ABC's of How to Be a Safe Gyroplane Pilot

CONGRATULATIONS!

You are among the very few who are learning about one of the most pleasurable forms of aeronautics. You're about to become a Gyro pilot, and perhaps own one of these great flying machines.

You already know the Gyro is different than any other kind of aircraft. So different, you should be aware at the beginning, that you will come to appreciate it's unique handling characteristics.

Make no mistake, Gyro flying is fun. But with the thrill of being airborne comes the stark realization that mistakes in the air can not only ruin your flying, but can even result in death. It doesn't have to happen if you are willing to devote the proper time to learning and following instructions. That will be paramount in this publication. We presume if you are sincere about wanting to learn to fly gyros you have the responsibility that goes along with having the fun.

As with any aircraft, the Gyro has its own limits as to what it will do in the air. You should always respect those limits. Anything you change in building a Gyro must conform to accepted standards. Likewise, failing to do proper maintenance and/or inspections can be extremely dangerous, and put you and others at risk of life and limb.

Who is responsible for the safe operation of the Gyro? Just like other aircraft, the FAA holds the pilot responsible. As the pilot, you must know all the procedures of operation and inspection which are found in the Pilot's Manual. You must also be aware of the Federal Air Regulations as they apply to your aircraft. Your personal safety and that of anyone in or near the aircraft is directly incumbent on the you as the pilot.

Although the Gyro is small, it is not a toy, and should be regarded for what it is: an aircraft to be maintained and operated by you.

The Gyro may look simple to fly, especially to licensed pilots of other aircraft. However, fixed wing or helicopter flight training is NOT SUFFICIENT to give you instant ability to fly the Gyro. You must take the necessary training first. We're not saying it's harder to fly, but there are some differences you will have to learn.

Depending on who you talk to, you'll hear that the Gyro is either "easy" or "hard" to fly. A pilot with lots of hours in the Gyro will probably say it's easy. That's because they've mastered the unique characteristics of Gyro flight.

Others may say it is difficult to fly. Some might even call it dangerous. These comments may come from pilots of traditional fixed-wind aircraft who think that flying anything should be like an airplane. Others may those who may use the term "dangerous" could be those so-called "experts" who are afraid to find out for themselves what may be "easy" for many of the rest of us.

The best frame of mind to have when you begin the learning process is to assume that Gyros are NOT easy to fly. But then compare it to some of the learning experiences you had when you were growing up. You learned to walk from patient parents. Your first attempts at riding a bicycle were on flat ground at very slow speeds. The same principles apply here. Take it one step at a time. You're going to learn a little more every day about Gyros. When developing through experience, you'll prove to yourself it was, in fact, easy to fly.

By reading about the Gyro, you're on the right track. But **you must get training from a Certified Flight Instructor (CFI) and follow it explicitly.** If all that is in place, you'll probably become a proficient operator and enjoy the Gyro in flight.

The Rotor System

O.K. Let's get started with some basics. The most important part of the Gyro is that the rotor blades are the control surface. The blades govern themselves in flight. They maintain a constant speed whether at maximum forward speed, descending vertically, or sideways or backwards. No loss of control response or stalling will take place.

Remember that you are flying the rotor, not the airframe. A gimbal hinge suspends the entire rotor system. When control is applied to the rotor, there is an immediate response. Then the airframe responds, just like the action of a pendulum. The entire lifting surface is being tilted. A message is given to the rotor to deflect, and you return the control stick to the neutral position.

In a fixed-wing aircraft, lift is only provided when the aircraft is moving forward. But in the rotor system, the lift is equal in all directions, or omni-directional.

All motions to control the Gyro are short motions, with instant pullback on the stick to the neutral position. This is different than the control of an airplane, where you push the controls and hold until the craft responds.

If the Gyro doesn't completely respond to your command, you wait 2 or 3 seconds and try the command again. Always return the stick to "neutral", and hold it motionless between movements. Beginners and fixed-wind pilots have a tendency to try to "overcontrol". In the Gyro, it's always move the stick and return to neutral, instead of holding the stick til the maneuver is accomplished. If you overcontrol and don't return to neutral, you could get into what we call "pilot-induced oscillation", or another term is "porpoising". We abbreviate that to call it P.I.O. Reaction time of a man is almost the same as the rotor response to control. So you must work faster, by moving the control stick...or slower, by holding the stick in the neutral position and shifting slowly. To counter too much control, go back to neutral with an opposite movement and then back to neutral.

The free-spinning, or auto-rotating rotor, flies in any direction from zero airspeed to the maximum speed in forward flight. Because the rotor has constant r.p.m. control response is positive through all flying speeds.

If the rotors are traveling at 200 r.p.m. the tip speeds are near 150 miles per hour. That means at flight speed the rotor tips are travelingat about 300 miles per hour. At this speed there is a tremendous force of energy in motion. You must always be aware and alert when the rotor is turning. If it should strike any object, severe damage could result to the aircraft. Always look out for nearby persons and don't think they wouldn't walk into the path of the rotors.

Even if you're an experienced fixed-wing pilot, you are finding out that the Gyrocopter is an entirely different kind of craft.

Let's get ready for takeoff. When the rotor accelerates past 100 r.p.m., or about 20 miles per hour on the ground, the Gyro goes back from nosewheel to the tailwheel. This keeps the rotor accelerating. But you don't hold the control stick back fully as the rotors accelerate, gaining more lift. If you do, you won't allow the machine to accelerate to full take-off speed.

So you drop the nose slightly, and take off from the main wheels. Your take-off speed is from 35 to 45 miles per hour.

Landing

To land you make a normal gliding approach, and reduce the throttle a few feet above ground. You round out, touch down the tail wheel, aligning the aircraft with the direction of movement.

Because gyros are always in "auto-rotation", landings with power off are much safer than in airplanes or helicopters. Gyros need much less space and airspeed to land than airplanes. And safer than helicopters because of a gentler angle of glide. Also, an "auto-rotational" power-off landing is a difficult emergency procedure in the helicopter.

When airborne, there is very little control necessary. The airframe follows the rotors. There aren't any abrupt pitch or roll effects when air speed or power is reduced. Because the rotors are free-wheeling, the gyrocopter is safer aerodynamically than either helicopters or fixed wing aircraft. That gives a degree of confidence toeveryone who learns to fly them.

Safety

Let's get back to safety factors once again. Gyro's are not intended nor designed to do aerobatic flying. **They will not fly upside down!** In fact, you should never exceed the rotor tilt of 30 degrees to horizontal. If you get in the "pilot-induced oscillation", P.I.O., or "porpoising" mode, pull back on the throttle and slow down right away. Then, land the gyro and relax. It means you are overcontrolling and are too tense that day. Handling the stick should be done with only three fingers while your hand rests on your leg. That's the only control you need.

The gyro, if it is trimmed properly, will maintain a positive G load on the rotor by itself and maintain stable flight, unless the operator forces it do something else.

Learning Process

Don't worry about the Gyro's flying capability. It is your own ability as the pilot that is the determining factor. With proper instruction, the pilot learns to make proper decisions, becomes aware of the elements, and gains a complete knowledge of what the gyro will and will not do. He learns to "think ahead". But it doesn't happen overnight. You need to be willing to apply yourself to learning at an organized pace, and be willing to accept and follow instructions.

When you start flight training, you'll start on a day when the winds are calm. Then, you'll know if what you're doing is being caused by you as the pilot, the wind condition, or the aircraft. As you fly more, you will encounter various air flow patterns, including what we call turbulence. Absorbed ground heat causes air to rise in a vertical flow, which expands and becomes lighter. That gives us less lift. You'll become familiar with these wind and air conditions as you gain more experience.

Your learning to fly gyros should never be a spectator event. You need all the concentration you can muster when learning to fly. You don't need the distraction of friends to make you forget what you're doing. And don't have photographers snapping pictures either. You may try to show-off for the camera, but again, that could take away from your concentration and put you into a dangerous situation.

As we said before, learning to fly gyros is a gradual process. So don't try to do it all at once. When you take 30 minutes of flight training, take the next half hour to relax and think about what you did. Mental exhaustion could impair your judgement, leading to a serious mistake. Make sure you take time to review what you've learned. Test yourself, and look at what is coming up next in your study.

When you think about it, the gyro is probably the safest flying machine ever designed. That is, providing it is operated within its limits and design plan. There are no complicated mechanical controls, and very few moving parts. That makes for a simple, but fun flying machine.

As you get ready to train for flight in the gyro, it is worth taking the time to learn more about this remarkable aircraft and how it came about.

History

Gyrocopters were invented and first flown in the U-S by Dr. Igor Bensen in 1955. Before the Gyrocopter, there was the Gyroglider of the 1940's. The original "autogiro" was invented by Sr. Juan de la Cierva, a Spanish aeronautical engineer about 60 years ago. He had been injured while testing an airplane design, and vowed to build a safe aircraft that would not stall or spin, and descend safely in case of engine failure. Cierva came to the U-S to form his own company. About 200 autogyros were manufactured and sold during the 1930's. Early uses were by the U-S Army and for agricultural work.

The name "Gyrocopter" combines the descriptions of the flying features of the autogyro and the helicopter. The name Gyrocopter is owned by Bensen Aircraft Corporation.

The first autogyros used short wings, but later the function of lift and flight controls were transferred to the rotor.

As you have learned, the rotor of the autogyro is not powered in flight. The airflow goes through the rotor from the bottom up. It is exactly the opposite for the helicopter, where the airflow comes from the top of the rotor. Because there is no power on the rotor, there is no torque against the airframe.

The helicopter came about much earlier than the autogyro. The first successes came in France as early as 1907. But the helicopter really didn't blossom until 1940, when inventor Igor Sikorsky developed the tail-rotor type of helicopter design we are familiar with even to this day. The helicopter's main advantage of course, is that it can take off and land vertically. Also that it can hover, and fly sideways and backwards. But the cost of this advanced flying machine puts it out of the reach of most average people.

The helicopter has a nose-down attitude during flight. That's because it must tilt its rotor forward and pull itself forward by the rotor. Just the opposite for the autogyro, which has the rotor tilted backward, with an almost level attitude during forward flight. It's forward motion comes from a pushing propeller.

Earlier, we mentioned the similarities between helicopters and autogyros. The term "gyrocopter" is really derived from those similiarities. For there are certain circumstances where the helicopter flies like autogryos, and autogyros fly like the helicopter. The helicopter flies like an autogyro when its engine quits or power drops to zero. Almost all helicopters have the ability fly in auto-rotation, where there rotors are turned by the force of wind alone, just as in auto-gyros. In a helicopter, this is a safety feature for descent under control in case of an engine failure. The autogyro acts like a helicopter when its rotor system is power-driven, even for a short time. It can execute a vertical takeoff like helicopter if the rotor blades are engaged by a mechanical device and pitch of the blades increased. It is known as a "jump take off". There are some autogyros that have jet power it their rotor blade tips, and can be switched from autogyro to helicopter regimes at will. Here the preference is to use the autogyro regime for cruising and the helicopter regime for takeoffs. A recent development is the auxiliary rotor drive. That pre-rotates the rotor while the craft is still on the ground. The result is a takeoff run of 250 feet or less, making the Gyrocopter a bonafide STOL (Short Takeoff and Landing) Aircraft.

That concludes this section of the training material. But there is much more to learn.

GETTING STARTED.

Before you do anything else, subscribe to **ROTORCRAFT MAGAZINE**. It's published by the **Popular Rotorcraft Association**. The annual subscription is $26.00. Send it to the following address:

PRA
P.O. BOX 68
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Rotorcraft Magazine will give you a good idea of the different kinds of aircraft to choose from. Also, you'll find out who the flight instructors are, as well as companies making the gyrocopters today. There are lots of articles about all aspects of flying gyros. Most of the manufacturers have material they will send you. Check out the classified section for used gyros, engines and accessories for sale.

