sector. Accidents still happen and, regardless of the cause, they adversely impact growth and trust in this sector.

On Oct. 30, 2018, an experimental amateur-built AutoGyro Cavalon crashed en route to Manatee Airport near Palmetto, Florida. The commercial pilot, with 4,010 total hours of flight time, and the pilot-rated passenger were both killed. The official cause of the crash has yet to be determined, according to a National Transportation Safety Board spokesman.

Allowing factory-built gyroplanes to be sold in the US would also help the community adopt universal standards for gyroplane operations to improve the safety culture as well.

"I agree 100%," said Luca Magni. "Not having factory-built aircraft means not having clear roles to train pilots and limits [to] commercial activity."

AutoGyro

Things are getting busy for AutoGyro USA in Maryland — a wholly owned subsidiary of Hildesheim, Germany-based AutoGyro GmbH. Sales are picking up, particularly for the Cavalon, a fully enclosed side-by-side two-seat gyroplane. With its large fuel tank, the Cavalon can stay aloft for five hours. Said AutoGyro USA Flight Instructor Bob Snyder: "The Cavalon is probably the biggest draw from a comfort standpoint."

Speed is also a factor in the Cavalon's appeal. When powered by the upgraded Rotax 915 iS, the Cavalon is the fastest side-by-side gyroplane on the market, AutoGyro GmbH stated.

In November 2016, the FAA type-certificated the factory-built two-seat Calidus using the primary category (see "Understanding the Regs" sidebar). The company offers the Calidus as type certificated and also as a kit. All German-manufactured AutoGyro aircraft are factory built.

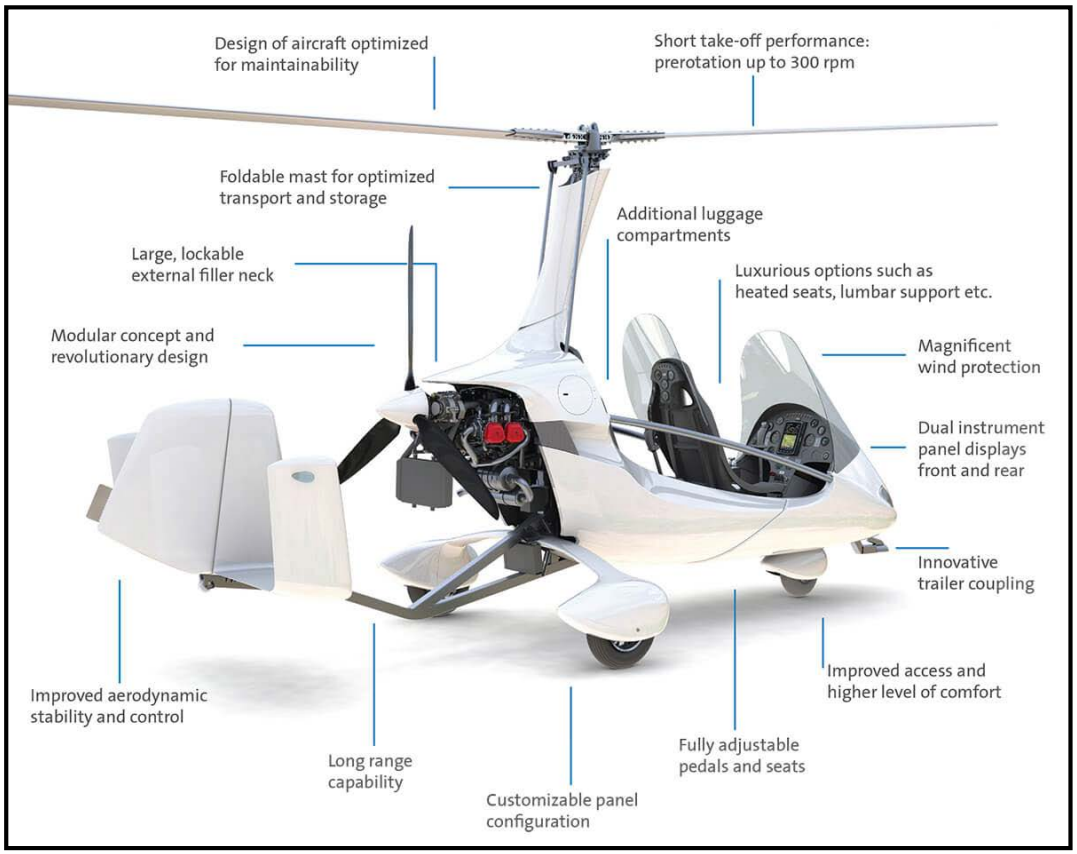
Other AutoGyro models include the tandem, open cockpit MTOsport, which was updated in 2017 and provides better takeoff performance than the 2010 model. AutoGyro GmbH built the prototype in 2003 and had it certificated by the German authorities the following year.

