Gyroplanes, the "New Generation"

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Aerodynamic technology is changing the shape of Gyroplanes. With stability issues addressed, Gyroplane popularity is poised for resurgence.

-- It's not your father's Gyrocopter! Re-engineered and reborn with newly appreciated and applied technology, the venerable autogyro of the nostalgic 30's has evolved through the old Bensen gyrocopter of our youth, beyond the backyard "gyro," to the new generation of the practical "Gyroplanes." Nearly as old as the airplane itself, the autogyro was invented in the early 1920's to address the nasty habit of fixed wing airplanes to stall and spin and do more nasty things to the intrepid aviator. Through nature's miracle of autorotation, borrowed from the common maple tree seed, the new generation of gyroplanes today stands revitalized and ready to fill its potential to be the safest and most capable light sport aircraft available.

Gyroplanes are truly unique aircraft. The inherent physics of the free spinning, autorotating rotor offer unique advantages over other aircraft "wings." The autorotating rotor will not stall. Once in the air, the rotor automatically and naturally adjusts its speed to carry the load presented to it, like having an automatically variable wing area. Whether moving forward through the air at top speed, descending vertically at zero airspeed, pulling high Gs in a pinpoint turn, or landing like a bird in short spaces at barely a running pace, the rotor offers dramatic authority over the wind and responsive control for the pilot without fear of stall, loss of control or sudden upset.

Centripetal forces in the spinning rotor stiffen the seemingly spindly blades to reliably support the full load and maneuvers of the gyroplane - without the structural and configuration penalties of long cantilevered or trussed wings. The resulting compact and stout airframes are simple, rugged and straight forward construction. The powerful "cyclic" pitch and lateral control, imparted by Mother Nature's magic of gyroscopic precession, offer safe and uniquely powerful maneuverability rarely found in other simple sport aircraft. These powerful flight controls require as few or fewer moving parts as the simplest of 3-axis airplanes. Rotors are truly omni-directional "wings" that require little attention to aircraft yaw or turn coordination, and provide exceptionally comfortable landing capabilities in even powerful, gusty crosswinds. The aerodynamic technology of today's "new generation" gyroplane now allows the full potential of the autorotating rotor to be truly realized.

What is the full potential of the gyroplane?

Applying the laws of aerodynamics and physics appropriately, enlightened "new generation" gyroplane designers are now providing aircraft that can be essentially insensitive to turbulent winds, with positively stable, safe and solid control characteristics throughout the extensive speed range. Such gyroplanes, due to their inherent self-correcting stability characteristics, automatically compensate for wind disturbances and avoid the twitchy and often dangerous sensitivities of the previous generation of gyros. Pilots can now be the full masters of their aircraft, providing purposeful commanded maneuvering inputs while the aircraft safely self-neutralizes the disturbances of wind turbulence and the sensitivities of high speed.

Such gyroplanes are truly easy to learn to fly. The stable gyroplane of this new generation requires flight proficiency acquired at least as easily in even rough air as the most sedate fixed wing trainers would require in calm air. Flying the gyroplane feels essentially like flying a much larger airplane, minimizing the pitch, roll and yaw disturbances wind turbulence can present in lighter airplanes. The rotor itself is much less sensitive to wind turbulence than a wing because it is effectively a high-speed heavily loaded "wing." The rotor in combination with the safe and stable airframe provides the comforting feeling of a truly solid, heavy aircraft, with the desirable nimbleness traditionally associated with light "gyros." This solid platform allows the free and confident mastery of the air with ease and comfort not imagined in most simple sport aircraft.

Flight in the new generation of stable gyroplanes requires merely loose monitoring of the cyclic (joystick), with feet and throttle hand unoccupied for the majority of time. Compared to helicopters and airplanes which, in turbulent winds at least, require animated attention of all feet and hands to roll, yaw and pitch disturbances, today's gyroplanes might require some minimal attention on the cyclic control to maintain a steady heading and altitude. Owing to the power of the cyclic control, in combination with the stable gyroplane's insensitivity to wind disturbances, the extremely nimble maneuvers in these gyroplanes require very little attention for the "uncommanded" inputs from external disturbances. The truly stable new generation of gyroplanes present none of the old propensities to over-control or the need for precise over-control to stabilize the traditionally "unstable beast."

A surprising attribute of the highly stable "floating-wing" gyroplane is the unique maneuverability for such a stable aircraft. "Fixed-wing" analogies suggest that you cannot have an extremely stable aircraft that is, at the same time, highly maneuverable. This is a correct paradigm for "stable" airplanes with wings "fixed" to the fuselage so that the whole, stable fuselage must, itself, pitch or roll to perform a maneuver. For gyroplanes, the rotor is not fixed, but is independently and powerfully maneuverable by the pilot, to affect radical flight maneuvers. The rotor supports and maneuvers the gyroplane – the rotor is the "wing" of a gyroplane. The stable airframe then simply accurately follows the flight path determined by the rotor. This is truly unique in simple sport aircraft – with minimal control effort, the gyroplane provides a solid, stable platform, highly insensitive to wind disturbances, but as highly maneuverable as many aerobatic airplanes! And, the stable new generation gyroplane airframe provides reliable flight reference cues for pilot precise control of those flight maneuvers.