Next, go with a Certified Flight Instructor (CFI) on a familiarization flight. It costs anywhere from $30 to $50. To obtain an hour of loggable instruction in a two-place gyroplane is about $100 which usually includes ground instruction.

DESCRIPTION

What exactly is the gyroplane? It is powered by an engine with a propeller, which is usually mounted behind the pilot seat. The rotor blades are free-wheeling in flight, to cause the craft to gain lift, just like the wing of a fixed-wing aircraft. Air passing through the rotors from below causes the blades to spin. The rotor disc tilts slightly backward at all times to allow the air to pass through the blades.

CONTROLS: There are three basic controls. The cyclic stick, throttle, and rudder pedals. The stick controls pitch and bank. The rudder is seldom used in flight.

Gyroplanes are usually built from kits under the FAA's 51% rule. The builder is required to perform maintenance. They are registered with an "N" number, just like all aircraft. But they come under the "experimental" category.

Most gyroplanes used to be single-place machines, and owners used to teach themselves by trial and error. Some would tow the aircraft without power and use it as a gyro-glider.

Now there are two-place gyros available which can be built by the owner. That is making training available through a special FAA exemption. Consequently, there are Gyro CFI schools opening around the country. We recommend you contact one of the CFI's listed in the back of this booklet for your training, or go to one of their referrals.

Most of the gyroplanes in use today are single-place open aircraft. Average cruising speed is 40-50 miles per hour. Cruising altitude is around 1000 feet. Some enclosed gyros cruise at speeds of over 100 miles per hour for over four hours. Single place gyroplanes in kit form range from $5,000 to $10,000. Used machines are available from $1,500 and up. Two place machines run from $10,000 to $20,000.

GETTING A LICENSE

There are several types of Private Pilots licenses. Such as airplane, helicopter, glider, balloon, and gyroplane. If you are already licensed in one category, you can add on another.

If you already hold a PRIVATE PILOT, AIRPLANE license, you add on the Gyro rating. You need to have 15 hours dual with a Gyro CFI. Also, 10 hours solo in the gyro, and a flight check with an FAA Examiner. There is no written exam here.

If you already hold a PRIVATE PILOT, HELICOPTER license, there is not a time requirement in training hours. But the differences require some training, normally five to ten hours of dual. A gyro CFI signs you off to take a check ride with an FAA examiner when he thinks you are ready.

If you're starting from the beginning, with no license, there are two choices. You can get a PRIVATE PILOT, GYROPLANE license. That requires an FAA Class 3 Medical Certificate, passing a written examination, 20 hours dual with a Gyro CFI, 20 hours of solo, and a flight check with the FAA examiner. Once the instructor finishes with the dual instruction, you can log your own hours of solo in your own gyroplane. You can't take any passengers while a student. After you pass the written test, you have up to two years to complete the training hours and take your flight check to get your license. The requirements for this license are extensive. They include dead reckoning navigation, electronic navigation, cross country flight, simulated instrument flying, night operations, two way radio communications, and takeoff and landing at tower-operated airports.

A simpler way to go is the new license, called RECREATIONAL PILOT, GYROPLANE. It requires an FAA, Class 3 Medical Certificate, Written Exam before solo, 15 hours dual with Gyro CFI, 15 hours solo practice, and Flight check with the FAA examiner. There are some restrictions. You can only carry one passenger. Your engine can't exceed 180 horsepower, can't operate over 10,000 feet altitude, or fly in visibility less than 3 miles. You can upgrade to the higher grade certificate after you gain experience. After 15 hours dual you are free to fly in your own gyro building up solo time. This at a cost of around $1,500 in flight instruction. Preparing for the written exam is done in a Ground School.

Recreational Pilots who have less than 400 hours of flight experience must have an annual review with a CFI which includes at least one hour of flight instruction and one hour of ground instruction. Recreational Pilots must also pass a check ride with a CFI if then haven't logged a flight at least once every six months.

A WORD ABOUT ULTRA-LIGHTS

There are gyro's which fit into the "Ultra-Light" category. They come under the FAA Regulations 103, which doesn't require a license. These gyros weigh under 254 pounds and carry only 5 gallons of gasoline. Most of them are underpowered with most engines in the 40 to 50 horsepower class. Most have two-cycle air-cooled engines, instead of the four-cycle water-cooled engines on standard gyros. Even though no license is required, hence no proper training, it is foolish to fly any aircraft without proper training. Get it from a CFI and log those hours toward a Recreational Pilots License in a standard Gyroplane.

LET'S GET READY TO FLY

Thank you for reading this material about Gyro's, and for watching the accompanying video tapes. While this is interesting material to read and view, it is no substitute for proper training with a CFI. I strongly recommend you seek out a CFI who will teach you the basics of flying the gyrocopter. After many years of flying all types of aircraft, I can truly say that flying the gyro is a unique and fun experience. I hope you will enjoy it as much as I do.

In closing, please re-read this material, and look at the videotapes several times. Thank you for your interest in Gyro's and for purchasing this video/print package. I believe it will give you the basis for a long-standing love affair with this type of flying!

Dan Leslie
Videogram Productions

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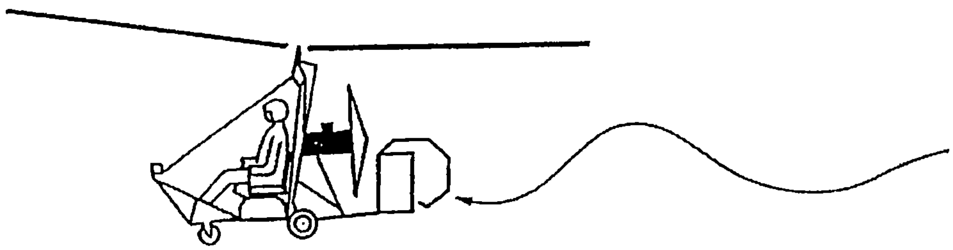
4460 Shemwell Lane,
Paducah, KY 42003.**

THE TWO MOST DANGEROUS THINGS IN A GYROPLANE

Fixed wing aircraft have their dangerous regions. This is stalling and spinning. Many people were killed by the inherent characteristic of fixed wings to stall and spin. Gyroplanes also have their dangerous regions - this is the dread of PORPOISING on the one hand and an INVERTED AIRFLOW CONDITION on the other:

A. PORPOISING

Porpoising is the up and down oscilation of the airframe below the rotor, accompanied by alternating diving and climbing of the aircraft. It can cause either an inverted airflow condition, or the rotor to strike the prop or tails in the back of the craft and result in the aircraft falling out of the sky if not stopped in time. Accident statistics showed that 100% of accidents caused by porpoising was fatal. It is thus a very dangerous condition. This does'nt mean however that it cannot be prevented or corrective action taken in time.



Porpoising can be induced in three ways:

1) PILOT INDUCED OSCILATION (PIO)

This is in our opinion, not the biggest cause of fatalities due to porpoising these days. With the two seater gyroplane came dual training, which reduced the risk of PIO greatly. Student pilots with less then about 7 hours on a gyroplane can however cause PIO on their first solo flight around the pattern at altitudes over 100 ft and too high airspeeds. With the ground reference being further away at higher altitudes the tendency to overcontrol in pitch often returns - even to pilots who learned to control the craft fine at lower altitudes. A pilot on his first solo can also overcontrol due to tension. Above 100 ft a loss of depth perception results. Your eyes are spaced apart only widely enough to judge accurately altitudes up to 100 feet. Above that, without experience, you will not be aware of losing or gaining altitude. This may lead to porpoising.

Overcontrolling is aggravated by the "pendulum" effect of a rotorwing which tends to overshoot the commands of the control stick. Unlike an airplane that has its wings and control surfaces rigidly attached to the airplane, rotorcraft airframes hang free below the rotor by a universal pilot. Therefore, there is a time lag between the instant the pilot applies the control motion, and the time he notice **the tilt of the airframe. The pilot must learn to anticipate this to prevent out of phase control actually increase the motion that the pilot tries to phase controling actually increase the motion that the pilot tries to stop. LACK OF ANTICIPATION CAN START "PUMPING" OF THE STICK AND OVERCONTROL. It is an abnormal reaction that happens only to green pilots. Once you learn to control it, anticipation becomes automatic.**

If porpoising is permitted to continue, alternating up-and-down gravity acceleration may reach zero and negative G's on top of the peaks. This cause an inverted airflow condition which is the real killer. See the section below on this topic.

Student pilots should never attempt solo flight above 100 ft until they have flown a minimum of 15 hours. Take your time, work up to higher altitudes gradually, and learn to anitcipate the control lag. It is easy to prevent PIO by not trying to FLY the aircraft, but to let it FLY ITSELF! If PIO is encountered REDUCE THE THROTTLE AT ONCE! Neutralize the stick, establich a smooth glide and then bring back the throttle slowly to maintain airspeed. Fly at 50 mph during all of your first 25 hours of flight training. Higher airspeeds can aggravate oscilations and the speed in which a pilot gets himself into trouble. So fly "low and slow" during your first 25 hours of training. Also, when flying your first circuits above 100 ft, watch out for PIO and be ready to reduce power.

2) GUST INDUCED OSCILATIO (GIO)

This will be the first (or only) place you will hear of a GIO as this cause of porpoising was not properly adressed before in gyroplane circles. It is our opinion, supported by extensive research into gyroplane accidents, that fatal porpoise accidents are priarily caused by GUSTS! It is also green pilots flying too high and fast too early in their training programme, that kills themselfes this way. The porpoise is induced by a sudden gust of air, causing the nose to pitch down. This combined with a green pilot who does not know how to handle the situation, can cause a combination between a GIO and a PIO. A GIO can actually be induced by a strong gust without the pilot doing anything! This way even an expert can get into porpoising. It happens as follows:
As the gyroplane fly straight and level, the center of gravity (CG) is acting AHEAD of the center of lift (CL). The gyroplane was designed this way: If a hang test was conducted from the teeterbolt, a properly balanced loaded gyroplane will actually hang 10 degrees nose down without engine thrust. As the engine pushes below the rotor on the frame, it induce a nose up moment. The rotordrag tends to pull the mast backwards, increasing this nose up moment. Under cruise conditions, the engine thrust and rotorgrag balances to produce a nose up moment just enough to allow the aircraft to fly level. It is this moment between the CG and the CL that cause porpoising:
(Pict. 1)
When the aircraft hits a sudden gust of air, the rotor speeds up, produces more lift and accelerates the aircraft upwards. The CG acting ahead of the CL wants to allign itself with the CL and the aircraft swings rearwards, causing the nose to pitch down:
(Pict. 2)
If the pilot keeps the stick in neutral, the backwards swinging of the frame, does the same as pushing forward on the stick, causing the rotor to pitch down in front:
(Pict. 3)
The airframe acting as a pendulum now swings forward out of phase to the rotorblades. With the stick still in neutral, the rotor tilts back. The airframe swings back, now completely out of phase with the rotors. The rotor strikes its teeter stops, bends down and the prop usually cuts the blades in half, causing the craft to tumble out of the air:
(Pict. 4+5)
How do we get out of a GIO. If you notice a GIO and the resulting pitching down of the nose, reduce power. If the gust was violent, cut power. This takes the "life" out of the porpoise. The nose will allign itself under the rotor CL and there wil be no moment which causes porpoising: The craft will go into a glide. Once the frame is stable, bring the power back to cruise and establish level flight again. This does'nt mean you have to cut power in every gust. The secret is to recognise a GIO. Generally you can prevent GIO by not wanting to fight gusts, but to ride it out. Don't either freeze on the stick or induce heavy controling. Hold the stick lightly and allow it to move where it wants. Dont be afraid to pull back slightly on the stick if a gust produce the nose to go down. In this way you prevent the rotor and frame to move toward eachother out of phase. Although a gyroplane can be flown in violent winds and gusts, it is not advisable to do so before you are an expert pilot.