AutoGyro USA is working with the FAA to grant type certificates to the Cavalon and MTOsport in the primary category as well. Having all the models FAA certificated would provide a "huge benefit for us," said Snyder, despite the expense and time it takes to gain certification. "It took us four years to get the Calidus certified."

Asked about the clientele, Snyder said the average customer is around 50 years old, a corporate or airline pilot, who buys the aircraft purely for recreation. Hobbyists purchase most gyroplanes. Yet ranchers too are interested in the aircraft. Ranchers use gyroplanes to monitor their herds, and farmers use them to check their crops. Much lower operating costs of gyroplanes over helicopters is a selling point, said the company.

Law enforcement would like to acquire the product, but they don't want the "stigma" of flying an experimental aircraft, said Snyder.

In Germany, the company has been producing about 300 gyroplanes annually since 2014. In November 2017, the company announced that it had delivered its 1,500th MTOsport — a significant portion of the 2,500 total gyroplanes it had then produced.



The MTOsport 2017 has several improvements over the 2010 model. (AutoGyro graphic)

In 2015, Autogyro unveiled its eCavalon to prove that electrical flight is possible for gyroplanes. Equipped with a Bosch engine, the prototype supplied electric power for up to 40 minutes of flight time. But due to the weight of commercially available batteries and maximum takeoff weight limits of gyroplanes, "it is at this point not possible to advance this project," said Judith Reichardt, spokeswoman for Autogyro GmbH.

Flight Training

A major concern of gyroplane manufacturers and regulators early on was the lack of specific training of those who build, buy and fly gyroplanes.

At present, the FAA requires that owners/operators have a sport pilot certificate to operate a gyroplane.

AutoGyro USA offers a pilot training program to enhance the skills of the customer pilot. The program includes instruction on operating in controlled airspace, working radios, dealing with weather and navigation, which is a big stumbling block for some wannabe gyroplane pilots, said Snyder. Most owners want to navigate via the GPS feature on their smartphones, which regulators will not accept, he said.

AutoGyro USA provides training at its headquarters at the Bay Bridge Airport in Stevensville, Maryland, and at some of the 12 US sales locations. One dealer in Texas also provides training for assembling AutoGyro aircraft.

Other gyroplane makers to whom *Vertiflite* spoke said they typically provide ground and flight training connected to a sale.

Most gyroplane makers or their designated instructors follow guidelines of the International Association of Professional Gyroplane Trainers (IAPGT). Some gyroplane trainers follow best operating practices of Dr. Phil Harwood, a Scottish flight instructor, author and flying standards expert. Harwood's stated goal is to create a one-world standard for the operation of gyroplanes.

Independent schools also offer training. Neil Laubach runs Gyro Ontario flight school west of Toronto, Canada. The facility provides ground school and flight training for prospective gyroplane pilots out of Waterloo International Airport (YKF). Students range from retired commercial airline pilots, Transport Canada inspectors, helicopter pilots down to ab initio (zero-hour) candidates.

Early on, Laubach trained pilots on the Magni M16, and has since moved up to the M24 because of the enclosed cockpit, which extends the training season.

For ab initio students, Transport Canada requires 45 hours of flight time, 45 hours of ground school. Flight tests are required to obtain a pilot permit, which is similar to the sport pilot license in the US. Costs of the ground school and flight school is USD$375 plus tax and USD$150 per hour, respectively. In Canada, pilots also fly factory-built gyroplanes.

Jaunt Air Mobility and Skyworks Global

New start-up Jaunt Air Mobility recently acquired all rights to the Carter Aviation Technologies slowed rotor/compound (SR/C) aircraft technology. The announcement was made during the Vertical Flight Society's Electric VTOL Symposium in January 2019. See "The eVTOL Industry in Transition," pg. 34 for details.

Salt-Lake City, Utah-based Groen Brothers Aviation joined VFS (then the "American Helicopter Society International") in the early 2000s, promoting its revolutionary Hawk 4T, the first modern high-performance gyroplane, which was powered by a Rolls-Royce 250-B17C turboprop engine and planned for certification under FAR Part 27. Groen's assets and intellectual property were acquired by Skyworks Global in 2016. (See "Advantageous Autorotation," *Vertiflite*, July/August 2018.)

In November 2018, American Autogyro International, Inc., now a subsidiary of Skyworks Global, announced the restart of production of the SparrowHawk III quick-build kit, which sells for $69,500.

The cost of operating gyroplanes is significantly less than that of

Silverlight Aviation's American Ranger 1 (AR1) gyroplane has with tandem seating and is convertible from fully enclosed or open windshields. (Silverlight photo)

rotorcraft. Direct operating costs for the SparrowHawk are around $65 per hour, according to Steve McGowan, a certificated flight instructor of helicopters and gyroplanes. McGowan is based in Macon, Georgia, and has assembled numerous SparrowHawks.