With the solid comfort of the gyroplane platform, with the ease of learning, with the mastery over wind turbulence, with the radical maneuverability and speed range, with its structural ruggedness, with its ability to land in short spaces at extremely slow airspeeds, and without the fear of stalls or

spins, the potential of this new generation of gyroplanes is to be the safest, most capable and most popular light sport aircraft available.

So, why don't we see more of these gyroplanes?

Actually, there are a number of "New Generation" gyroplanes available now that overcome the old safety issues and stigma of "gyros" that has so deterred the mainstream acceptance of the traditional "gyro." Very frankly, the old stigma of "gyros" is based on disturbing fact. Historically, "gyros" have had a poor accident record. Many gyros evolved from the minimal Bensen Gyrocopter of the late 50's and early 60's. Additions and modifications of more powerful engines, larger propellers, enclosures and large windscreens, corresponding higher airspeeds - with poor or only intuitive attention to basic aerodynamic and stability principles - resulted in stability and control issues that made flying in turbulence and at higher airspeeds dangerous for the less expertly proficient fliers. Unstable gyro designs require more intensive training and practice. Coupled with gyros that required extensive proficiency, the early limited availability of professional training and a lingering culture that had promoted self-training, resulted in a truly deplorable accident rate!

There now is a new and growing recognition of these stability and training issues that is rapidly permeating the sport and changing the culture to at long last allow gyroplanes to realize their true safety potential. There is now a widening promotion and understanding of professional aerodynamic stability and control design principles embodied in this new generation of gyroplanes.

Stability and Controllability! Why are these issues?

Stability is the inherent ability of any aircraft to correct for disturbances to that aircraft's trimmed and steady condition. Wind and over-reactive pilot inputs are the common disturbances, both of which result in G-load disturbances. A stable aircraft is one that self-compensates for external disturbances to minimize their effects on the flight condition and minimize pilot-required efforts to correct for those disturbances. Controllability means the precise and coordinated responsiveness of the aircraft to pilot "commanded" inputs, and an aircraft reactive response that provides the pilot sensory cues to allow the pilot to precisely maneuver the aircraft as intended. This means the nose attitude, airspeed and G-load sensory feedback signals indicate to the pilot the exact measure and timing of the required pilot input. Put both together, the pilot is occupied only with his/her intentional, "commanded" flight path or maneuvers, without the added burden of compensating for either external disturbances or for the aircraft's erratic reaction to those disturbances.

For too long, earlier evolutions of gyros presented instabilities and control characteristics that made learning to fly a gyro a long, challenging and sometimes dangerous proposition. Although the challenge might have appeal to numbers of adventuresome pioneers, today's new generation of gyroplanes provide normal, natural and intuitive control characteristics which present few learning challenges and reduce time required to develop proficiency to safely fly the gyroplane. Those "old generation" gyros were sensitive and dangerous in gusty winds, especially at high speeds. Their instability, and the un-natural flight cues those instabilities presented to pilots, made pilots prone to over-control or mis-timed, out-of-phase control responses – and prone to Pilot Induced Oscillations (PIO). The "old generation" popularity of larger propellers, high

propeller thrustlines, and larger engines, often inadequately balanced by an insufficient Horizontal Stabilizer (HS), made such gyros prone to Power Push-Over (PPO) – the historical nemesis of gyroplane safety!

Gyroplane stability and controllability technology has been "re-discovered" over the last decade or so. These principles were well understood and appreciated in the early age of the tractor autogyros, but became somewhat forgotten in the successive "intuitive" evolutions of the popular pusher Bensen Gyrocopter. Gyrocopters and "gyros" lacked the professional design and testing resources provided over those same years by commercial and military advancements for airplanes and helicopters. Gyroplanes are not "fixed-wing" aircraft and as such, many intuitive fixed-wing analogies and design approaches do not apply. "Intuitive" gyrocopter evolutions perhaps did not fully recognize or accommodate the fact that the CG can move relative to the "wing" (Rotor Thrust Vector), and that subsequently, the stability characteristics of the gyro can change with different flight conditions of higher airspeed or power.

It is precisely that failure to properly accommodate this "floating-wing" attribute that had led to the stigma that gyros are dangerous and difficult to learn to fly! In a ("floating-wing") rotorcraft, anything that causes the nose to fly lower than its natural attitude causes the CG to be aft of the Rotor Thrust Vector (lift line of the rotor). This would be similar to loading an airplane tail heavy – very difficult to fly!

In a gyroplane, several configuration issues can, if not appropriately addressed in the aerodynamic design, cause the nose attitude to fly lower and create this much less stable condition under the conditions of high power or high speed:

- High, unbalanced propeller thrustlines – this means the propeller is located high on the airframe, higher than the CG of the aircraft so that propeller thrust tends to push the nose lower – destabilizing effect. This is most severe at higher power settings, and is the now commonly understood condition that suggests possible stability and safety problems.