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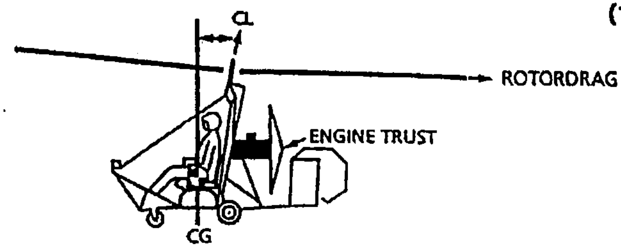

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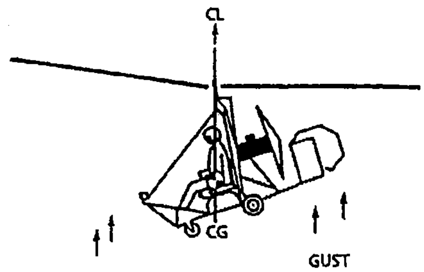

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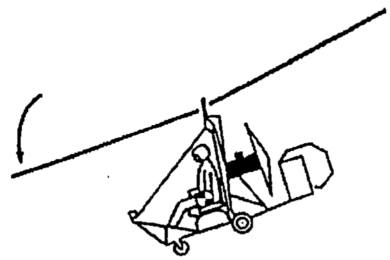

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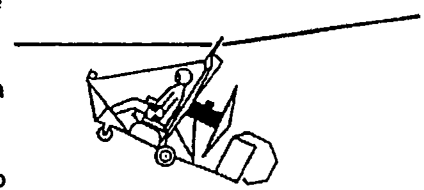

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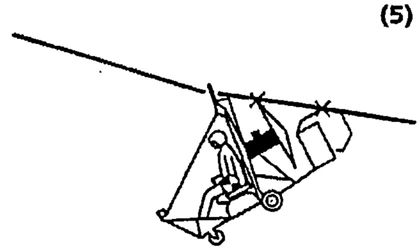


3) AIRCRAFT INDUCED OSCILATION (AIO)

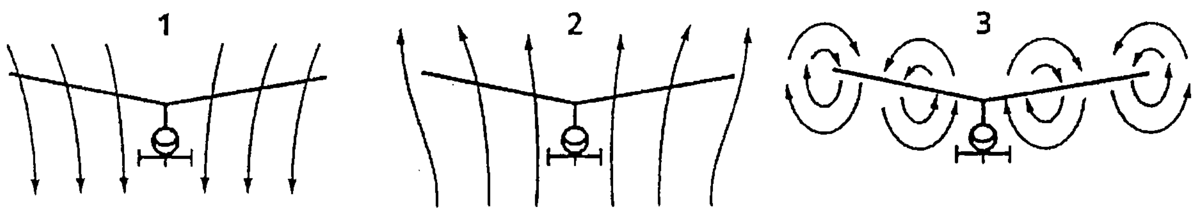
It is a fact that porpoising can be caused by an unstable aircraft due to a weak design, no horizontal stabilisation, an out of balance or wrongly loaded aircraft, too much play in the control system etc. With good design available these days, the extend of this cause is low. However, always inspect your control system for excessive play, always load the aircraft within its CG limits, and always do a hang test before you test fly it and after you changed something.

B. INVERTED AIRFLOW CONDITIONS

In early gyroplane literature you will often read of "unloading the rotorblades" or "negative G's" as a very dangerous thing to do in a gyroplane. The truth is that it is not only unloading of the rotorblades which are dangerous, but also an INVERTED AIRFLOW CONDITION. A negative G manoeuver also CAUSES an inverted airflow condition, and it is inverted airflow which is the real killer in gyroplanes. For a complete picture we will discuss both:

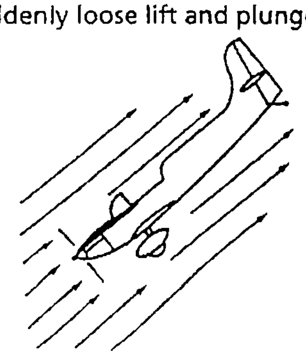
A NEGATIVE G is induced only by a pilot making a sharp pullup (usually to impress spectators). To level out after the climb, the stick is pushed forward instead of power reduced. The push over results in a "light-in-the-pants" feeling, indicating a zero or negative G condition. The rotor needs a constant positive G-loading (airflow from below) to maintain speed in autorotation. Negative G's will cause the sustained for a long time, causing the rotors to loose so much speed that it can start flapping (buffeting) if airspeed is gained again. This is similar to flapping encountered by novice pilots on the ground trying to take off with insufficeint rotor speed. At least 20% of the rotorspeed will have to be lost for a negative G Manoeuver to become dangerous. It is very difficult to achieve this in flight. However always avoid manuevers when long unloaded conditions with low rotorspeed is followed by an abrupt high load condition, as flapping may follow. If blade flapping is ever encountered in flight, the remedy from this predicament is the same in the air as on the ground: Cut the throttle and unpitch the rotor. If this is not done the flapping will increase and the blades will strike the prop or rudder.

Most accidents after a pullup-pushover manoeuver however results not because of rotorblade flapping, but of the aircraft tumbling tail over nose out of control to the ground. This is the result of an INVERTED AIRFLOW CONDITION. This can be caused both by pushing the nose over after a steep climb out and pushing the nose down suddenly in very high speed flight:

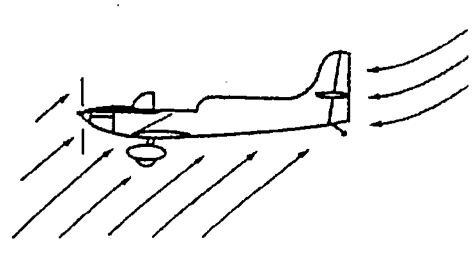


Vortex Ring State

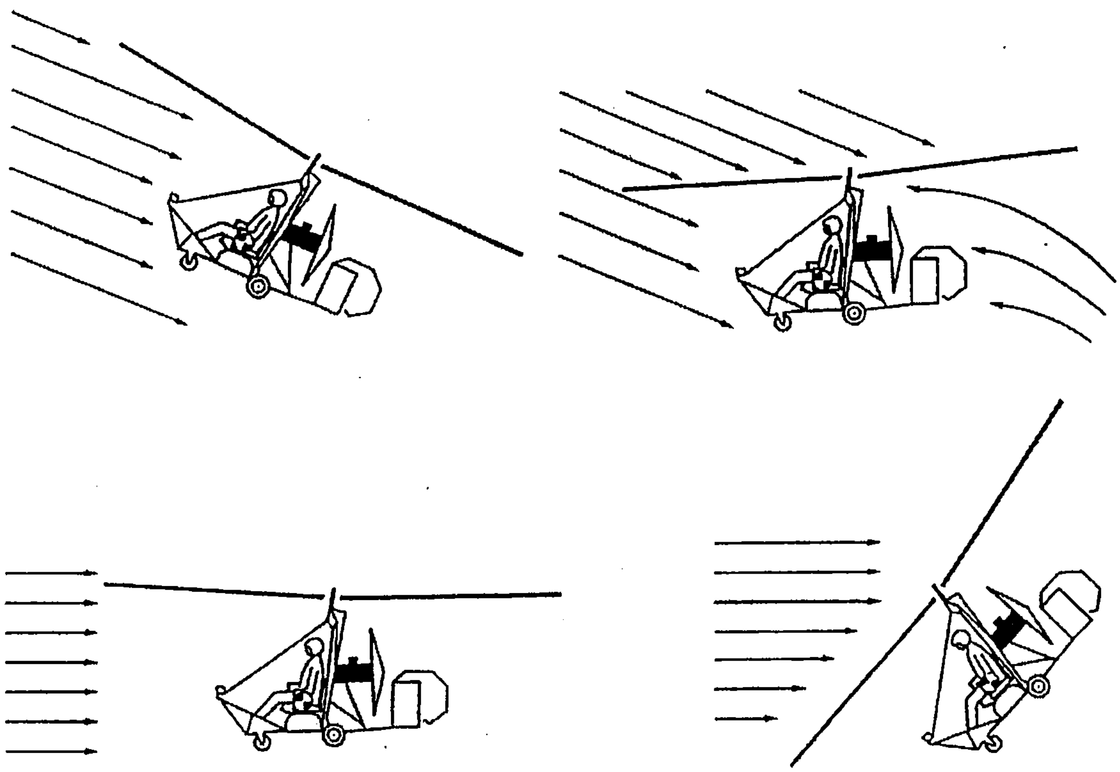
To understand an inverted airflow condition, you must understand the different operating principles of a rotorsystem: Helicopters usually fly in a mode called the HELICOPTER MODE. In this mode the airflow is from the top down through the rotorblades. Then there is the AUTOROTATIONAL OR GYROPLANE MODE of flying in which the airflow is from the bottom up through the rotorblades. Helicopters uses this mode for emergencies. The third mode is what is called "VORTEX RING STATE". In this state the rotor does'nt know if it is a helicopter or gyroplane rotor as the air that is going upwards through the blades is returned and goes downward again in vortexes. In this state the rotor does'nt produce any lift, and as a result also no drag. Helicopters encounter vortex ring state if it enters its own downwash in a steep descent or near the ground before landing. It will suddenly loose lift and plunge down. It is also called "power settling". Vortex ring state can in principle also be encountered in a gyroplane in a steep or vertical descent, however the downwash through a rotor in autorotation is much smaller than through a helicopter rotor. Downwash thus does'nt produce a hazard to a gyroplane. Where vortex ring state however is very dangerous for a gyroplane is after a push over manoeuver either after a steep climb out or high speed flight. The rotordisc will enter vortex ring state if airflow is allowed to enter from the top of the disc in stead of a constant entrance from below. This happens if a pilot does'nt reckon with the direction of the relative airflow at all times.



Fixed wing pilots often get themselfes into trouble when pulling out of a dive by not paying attention to the REALITVE AIRFLOW. A fixed wing can actually be stalled in a dive! The reason is that relative airflow is running in the direction in which the aircraft dives. By pulling out of the dive the aircraft can easily exeed the wing's stalling angle, causing the aircraft to stall at a high airspeed:



Exactly the same thing happens to a gyroplane in a steep climb. The relative airflow is no more from front to rear, but is flowing in the direction in which the aircraft climbs. When a pushover manoeuver is induced, the airflow (still flowing from above) starts flowing through the top of the rotordisc causing the disc to enter vortex ring state. The disc suddenly looses all of its lift and resulting drag. However the engine still pushes against the airframe below the motor. Without any rotordrag to compensate for the engine thrust, the engine thrust causes the airframe to tumble forward in a somerault:



How can an inverted airflow condition be caused in a high speed straight and level flight? Drag increases to the square of the forward velocity. This means that the drag on a body travelling through the air is four times grater at 100 mph then it was at 50 mph. As the Gyro travels faster and faster, the drag on the airframe suspended below the rotor increases a lot.