Assembling the SparrowHawk III quick-build kit takes around 94 hours, said McGowan, but does not include the application of paint and installation of electrical systems. Assembling earlier models of the SparrowHawk took around 300 hours. The extra time was due, in part, to the fact that the assembler had to cut the metal and drill holes into the material. Today's kits are more assembler-friendly but still have to meet the 51% rule, he said.

As reported last summer in *Vertiflite*, Skyworks Global planned to "begin with the SparrowHawk III kit gyroplane, then with the larger Hawk 5 gyroplane built offshore, and potentially with tip-jet-driven gyrodynes that can take off and land vertically and hover." The Hawk 5 will be a "runway independent commercial gyroplane intended to transport people and materiel," said Skyworks Global Chief Technology Advisor Don Woodbury. "This will be the first commercial gyroplane of the modern era."

Like the 2-seat SparrowHawk, the Hawk 5 is anticipated to operate at a fraction of the costs of a similar gross-weight helicopter. "The Hawk 5 will realize the full potential of a gyroplane, with a combination of performance, low operating cost, and safety that provides great value to commercial operators," said Woodbury.

The Hawk 5 fuselage resembles a helicopter, but with no anti-torque mechanism required due to the autorotating rotor system,

The Jaunt Air Mobility air taxi leverages the technology developed by Carter Aviation Technologies for its slow rotor/compound gyroplane. Jaunt is developing an all-electric VTOL air taxi for the Uber Elevate mission. (Jaunt image)

The Groen Hawk 4T flew in support of the 2002 Olympics in Salt Lake City. (Skyworks image)

and very different tail surfaces. Skyworks Global already has 15 orders for the Hawk 5.

In other developments, Skyworks Global said it has initiated the development of the eGyro electrically-powered gyroplane and that it plans to build a prototype with an as-yet unnamed partner. Skyworks has recently engaged Dr. Ashish Bagai to support the project as the eGyro Chief Engineer. "The eGyro is a clean sheet design that provides a unique opportunity to leverage the flexibility and performance that electrification offers to the eVTOL domain," said Bagai, who has a long history of involvement in the development of advanced vertical flight concepts with stints in the Department of Defense and industry.

"As part of the eGyro effort, we've brought on a teammate to develop a simulator for the eGyro," said Woodbury. No further details on the eGyro or the new partners were available at press time.

As to the safety of today's gyroplanes, Woodbury was succinct: "If properly designed and flown within their flight envelope, gyroplanes are fundamentally safe," and highlighted that the rotor is always in autorotation.

"This isn't rocket science. The innovation of the gyroplane is nothing new," said Woodbury. "It is a matter of taking the same design principles from fixed and rotary-wing aircraft and applying them to gyroplanes."

Woodbury is a former program manager and director for the Pentagon's Defense Advanced Research Projects Agency (DARPA). While there, Woodbury initiated and led the Heliplane program a decade ago, with Groen Brothers as the primary performer.

The Heliplane was to have been a 400 mph (350 kt or 645 km/h) vertical takeoff and landing (VTOL) aircraft with a 1,000 mile (870 nm or 1,610 km) range and a 1,000 lb (450 kg) payload. DARPA abandoned the Heliplane program when Woodbury moved on, but the technologies developed and patented under the Heliplane program were part of the acquisition by Skyworks.

Skyworks Global's VertiJet will leverage technology from the DARPA Heliplane programs. Like the Heliplane, the VertiJet will have a projected top speed of 400 mph and a range of 1,000 miles. The aircraft will combine the interior elegance of business jets with the ability to operate from helipad-sized surfaces.

VertiJet can take off and land like a fixed-wing aircraft, like a gyroplane with an unpowered rotor, or like a helicopter with a rotor powered by tipjets.

The Skyworks Hawk 5 is a larger, more capable version of the Groen Brothers Hawk 4T. (Skyworks image)

Skyworks announced its VertiJet tipjet-powered civil gyroplane on Feb. 1. It leverages the Groen Brothers technology from the DARPA Heliplane program. (Skyworks image)

The VertiJet will employ new approaches to noise reduction in noise-sensitive areas when operating as a helicopter and will benefit from the quiet operating characteristics of a fixed-wing aircraft during cruise. The aircraft will be able to fly as a fixed-wing aircraft, gyroplane or helicopter — or a combination of all three. In cruise, VertiJet employs a conventional fixed-wing approach for lift, plus turbofan or turboprop engines for propulsion. In flight, the aircraft is controlled with traditional fixed-wing aircraft controls and pilot skills, according to Skyworks Global. "What I find to be most exciting about the VertiJet is the ability to provide business jet performance in a runway-independent aircraft," added Woodbury.

VertiJet joins a portfolio of Skyworks Global aircraft that includes the SparrowHawk III and the larger, four-passenger Hawk 5.

These highly advanced true vertical take-off and landing gyroplanes mark a significant step in not only the evolution of the autogyro, but also in new configurations that promise to revolutionize vertical flight.

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 *rwmassoc@verizon.net*.