- Large, draggy fuselages and windscreens – if not properly designed and balanced by a sufficiently large HS, a bulky enclosure can drag the nose attitude lower. Large sloping windscreens can push the nose attitude lower. Both of these destabilizing effects are most severe at higher airspeeds.

- Lack of an adequate Horizontal Stabilizer – the HS is the means to balance the static destabilizing effects of propeller thrust or aerodynamic forces on the airframe. The HS, in any aircraft, is also the simplest means to provide the required dynamic stability – ability of the aircraft to dampen or reduce any natural oscillatory characteristics, similar to feathers on an arrow. The proper design of the horizontal stabilizer maintains stable positioning of the CG (relative to the Rotor Thrust Vector) and is the critical element of the new generation of gyroplanes!

So how does this "New Generation" of gyroplanes make a difference?

Properly applied aerodynamic attention to the above and others issues, in this new generation of gyroplanes, achieves a new, perhaps higher degree of stability and controllability than available in

most, if not all, light sport aircraft. These newly appreciated and applied aerodynamic principles employed in "new generation" gyroplanes include:

- Aerodynamics that hold the nose level relative to flight path – maintains the position of the CG well forward of the Rotor Lift Vector, to assure stability at all airspeeds and power settings.
- Aerodynamics where disturbances cause airframe pitch reaction in the corrective, stable direction (from wind, pilot and G-load disturbances). The corrective airframe pitch response provides powerful automatically stabilizing cyclic inputs to the rotor.
- Use of proper Horizontal Stabilizers – balances any "de-stabilizing" static forces (maintains CG position), restores "trimmed" airspeed after disturbances (airspeed stable), and provides the dynamic stabilizing "feathers" required by any stable aircraft.
- Shorter, more readily balanced propeller (thrustline) offsets from CG.
- More attention to propeller thrustlines, moments of inertia of the airframe and rotor, fuselage aerodynamic destabilizing moments – all of which interrelate to contribute to stable and solid controllability harmonized to the human pilot.

This new generation of gyroplanes is also a catalyst for a new gyroplane culture that is changing from the dare-devil "train yourself," "fly from your backyard," "who needs a stabilizer" attitudes that have too long prevailed in the gyro community. The new culture is an enlightened promotion of the issues and solutions for much safer gyroplanes and gyroplane pilots. The knowledge "base" for gyroplane aerodynamics is now popularly circulated, understood and appreciated within the gyro community and incorporated in training syllabuses. Examples of safer gyroplane configurations and attributes are now being offered by manufacturers, builders, and enlightened "old-timers" in the sport. An accurate appreciation of these critical gyroplane issues and solutions is becoming recognized as a basis for making good piloting decisions about the safe limits of both aircraft and pilot. The stability "believers" now outnumber the skeptics. A community culture that promotes the essentials of stability, the essential elements of good training, and the validity of gyroplane stability and aerodynamic principles is strongly emerging.

Complicated regulations and impractical requirements for ratings have unintentionally discouraged effective gyroplane training and prevented expansion of gyroplane instructor availability. Concurrent with the expected release of the new Sport Pilot rules, the FAA is expected to remove the impediments to earning Gyroplane Private, Commercial and CFI ratings. They are expected to provide practical means for training ultralight gyroplane pilots and the new Sport Pilots for gyroplane endorsements. The FAA is working with the gyroplane community to address these and other regulatory details, newly appreciated by the FAA to have been unnecessary impediments to gyroplane safety. With the requirements of the expected Light Sport Aircraft rules, the FAA is supporting an ASTM Gyroplane subcommittee development of a new and practical Design and Performance standard for gyroplanes – a standard that is expected to encourage an ever more safe gyroplane sport through educated consumers, enlightened builders responsible manufacturers, and knowledgeable pilots.

SparrowHawk:

The new SparrowHawk offering by American Autogyro Inc. achieves impressive stability with a large, effective horizontal stabilizer and a propeller thrustline closely aligned with the CG of the aircraft.

Magni :

The imported Magni gyroplanes from Italy have exploded in popularity around the world due to their demonstrated safety performance. Vittorio Magni achieves superb stability and controllability through the "harmonized" balance of inertias, thrustlines and airframe aerodynamics with a highly effective horizontal stabilizer.

Dominator:

The Rotor Flight Dynamics pioneering Dominator propeller thrustline compliments the effective horizontal stabilizer by positioning the aircraft CG well forward of the Rotor Lift Vector.

Little Wing:

The classic tractor “autogyro” configuration of Ron Herron’s Little Wing gyroplane allows good alignment of the propeller with the aircraft CG and a very effective horizontal stabilizer due to its mounting far aft on the empennage.

Air Command:

The new Air Command models impressively sport an improved propeller thrustline and more effective horizontal stabilizers for dramatic stability and safety improvements over the popular but traditional much less stable, early Bensen-style models. Air Command International is widely praised for taking this challenging step toward a safer gyroplane sport.