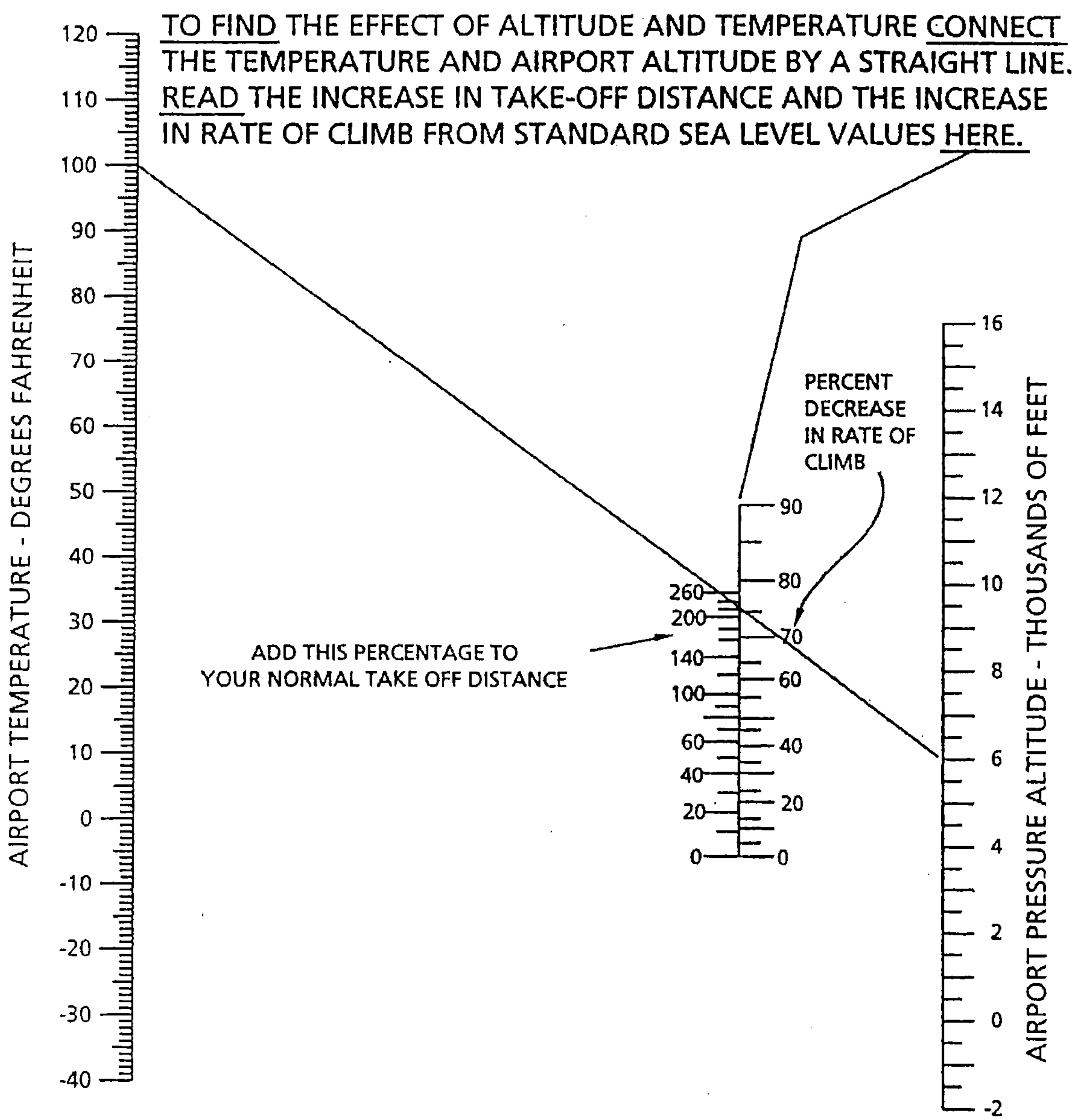
However, the faster you fly, the smaller the angle of attack of the rotordisc becomes to produce the same amount of lift than at lower speeds. This causes the rotordrag decrease with increasing speed. So the airframe drag increases, the rotordrag decreases, causing a nose down moment due to the thrust of the engine pushing above the CG. The very small rotor angle of attack leaves little room for safety. A gust at high speed, or the pilot making a sudden nose down stick movement, can cause an inverted airflow condition, vortex ring state and a forward somersault out of control!

This will only happen near the VNE, so cause should be taken not to manoeuver the stick forward in high speed flight (above 80 mph). If you want to descent, reduce power. The same counts for levelling out after a steep climb out. Dont push forward, reduce power. You can also do a banked turn at the top of a climbout to maintain a positive G-loading while changing to level flight. There is a way to stop the forward tumbling of the craft if it is ever encountered. CHOP POWER and pull back fully on the stick. Throttling back gradually will not help. CHOP the power immediately and you might survive it. But remember, this condition is primarily induced by the pilot flying the craft outside its envelope. So it can be prevented. The fact that it can porpoise and rotorblades be unloaded does'nt make the gyroplane a dangerous aircraft. The gyroplane is a very safe aircraft and for you will be a very safe aircraft, if you know its weak spots, avoid them, and know what to do if you get into it.

EFFECTS OF TEMPERATURE AND ALTITUDE

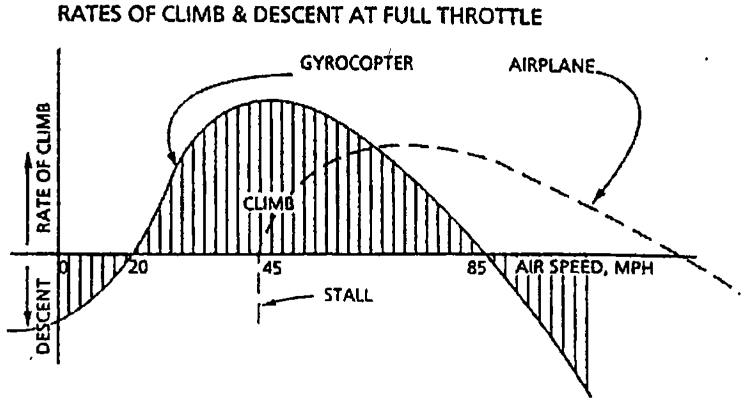
Be very careful for something called a high "DENSITY ALTITUDE" (DA) which simply means thin air. A high DA is caused by the three H's - HOT, HIGH, HUMID conditions. These things makes the air thinner and you need air to ride your gyro on! Air density decreases with altidude, and the effects of higher temperatures and humidity combine to reduce your aircraft's-performance - especially take off distance, climb rate and playload capability. At higher altitudes, temps or humidity, an aircraft must pass through air faster in order to achieve the same lift and performance.

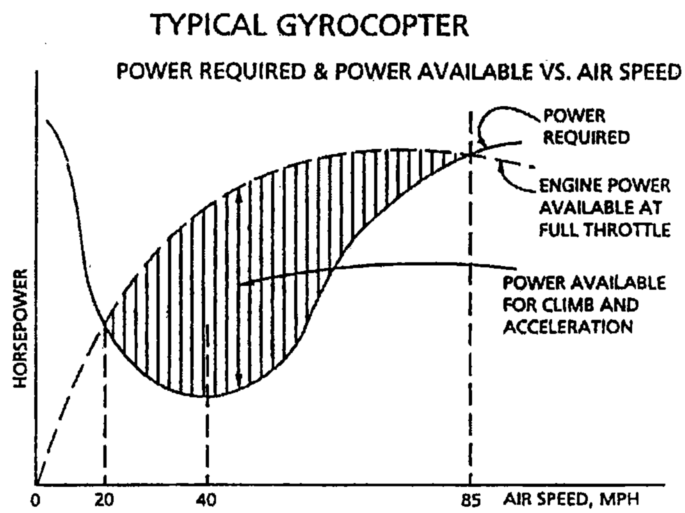
Do not try a take off from a too short runway on high airfields or hot or humid days. Abandon the take off in time if you run out of runway. Always calculate your take off distance. Also keep in mind the wind direction, payload of your aircraft and slope of the runway. An approximate method to determine DA is to add 60 feet to your field elevation, for each one-degree increase over "standard" temperatur. The following graphs will help you:

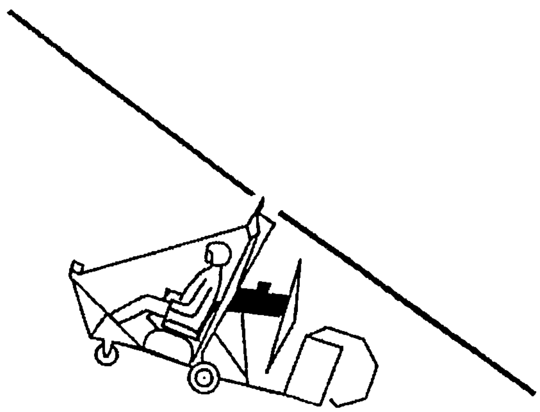


EXAMPLE: The diagonal line shows that 230% must be added for a temperature of 100 ° and a pressure altitude of 6,000 feet. Therefore, if your standard temperature sea level takeoff distance, in order to climb to 50 feet, normally requires 1,000 feet of runway, it would become 3,300 feet under the conditions shown. In addition, the rate of climb would be decreased 76%, meaning that if your normal sea level rate of climb is 500 feet per minute, it would become 120 feet per minute.

FLYING BEHIND THE POWER CURVE







Our "common sense" tell us that flying slowly takes almost no energy, and it takes less power to move at 20 mph than at 40 mph. Right? WRONG! If you know how this works, you will sooner or later find yourself in serious trouble. To be caught "behind the powercurve" can be a dangerous place to be in a gyroplane, especially near the ground and to student pilots.

If you look at the "power required curve" of rotorcraft, you will notice that it takes lots of power to fly slowly. This is simply because the rotordisc is tilted back with a larger angle of attack in order to produce enough lift to stay airbone. The large rotorangle creates more drag, requiring more power to overcome. Any aircraft (including birds and bees) have a certain level flight. This is the "minimun power required" speed (MPR). This is the speed at which the rotor is flying on its best lift to drag ratio. This is also the best rate of climb speed (with the most power in reserve available for climbing) and best gliding speed (with the least amount of drag for a shallow glide angle). That MPR speed is usually 45 to 55 mph for most small rotorcraft. It again takes up more power to fly faster than MPR. So more power must be added to fly both faster or slower than that speed.

The gyroplane is one of few aircraft that can safely be flown behind its MPR airspeed, because it cannot stall. So, what happens when you fly below this critical MPR airspeed? You must add power. The slower you fly, the more power is required, until you run out of power and the engine runs open widely. This is flying on the EDGE OF THE POWERCURVE. Reduce the airspeed by pulling back more on the stick and the craft will beginn to settle. Near the ground this can be dangerous. To get back to your MPR speed again, more power cannot be added because you are already on full power. So what remains? The stick must be pushed forwards to put the craft into a dive in order to convert potential energy into airspeed. For this, altitude is needed.

Beware to be caught behind the powercurve near to the ground. Remember that more power is required in a turn. To the comfort of rotorcrafters, it can be said that their machines never run out of lift, even at zero airspeed, but they most certainly can run out of altitude. And flying behind the "backside of the powercurve" is the quickest way to run out of altitude. The only way you can check your descent if you got behind the powercurve, or to initiate a climb, is to DIVE MOMENTARILY to get 50 mph. If in aturn, flatten out the bank as soon as possible. It is a bad habit to fly near the edge of the powercurve, for if the engine would quit, the aircraft would have an unnecessarily steep glide angle and little reserve energy to execute the flareout for landing. THE BEST FLYING SPEED IS ABOVE 45 mph, or if you are traveling cross-country, 55-65 mph.

Before any attempt is made to land on unfamiliar terrain, first fly over the area and analise conditions. Learn to expect and handle turbulence, drifts, downdrafts and wind shear. Remember, in hotter weather when the air is thinner, you will settle more rapidly. Also in summer weather be aware of strong thermals during an approach which can lead you to overshoot your chosen landing spot. It does'nt take an expert to fly safely in most conditions. But it does require selfdiscipline and a basic knowledge of general atmospheric conditions. Your attitude is what's really important. You can fly like a professional with only 50 hours of flying time, or as an amateur at 2000 hours. Know your air and learn to expect the unexpected!

WIND SHIFTS

HOW TO FLY OVER WIRES

High tension power lines and ground obstacles have claimed more lives of rotorwing pilots than most other causes. The reason is that our craft are so at home down low, that this is where it is mostly flown. Wires are difficult to see when looking down from above. Even when spotted, distance to horzontal wires is very difficult to judge. A low-flying pilot who is unaware of this, exposes himself to serious risk. So what is the pilot to do? Look for vertical telephone poles and towers. If you spot a pole, you can rest assured that wires are attached to it somewhere, even when you cannot see them. Adopt this rule: Always fly over the POLES, NOT THE WIRES, even if you clearly see the wires. The reason for this is that your eyes cannot tell the distance to the wire and can easily fool you, while it can judge the distance to a vertical object more accurately.

TEN SAFETY RULES

1. Do the basic things good. Do your preflight and check for enough fuel, clean and correctly mixed.

2. No one but the pilot and the passenger may be permitted near the aircraft when the engine is started. Beware of the propeller and always shout "Prop clear" before starting the engine.

3. Dont start the rotor when anybody is near it. Taxi away from all persons before starting the rotor.

4. Taxi slowly and dont turn abruptly on the ground. Never taxi close to people, especially children, other aircraft or obstacles, while the rotor is turning. Turn the engine off when someone is approaching the craft.

5. "A superior pilot uses his superior judgement to avoid those situations which require the use of this superior skill" (Astronaut: Frank Borman). Avoid sharp pullups, rolls, or other aerobatics. Be VERY careful in front of spectators. The safety of your aircraft decreases in direct proportion to the amount of people watching!

6. Always have altitude, airspeed and/or power in reserve when making a turn near the ground. Avoid downwind turns at low altitude. It does not matter whether you fly a gyro, an airplane or a helicopter, the rule applies to all flying machines.

7. "ALWAYS LEAVE YOURSELF A WAY OUT!" (Genl. Chuck Yeager). Always have a landing site available within gliding distance. "We are all accident prone. If your emergency training is up to date, you can survive any emergency" (Test pilot: Tony Levier).

8. "Be sharp - stay up on the edge of your seat" (Test pilot: Scott Crossfield). Bear all facts in mind: the wind direction, temperature, humidity etc. "Know your aircraft. Know its limitations and above all - know your own limitations" (Bob Hoover).

9. Always keep the log of your and your aircrafts flying hours on date and do your maintenance in time.

10. We have meet the enemy ...it is us!

TRAILERING YOUR AIRCRAFT

Transporting your Gyro from one location to another must be given the utmost of care and consideration. The hardest your aircraft will ever work is on the ground. There is little you can do to damage the aircraft in flight. Therefore, we suggest that you trailer the craft in the following manner.

1. A suitable flatbed trailer or the custom Venter trailer may be used that has a soft suspension.

2. When your Gyro is loaded onto a trailer, it must sit freely in the main wheels and nose wheel. The aircraft should be secured to the trailer with rubber tie-down straps over both axles and the nose wheel. Permanent wheel chocks mounted onto the trailer for all three wheels is desirable.

3. NEVER, under any circumstances or advise from others, should you transport the Gyro with the rotorblades attached to the aircraft. It does not matter how well you support them. Take the five minutes to assemble and disassemble the blades before transportation.

4. We recommend that while transporting your craft, you cover all vital areas. Put a plastic bag over the head, carburettors and air cleaners. Cover the cabin and windscreen with our custom made cover and put the blades in their bags. Do not let loose tarp flap against your aircraft, because it's possible that the paint could be rubbed off in that area.

ROTORCRAFT DICTIONARY

Rotorwing aircraft have developed a whole vocabulary of new words which describe special parts or conditions peculiar only to their element. To help you get acquainted with this new medium, this dictionary defines and describes some of the words most widely used:

AIRFOIL - streamline shape of aerodynamic surfaces designed to produce a minimum of drag and maximum of lift.

ARTICULATED - a mode of attaching the rotor blade to the mast. A blade is „fully articulated" when it is similar to a shoulder joint in its root attachement. This joint allows the rotor blade to flap up and down, move fore and aft (in „lead and lag" motion) and twist around its own axis (pitching motion):

AUTOROTATION - self-energized turning of the rotor akin to that of the seed of the maple tree. Unlike „windmilling" where blade pitch is negative, autorotation is obtained with positive pitch settings by the flow of air through it in an upwardly direction. By contrast, in helicopters the air flows through the rotor in a downwardly direction.

ADVANCING BLADE - The portion of the rotor disc in which the rotation of the blade is moving in the direction of the aircraft's travel.

AERODYNAMICS - hydrodynamics and aerodynamics are both branches of fluid dynamics, which is the study of fluids in motion.

BLADE LOADING - the load placed on the rotor blades of a gyroplane, determined by dividing the gross weight of the craft by the total combined areas of all blades (not the disc area).

BALANCE - rotorblades that are equal in weight will balance each other. Unbalanced rotor blades may cause control stick shake and instability when in flight.

BANK - sideward tilt of the aircraft in flight necessary to keep the craft from skidding outward or slipping inward during a turn. In a correctly executed turn the bank exactly compensates for the centrifugal force.

CEILING - the maximum altitude to which a gyroplane can climb, because of thin air, the engine decreases in power, or the rotor blades no longer provide lift to climb. Pith of the blades is increased for a higher ceiling.

CENTER OF GRAVITY (CG) - a point where the resultant of all weight forces will balance evenly from this point. Just in front of the mast and on the rotor-axis.

CENTER OF PRESSURE (LIFT) (CL) - a point where all the aerodynamic forces of the airfoil surfaces are concentrated.

CENTRIFUGAL FORCE - the force caused by the rotation of an object with mass. (Technically more correct to speak of centrepetal force).

CONING ANGLE - the blades tend to bend upward in flight when they are lifting the weight of the aircraft. Referred to as the coning angle, similar to the dihedral of a wing.

CRUISE SPEED - an airspeed that usually results in the best fuel economy at about 75 % power.

CHORD - the length of the airfoil from the leading edge to the trailing edge.

CHORDWISE BALANCE - an engineering term that refers to the mass balance of the airfoil. It is usually made to coincide with its center of lift.

COLLECTIVE - collective pitch control changes the pitch of all rotor blades in unison, thus verying the total lift of the rotor.

CYCLIC - repetitive once-around-the-circle change in the pitch angle of each rotor blade as it turns around the axis. Cyclic pitch control has the purpose to tilt the direction of lift force of the rotor for control.

CONTROL SENSITIVITY - the rate of rotor response to the rate of control stick inputs. High control sensitivity is common to small helicopters and undersirable. Large, slow turning rotors have a low control sensitivity - desirable.

CRAB - the attitude of the gyroplane with respect to its ground track as the aircraft is flying in a crosswind.

COMPOSITE - modern construction method of structural aircraft parts using fibreglass and foams. With the advent of composite materials, it was determined that the structure could carry as much load as aluminum-alloy, but had a much greater resistance to damage and fatique with a lighter weight and smoother surface.

DCA - Directorate Civil Aviation.

DISC - area swept by the rotor blades.

DISC LOADING - the gross weight of the gyroplane devided by the rotor disc area. The greater the disc loading, the gyroplanes's sinking speed will increase, and its glide-angle will become steeper.

DENSITY ALTITUDE - Pressure altitude calculated from air temperature, altitude and humidity.

DISSYMMETRY OF LIFT - the unequal lift across the rotor disc, caused from the advancing blade creating more lift than the retreating blade.

DOWNWIND - flying with the wind directional. Flying downwind near the ground is dangerous, true airspeed is lower than ground speed and the aircraft's lift is less.

ENDURANCE - the maximum length of time a gryoplane can stay aloft on its fuel supply.

EAA - Experiamental Aircraft Association.

FLARE - a landing manoeuvre performed near the ground to slow the gyroplane's rate of descent and airspeed. The gyroplane is in a nose-high attitude during the execution of this maneuver.

FLUTTER - a self induced (usually chordwise) oscillating motion of improperly designed or balanced rotorblades.

FATIGUE - a property of structural materials which makes them break down under repeated stresses, while they would now break down under stresses twice al high if applied only a few times. Vibration is the major cause of fatigue failures in rotorcraft.

FLAPPING (Teetering) - up and down motion of the rotor blade around its flapping hinge. Rotor blades flap as much as 8 degrees in forward flight. Without flapping, a rotorcraft would roll over on its side because advancing blade would produce more lift than the retreating blade.

FLAPPING (Buffeting) - the spanwise oscillation of the rotorblades in its teeter hinge, resulting in it the blades hitting the teeterstops, possibly destroying the head and blades because of too fast acceleration with too little rotorspeed on the ground take-off.

GIMBAL - a mechanism which permits the tilt of the rotorhead in any direction but restains its rotation. If axes of tilt do not intersect the axis of rotation of the rotor, the gimbal is said to be „off-set". A correctly designed offset gimbal head allows the gyro to fly hands-off.

GROUND EFFECT - a ground cushion of extra buoyancy near the ground, which makes aircraft float a few feet off the ground as if on a denser pillow of air.

GROUND RESONANCE - a violent „dance jig" that a helicopter sometimes develops when its rotor is turning while it stands on the ground. It happens only to rotorcraft equipped with lag hinges (unnessesary in two bladed teetering rotors-systems) and inadequate dampers.

GYROCOPTER - a name coined by Bensen Aircraft Corp. describing a gyroplane type rotorcraft.

GYROPLANE - the proper name reffering to a rotorcraft with free-wheeling rotors, which is propelled by a separate forward thrusting propeller. See also Rotorplane.

GROUND VORTEX - the horizontal whirlwind that forms at the forward edge of the rotorwake when the gyroplane flies at low speeds close to the ground.

(HORSE) POWER LOADING - the ratio of the gross weight to horsepower, obtained by dividing the total weight by the engine's horsepower rating.

HELICOPTER - a type of rotorcraft whith engine driven rotor in flight and which can hover in calm air. Air going through its rotor always travels from above downwardly through the disc. In forward flight its rotor is tilted forward as the lift force itself is used to obtain the forward thrust. When the rotor is shaftdriven, various methods of torque compensation must be proveded, such as tail rotors, second rotors, etc.

INDUCED DRAG - drag due to lift of the rotor.

JOYSTICK - control column in aircraft, also referred to as „CYCLIC CONTROL" in rotorcraft.

KEEL - the main structural member of the rotorcraft which runs fore-and-aft of the airframe. Nosewheel and tailwheel are carried on its extremities.

LIFE - maximum safe duration of operation of any part of rotorcraft. It is limited by the probability of either fatigue failure or excessive wear.

MAST - main vertical structural member of the rotorcraft which connects the airframe to the rotor. In spite of its simple function, the mast must be very carefully designed to minimize the feedback of damaging vibrations between the rotor and the airframe.

LAMINAR FLOW (BLADES) - the airflow immediately against the rotor blade (boundary layer) is of most importance in the efficiency of the blade. It is only possible for composite blades which cause unusually low drag. It was determined that the slightest buckle forming in the „skin" caused by things like rivets, could nullify the advantages of the blade section. Surface smoothness and polish have a noticeable effect on efficiency.

NEGATIVE G'S - the state of a gryplance after a steep climb and pushing forward of the control stick so that air is forced against the top of the rotor disc. When this condition leads to the ring-vortex-state in the rotor in can be fatal.

PARASITE DRAG - drag other than induced drag. Rotor drag caused by forward velocity. Airframe drag.

PATTERN - the in-plane alignment of both rotorblades so they perfectly balance each other.

PORPOISING - oscilations caused by the pilot by over control and inexperience, gusts or unbalanced gyroplanes.

POWER LOADING - the ratio of the gross weight to the horsepower rating of the rotorcraft's engine.

PRESSURE ALTITUDE - the altitude that is indicated on your altimeter.

PITCH - an angle of the airfoil of the rotorblade to the plane of the rotor disc.

PRA - Popular Rotorcraft Association.

PULLOUT - a flight manoeuvre at the bottom of a dive. It could result in gravity exceeding +2.

PUSHOVER - a flight maneuver on top of a climb, or a nose-down dive from level flight. When done abruptly, inverted airflow and a funeral may be caused.

RANGE - maximum distance a rotorcraft can fly without landing or refueling.

REDUNDANCY - a fail-safe design which provides a second stand-by structural member, should the main one fail, or providing two members to do the same function. Dual ignition in airplane engines is typical redundancy.

RING-VORTEX-STATE - power settling in helicopters. A flow state of the rotor in which tip vortexes pass through the rotor disc. Cause for many accidents in gyroplanes. No lift or drag produced by rotor.

ROTORPLANE - see Gyroplane.

ROTOR-BLADE-STALL - airflow over the inboard portion of the retreating blade is reversed such that it is stalled. Large flapping causes the tip of the retreating blade to stall at high forward speeds (150 mph).

RETREATING BLADE - this blade is on the opposite side of the advancing blade. It travels with the wind created by the forward motion of the rotorcraft.

ROLL - tilt of the gyroplane along its longitudinal axis (see bank). Controlled by lateral movements of the joystick.

ROTOR - the lift-producing turning airfoil system of a rotorcraft. Rotorblade refers to a single blade only.

SERVICE CEILING - the altitude at which the rotorcraft still maintains the potential to climb at 50 feet per minute.

SPEED STABILITY - the tendency of the rotorcraft to pitch up or down when the forward speed is changed.

STALL - the separation of the airflow from the surface of the airfoil or any other component. The resulting loss of lift is a stall.

STABILITY - the tendency of a rotorcraft to return to its original flight condition after a disturbance.

TEETERING ROTOR - a two-bladed rotor with a single horizontal hinge for flapping.

THRUST - the pushing or pulling force developed by an aircraft engine.

TIP STALL - the stall condition of the retreating blade which occurs at high forward speeds (approximately 150 MPH).

TORQUE - a rotary force, a reaction to the turning effort supplied by the engine. Anything that rotates and consumes power produces a reaction torque in the direction opposite to its rotation. Tail (antitorque) rotors are added to helicopters to overcome the torque produced by the rotation of the main rotors. No torque is produced by gyroplane rotors because they are not engine driven.

TRACKING - of the rotor is an operation necessary to assure that every blade rotates in the same orbit. This means that each blade tip must follow the path of the preceding one. If not, a vibration will develop, which is similar to „dynamic unbalance" of a wheel.

YAW - turning of the gyroplane to the right or left by changing the direction of the airflow over the tail surface through the use of the foot pedals.

GYROS DO NOT STALL

By DR. IGOR B. BENSEN, P.E.

Misinformation is worse than ignorance. An ignorant pilot proceeds with understandable caution and probes for correct answers before courting disaster. A misinformed pilot confidently plows into the danger zone and is unprepared to meet the disaster when it strikes. Wrong knowledge is worse than no knowledge.

Much has been said in recent aviation literature (including some FAA and NTSB reports) about accidents caused by „Stalls" of gyrocopters.

Let's set the record straight. Gyrocopters don't stall. At least, not in the same sense as the airplanes. Airplanes encounter stall primarily at low airspeeds, at which time they experience an abrupt loss of lift and control.

Gyrocopters won't stall at low airspeeds, period. However, a partial stall may be induced on the retreating blade at very high speed, usually requiring a dive to about double of cruising speed. But no abrupt loss of lift and control occurs then. This type of stall has no similarity at all to the classic airplane stall.

Let's examine them both and clear away some misinformation.

IT CAN'T STALL

In common pilot parlance, „stall" means sudden loss of lift and uncontrollable loss of altitude. Aerodynamicists have other definitions, but this popular concept is usually implied to be the principal cause of stall accidents. This being the case, then it can be said categorically that: „Gyrocopters do not stall." You see the evidence of it every time vou watch gyro pilots making vertical descents. Airplanes can't do it. Airplanes depend on forward speed for lift and control. At a certain minimum speed they stall and drop out of control. Gyrocopters do not. At low speeds they begin to settle down „on the backside of the power curve,"but continue to fly under full control. Even at zero forward speed, in vertical descent, they still retain full control. That's the big difference between airplanes and gyrocopters.

CIERVA'S HERITAGE

When Juan de la Cierva invented the gyrocopter (autogiro) rotor in 1923, he achieved just what he intended: a stall-free lifting surface. Rotor blade tips of the gyrocopter fly through the air at about 350 mph in all flight regimes, regardless whether the gyro flies forward, sideways, vertically, or in any combination, with power, or without power. This is why they call it „autorotation" - a self-induced automatic rotation. It's always there. No matter what he does, except when he deliberately initiates inverted flight, the pilot cannot vary its rotor speed more than plus or minus 10 percent.

Cierva invented this gyro rotor after he saw a good friend of his killed in a typical airplane stall accident. He vowed to develop an aircraft that could not be stalled, even accidentally. He was eminently successful. Whether the gyrocopter flies forward, or descends vertically, the air flow through its rotor turns it like a windmill. This rotation will not stop, even at zero airspeed, so long as the aircraft remains airborne.

For the same reason, it is impossible to stall it. The pilot does not have the collective pitch control lever in gyrocopters and therefore cannot suddenly increase the pitch of the entire rotor blade. Remember, the stall will not occur until the total effective angle of incidence exceeds some 16-degrees, depending on the airfoil used. Pilot's cyclic control is usually limited to about 8-degrees, so he cannot exceed it cyclically either.

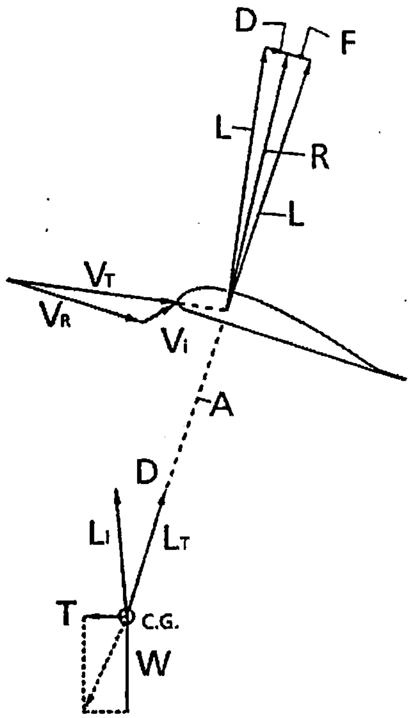
Actually, the effective incidende of the airflow over the airfoil varies widely along the span of the rotor blade. It may be indeed stalled near the roof under some flight conditions, but the center section of the rotor having low relative airflow produces very little lift and can be ignored. Most of the lift is produced near the tips where the airflow is the highest, and relative incidence is the lowest. Induced flow through the rotor is also strongest near the tips. For this reason, any increase in incidence near the tips is followed immediately by the increase of the inflow pattern which decreases the incidence. This self-regulating action is characteristic of autorotating rotors and is, in fact, the major safety factor of Cierva's invention.

LOW SPEED VS. HIGH SPEED

An airplane wing, of course, can be stalled at high speed as well as at low speed. It is the angle of attack, not the airspeed, that stalls the airfoil. However, the slow speed stall is by far the most dangerous condition for airplanes, because it usually occurs during maneuvering near the ground. Sudden loss of lift and control is accompanied by the loss of altitude, which often is too low for recovery.

Thus, to repeat: in airplanes, stall is a LOW speed phenomenon; in gyrocopters, stall is a HIGH speed phenomenon. But for the airplane pilot it may be disastrous, and is an ever-present danger. For the gyrocopter pilot, it is a non-dangerous nuisance and may never be encountered except when deliberately induced.

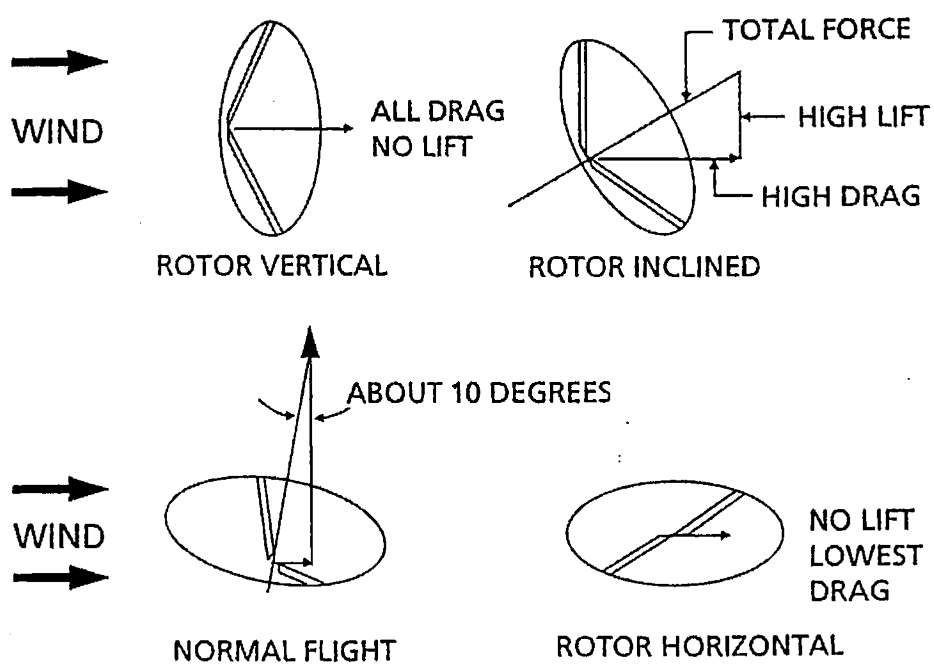
AUTOROTATION FORCE DIAGRAM



LEGEND:

A - AXIS OF ROTOR ROTATION
V_R- VELOCITY OF AIR DUE TO BLADE ROTATION
V_i - VELOCITY OF AIR INFLOW INTO THE ROTOR
V_T- TOTAL AIRFLOW VELOCITY
L - LIFT OF THE AIRFOIL
D - DRAG OF THE AIRFOIL
R - RESULTANT FORDE ON AIRFOIL
F - FORCE THAT DRIVES THE AIRFOIL AROUND THE AXIS
L_i- LIFT FORCE TRANSMITTED TO THE MAST
L_T- TOTAL LIFT TO THE ROTOR
T - THRUST OF THE PROPELLER
W - GROSS WEIGHT OF THE GYRO
C.G.- CENTER OF GRAVITY OF THE AIRCRAFT

WHAT MAKES IT LIFT? THE ANGLE OF ATTACK!



"Normal Flight" sketch has the most lift, lowest drag, and is best for flying!

JUST HOW „TRIM" ARE YOU?

Are you flying your Gyro, or is it flying you? Does your Gyro require constant control input to maintain straight and level flight? - - to maintain a constant airspeed? - - to correct for a yaw condition? If the answer to any of these questions is yes, proper aerodynamic trimming of your Gyro could be the „Magic Cure"!

Proper trim can be accomplished only if your Gyro is assembled correctly, and individual assemblies installed following all tolerance quidelines. To review this, let's go back and check a few important points, just to be sure.

LONGITUDINAL TRIM

1. Remember, when using the Gimbal Control head, make sure the Teeter Stop Plate, or Torque Tube is horizontal when the control stick is centered and vertical!

2. When using the Joystick, make sure your pushrod tubes are properly adjusted. The lateral head stops and lateral control stick stops should touch at the same time. The Joystick handle should touch the Keel (down stop) when the Gimbal Head contacts its forward stop. Likewise, the „up stop",-7 angle, when properly located on your seat bottom vertical brace angles, must contact its rearward stop. It is very important the -7 angle be in place to prevent over-stressing the control head and Joystick!

Now that you have everything properly adjusted, let's „trim" your Gyro!

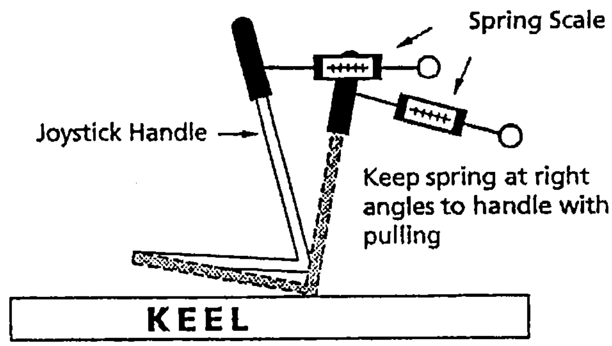
A ground-adjustable clamp, or longitudinal trim bracket, included with all Bensen Gimbal Heads, is located on the Mast tube. The clamp position determines the proper spring tension on the off-set head, required to provide a hands-off longitudinal stick position in flight. At the proper clamp position, inflight the stick position should be maintained with „X" power setting, for „X" gross weight, and „X" airspeed. The precise location of your clamp bracket to obtain the „trimmed" airspeed you desire will vary according to your operating gross weight, rotor hub length, pitch setting, altitude and temperature, engine and propeller combination, and spring rate. Spring Rate - is pounds of force required to stretch the spring a distance of one-inch.

So, where do you start in locating a clamp bracket position, and how do you tell if you are „in-the-ballpark"?

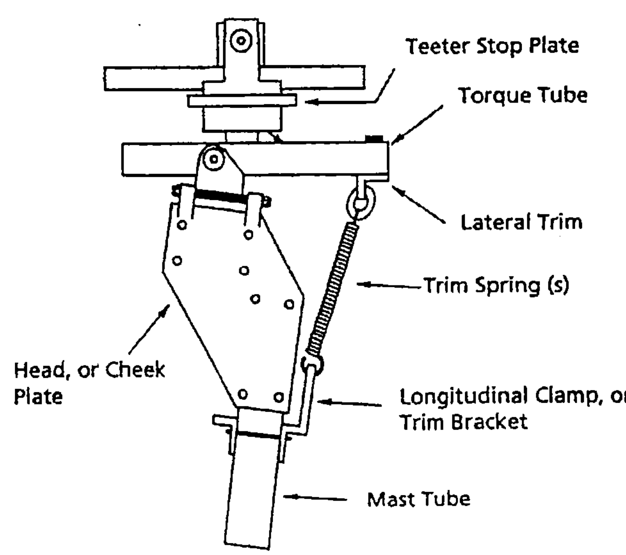
First, remove your rotors and rotor hub from the Gyro. Now let's base our calculations on an average Gyro gross weight of 500 pounds, using two springs and trimmed to fly „hands-off" at 45 mph. Locate for yourself a „fish scale" and tie it to the handle of your control stick at the hand-holding position. Pull the scale at right angles to stick. Re-adjust your clamp bracket position as necessary to obtain the following readings: (All dimensions are measured from the bottom of your head plates to the top of your clamp bracket.)

1. With initial clamp position of 1.3", using the Joystick: to just move the stick should give you a scale reading of 7 lbs. To pull the stick fully forward, a force of 8.75 pounds will be required. Re-adjust your clamp as needed to obtain these force readings!

If your Gyro is heavier than the normal 500 pound gross weight, the clamp position dimension will be greater, and the scale readings will be higher. If you are in the lighter gross weight catagory, of course the clamp position dimension will be less, and your scale reading will be lighter than above.



(Figure 1)



(Figure 2) Sketch: Gimbal Control Head

FLIGHT TEST

Final adjustment of longitudinal trim can be accomplished only through flight test. In straight and level flight, release the control stick longitudinally using rudder as necessary to keep your drift indicator pointing straight at you. Hold lateral pressure only on the stick as is required to keep the Gyro from banking. Now note your airspeed. If it is lower than you desire, the clamp bracket will need to be adjusted higher, to lower spring pressure load. If your airspeed is too fast, the clamp bracket needs to be lowered or tightened. Approximately a 3/8" change in clamp position, changes your airspeed 10 mph. Adjust your clamp position until stick force becomes zero at 45 mph.

LATERAL TRIM

Well, we have you flying now with hands-off precision longitudinally at your gross weight and airspeed. But what about lateral stability? During your flight test, if lateral pressure was required to prevent banking, then something else needs adjusting. On the rear of your Gimbal Head torque tube, loosen the (2) 1/4" bolts that pass through your slotted bracket. This bracket is for lateral trim of your Gyro. When using the Joystick, move your bracket off-center in the same direction that lateral pressure was required on the stick.

YAW TRIM

Now that your rotor and control system are adjusted correctly for level flight and at your desired airspeed, we have to correct our rudder system to prevent yaw, and keep our drift indicator flying straight.

The rudder trailing edge is pre-formed or bent 5 degrees to the left to act as a „trim tab". This tab deflects the rudder to the right side. If right rudder was required in level flight, to keep your drift indicator straight, then more bend of the trim tab is required. If you needed left-rudder, your tab 5 degree bend should be reduced.

Adjustments completed, you now have an aircraft that can actually be flown hands-off! If your trim setting was for instance 45 mph, with full throttle your Gyro will maintain a climb at 45 mph. At cruise throttle, your Gyro will maintain altitude 45 mph. With closed throttle, your Gyro will maintain a glide at 45 mph.

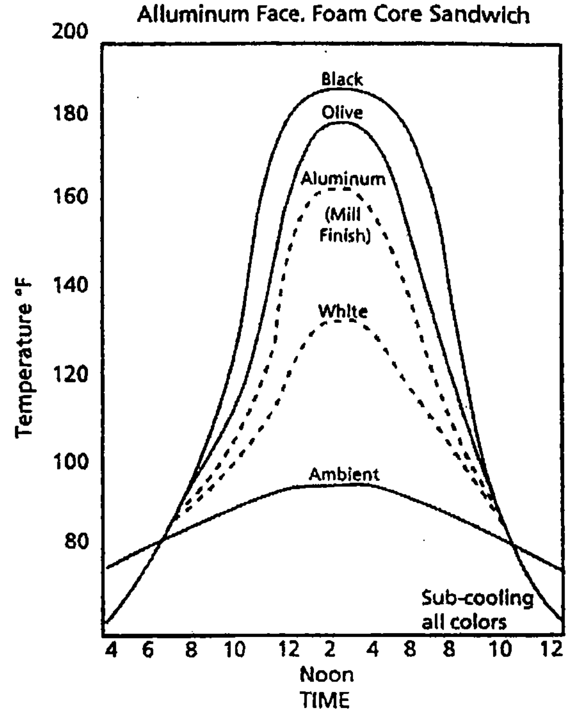
TEST IT

Let's give it a try! Go out and fly. With the correct throttle setting of say 45 mph, your Gyro should take-off, climb, level out, and maintain 45 mph without any stick force input. Now, reduce throttle, but don't touch the stick. Your Gyro should set up a glide path for you at 45 mph, and all because of proper trim!

Relax! Imagine your stick as a cotton ball that could not be squeezed. That's all the pressure you need! Relax and enjoy.

Now, have fun with your „tamed beast", and learn what „fun flying" is really all about!

Figure 3
DAYTIME PANEL SURFACE TEMPERATURES
Alluminum Face, Foam Core Sandwich



MAKE MINE WHITE

What color is your Gyro painted? What color helmet do you wear? Few people realise the importance of color and the heat it can generate in bright summer sun. Those hardy souls among us, myself included, who like to walk barefoot in the Summer, will be quick to tell you to avoid walking on black asphalt on midday. Asphalt melts at 160 degrees, but human skin can tolerate only 135 degrees without blistering. It doesn't occur but to a few that these same laws of radiation apply to helmets, your aircraft surface, and even the clothes you wear!

The Figure 3 Diagram shown here, shows what temperatures can be reached on a painted surface during an average Summer day. Starting with a mild 75 degrees „F" in the morning, the temperature of the outside air may be expected to rise to 90 degrees or more by 3 pm, and then will decline again back to 75.

Look at what happens to surfaces exposed to direct sunlight! If you wear a white helmet, its outside surface temperature will get up to 130 degrees. Your aluminium frame might rise to 160 degrees

(Ouch! - that's too hot to touch! Did you ever try to change aluminium rotor blades in hot sun? If you did you already know this.) But if you wear a black or dark helmet - look out! You might „cook your brains" with temperatures as high as 190 degrees! Your head, of course, will try to protect itself by sweating profusely, but without any movement of air, it won't help very much. You might actually go into shock and pass out, as it often happens to motorcycle and dune buggy buffs in the desert. The difference is that they are on the ground, but you are in the air. They can just stop, and somebody helps them out. There is no one in the air to help you. So, you have to look out for yourself.

This dark color hazard is not all that cut-and-dry danger as we make it sound. Certainly, if there is wind, and in flight, your helmet's temperature is lowered by increased convection. But there is a lot of foam padding between its surface and your head, and this can be both beneficial and harmful. It produces a considerable time lag in the flow of heat, and thus may continue to heat your brain even after you begin to fly.

The best policy is to avoid any chance for an overheated helmet, period! If so, then dark colors and even aluminium paint are OUT! White or near-white is the only answer.

For me, I may jazz mine up a bit, with some thin stripes maybe to add some class, but otherwise, MAKE MINE WHITE!

WATCH THOSE SCRATCHES

Everyone knows that scratches, dents, and nicks are the first introduction to more problems. A scratch in automobile paint for instance is an open invitation to rust and corrosion. If the problem area is not taken care of immediately, the corrosion may continue, working its way completely through the metal.

„Ground-Bound" vehicles can survive this problem, even untreated, for long periods of time. NOT SO in aircraft! Aircraft structures are normally designed so that each part is responsible for some portion of imposed flight loads. If anything upsets the calculated designed strength of a part, such as scratches, bends, or nicks, the part is weakened and DANGER EXISTS!

Rotor Blades, Rotor Hubs, Mast Support Structures, Brace Angles, and Landing Gear are especially susceptible to this condition. All Rotor Blades, be it Helicopter or Gyrocopter, continually flex themselves in flight. Scratches and nicks lengthwise of the rotor span are DANGEROUS, but not as critical as scratches across the spar or rotor chord, or progressing from a rivet hole. These can eventually lead to fatigue of the part which of course means failure. No matter how well an item is designed, misuse can totally destroy it.

A good example of fatigue failure would be standard window pain glass. To cut glass to the required size, the first procedure is of course to scratch your intended break line with a diamond glass cutter, and tap the glass edge which will cause it to break on your scratched line. Even something as simple and light as paper will not tear in a straight line until it is first creased. You guessed it - - the crease acted as a fatigue line, weakening the paper fibers which enabled you to tear it with ease - - along a straight line.

THE POINT

Check all parts of your Gyro for scratches, dents, nicks or abrasion. If you see any, polish them out with fine sandpaper, followed by fine steel wool, or a burnishing tool.

Check especially all parts of your Rotor Blades; the main leading edge spar,top and bottom skin surfaces, and all rivets. If you have allowed your rotors to flap,or they have been subjected to severe ground handling, the first sign will be „popped" rivets and/or buckling of the lower skin surface.

Check all cross-brace angles, especially at the fillets and radius points. Make certain that you polish all saw marks to a smooth finish.

If you have used a scribe to lay-out any holes, make certain the marks were within the confines of the area to be cut or drilled, and not protruding past these areas. If they are, polish them out.

If you have any questionable areas on any of the mentioned items, especially Rotors, Rotor Hubs, or Rotor Heads, you may send them to the Bensen Factory for a FREE Inspection. We will give you an honest evaluation of your parts with a detailed Inspection Report.

The old cliche „An Ounce of Prevention Is Worth a Pound of Cure" still holds true. If you provide the initial Prevention, the Cure will take care of itself.

Gyroplane Training Notebook - Part 1

By Tony Bolinger, Flight Instructor

In this series of articles, Tony Bolinger shares the knowledge and experience he has gained in many hours of training new gyroplane pilots. The purpose of this series, Tony emphasizes, is not to prepare someone to go out and teach himself to fly, but rather to help understand the gyroplane better.

The Basic Theory of Gyroplane Flight

At forst sight, you will notice that the gyroplane has a propeller like an airplane and rotor blades like a helicopter. Resembling a helicopter more than an airplane, the gyroplane differs from the helicopter in that it derives its lift through air passing up through the free wheeling rotor system and receives its thrust by way of an engine driven propeller, while the helicopter receives both its lift and thrust from the powered rotor system.

The collective pitch in a rotor blade is comparable to the angle of incidence in a fixed wing aircraft and as such is inclined up into the airstream. This inclination causes the air passing over the top of the rotor blades to travel a greater distance thus producing lift.

The rotor system in motion forms a rotating disc. The blades in the advancing half of the disc create a greater amount of lift than the blades in the retreating half of the disc. This phenomenon is called „dissymetry of lift" and is compensated for by increasing the pitch in the retreating blade and decreasing the pitch in the advancing blade.

This is accomplished through control rigging and the flapping action of the rotor system. As the rotorcraft increases in forward speed, the angle of attack in the retreating blades continues to increase until the angle becomes so great that the retreating blades stall. Contrary to stall characteristics in a fixed wing aircraft which limits its slow speed capability, retreating blade stall is the major factor limiting high speed capabilities of rotorcraft. This condition must be avoided by exercising caution at high speeds. As each retreating blade begins to stall, a vertical vibration is felt in the aircraft. For each revolution of a two bladed rotor system, two vibrations are felt, known as a „two per rev" vibration.

What is the most important component on this aircraft? That's right, it's you The Pilot: It is apparent that you've decided you want a gyro and are doing the right thing in having someone competent teach you to fly it. I've seen all too many cases where the „competent" pilot tries to teach him or herself to fly this machine and promptly damages it or worse, themselves. It is vital for you to have the right attitude when going into this sport. You must know that this little aircraft can be dangerous, not only to you but to others around and it needs to be treated that way. I shy away from those with that „I've never had an accident" or „It can't happen to me" attitude. Just about any seasoned pilot will tell you that there are those that have and those that are going to. It only takes a fraction of a second to become one of those that have in any aircraft. As safe as this aircraft is, it can still be the source of great despair in the wrong hands.

Ask yourself why you want to fly the gyro. The answer is the same for just about everybody - FUN. But remember, this is not a toy, it is a machine that requires respect and consideration. What are you going to do with your aircraft? Again the answer is usually, HAVE FUN - if someone tells me that the aircraft is going to be used for any other reason, I just shake my head and smile. Let's face it we're all in this for fun, but let's not forget that like most anything that's fun, it can be dangerous.

Now that your head is on straight, what about the rest of you? Are you a healthy person? There is no warning labels that say „take only as directed", even though I feel there should be. I've seen the most experienced pilots become „anxious" in this aircraft, and some never do get used to it.

Lets face it, flying this machine is like no other flying sensation. You're out in the open with nothing around you, traveling at respectable speeds and usually close to the ground, and it's a very different set of feelings than any you're likely to be accustomed to. This is especially true at times like your first solo or later, as your proficiency develops, your first attempts at advanced maneuvers. The aircraft is perfectly capable of such things in the hands of a competent pilot with a cool head. Even after many hours of both instructing and solo flight, I still get that thrill and excitement I did in the beginning. I strive to learn something new, if not about the aircraft, then about myself, every time I go up. I never intend to be one of the „know it alls."

If you are an active pilot already, then you probably have a current medical certificate. If you are not or it's expired, get one. At least a Class Three medical. It doesn't cost much or lake a great deal of time and it may save you a lot more than you spend. If you think you can't pass a physical exam for any reason or haven't had one in some time, why not find out? Most flight surgeons are cooperative and will help if they can.

Your aircraft requires certain attention and maintenance to be safe.
Give yourself the same consideration. „Get a preflight before you preflight." It is true in any case.

SAFETY FIRST.

The Air Command Gyroplane

The Air Command utilizes a two bladed semi-rigid rotor system. This means that the rotor system is allowed to „flap" but has no „feathering" action. Properly adjusted, the rotor spins smoothly. If an out of balance condition is encountered, it can be adjusted mechanically. The track of the rotor system can be adjusted by means of a cam type pitch block on top of the rotor head. By loosening and tightening the appropriate bolts, the pitch in one blade increases while the pitch in the other blade decreases. With the proper touch and a little patience, the blades can be made to fly in the same plane of rotation or „in track". If, after proper tracking, a vibration is still felt, it is caused by an out of balance condition. Assuming the blades themselves are weighted equally, this means that one side of the rotor disc is heavier than the other. Because the rotor blades are offset at the rotor head, they can be adjusted laterally by means of a threaded bushing at the teeter bolt. By moving the entire rotor system one way or the other over the center of the mast, one side becomes heavier while the other side becomes lighter, thus balancing the system „span-wise." This is a trial and error adjustment and again, patience is an assel.

It is readily known in the aviation world that negative „G's" in most aircraft is a condition that must be handled with extreme caution and must be absolutely avoided in the gyroplane. When negative G's are encountered the reversed air flow through the rotor system unloads the rotor, allowing it to flap freely, destroying both lift and control with catastrophic results. „Pushing over the top" of a climb or making sudden forward stick inputs in cruise flight must avoided.

You will find that because this aircraft is very light on the controls, a tendency to over control, especially in pitch, is likely. This tendency can lead to a condition called „porpoising" or „pilot induced oscillation", and if not recognized and compensated for right away, this condition can develop to the point od negative „G's" . Chasing the attitude or trying to fly the aircraft out of this condition will normally lead to over controlling and make matters worse. The best way to recover from porpoising is to remember the words „pilot induced." It's not the aircraft doing it, it's the pilot. So all the pilot has to do is stop moving the stick and the aircraft will stop porpoising. If the condition is encountered at a high power setting, a reduction in power will also help. You will find that stick pressures rather than stick movements are all that are required to fly the aircraft smoothly and precisely. As your proficiency develops, you will discover a variety of „tricks" this aircraft is perfectly capable of. But in the beginning, it will be necessary to concentrate on the basic maneuvers.

The Flight Controls

As stated before, the aircraft is very light on the controls and responds best to control pressures rather that control movements. Quick jabs or large control inputs tend to confuse both the aircraft and the pilot. The stick should be held lightly in the right hand, preferably with the right forearm resting on the right thigh. The throttle is controlled with the left hand and the rudder pedals are controlled by toe action.

In relation to the nose of the aircraft as seen from the pilots seat, back on the stick is up, forward is down. Left stick pressure will cause a left bank and right pressure will cause a right bank. The rudder pedals are also directional both in the air and on the ground. In the air, left pedal will cause a left yawing effect and right will cause a right yawing effect. The throttle, which I also refer to as a primary flight control, is rigged so that forward movement will increase power and rearward movement will decrease power. It will be fearned during your instruction that the throttle is a control that needs to be anticipated. Remember to anticipate your power requirements before they can anticipate you.

The balance spring serves to compensate for unwanted stick pressure in straight and level cruise flight. You will note that stick pressures change as the condition of flight changes. For instance, a power off sink will cause an increase in aft stick pressure. This is normal and to be expected. Again, the spring is adjusted for cruise flight by increasing spring tension if stick pressure is forward (nose wants to drop), or decreasing tension if stick pressure is aft (nose wants to rise). Lateral stick pressure can be adjusted by rotating the top mounting tang either left or right of center. Left of center will alleviate left stick pressure and right of center will alleviate right stick pressure.

The rudder also has a trim tab that can be adjusted to „keep your tail behind you". If the aircraft yaws to the left without your help, bending the trim tab to the left will cause the nose of the aircraft to stay right. Bending it to the right will have opposite effect. Though a properly trimmed aircraft will momentarily fly „hands off", it should be remembered that releasing any of the controls is not recommended procedure. Even balanced properly, the aircraft lacks dynamic stability, like any rotorcraft, and will not fly itself. It therefore requires a pilot to be close by at all times. A prudent pilot stays in control of his aircraft at all times.

Gyroplane Training Notebook - Part 2

By Tony Bolinger, Flight Instructor

This is the second in a series of articles in which Tony Bolinger shares the knowledge and experience he has gaind in many hours of training new gyroplane pilots. The purpose of this series, Tony emphasizes, is not to prepare someone to go out and teach himself to fly, but rather to help understand the gyroplane better.

PREROTATION AND TAXI

Prerotation is necessary to get the blades turning before the takeoff roll begins. This serves to shorten the takeoff distance and help to deter the effects of flapping. Start prerotation at idle rpm with light pressure on the prerotator lever. Once the blades are turning, increase pressure on the lever until a slight drop in rpm is heard. Holding the brakes if so equipped, increase engine rpm and pressure on the lever until the desired rotor rpm is reached.

If the rotor rpm catches up to the engine rpm, the prerotator will disengage. If that happens, let off the lever, increase engine rpm and re-engage the prerotator. If you use too much pressure when you first engage the prerotator, it will cause „chattering" at the head and undue stress and wear on the system. Let the rubber wheel slip at first and then bear down. If equipped with a rotor tach, about 100 to 150 rpm is sufficient. If not so equipped, watch the rotor blades. When they begin to „blur" or when you can no longer count each blade as it passes, that should be sufficient rpm to start the takeoff roll. In either case, what is needed is enough rotor rpm so that you can bring the stick back to the stop, fully loading the rotor system. More on that when we get to takeoffs.

Taxiing is made simple by means of the steerable nose wheel and rudder. The rudder, being ineffective at slow speed, becomes important once the takeoff roll is started. The aircraft is very stable on the ground and can be taxied at rather high speeds as long as some cautions are used. Always level the rotor system by holding forward stick when moving with low rotor rpm, or if the rotor is not turning. Holding the rotor level will cause the wind to have less effect on the system and help to keep the blades from flapping into the ground.

Taxi slowly over rough ground or for a long distance. It may be best to prerotate first. When taxiing with the blades turning, remember that any air going through the system will cause them to turn faster, thus creating more lift. Holding the blades level will help keep it solidly on the ground. Avoid high speed turns on the ground, especially with the blades turning, because the aircraft can become „light" and it could roll over. Leveling the rotor system will create less lift and more stability. Gusty, windy days are especially hazardous and extra caution should be used. Leaning the spinning rotor system into the turn slightly will help on such days.

Brakes, even though an option on the aircraft, are recommended. After all, brakes are cheaper that rotor blades. Remember to be aware of others around you. The propeller will put out a lot of prop blast behind you and cause concern to others and their equipment. And never - repeat never - walk away from your aircraft with the blades turning. This is a good time to talk about the:

ROTOR BRAKE

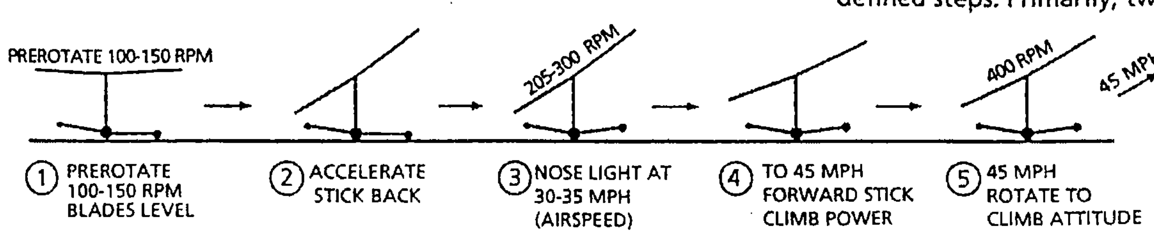
The rotor brake is a simple device and well worth the nominal extra cost for it. It works by placing the puck in a horizontal position against the front plate of the rotor head assembly and holding forward stick. This causes the rotor head ring gear to engage the brake, thus effecting a braking action.

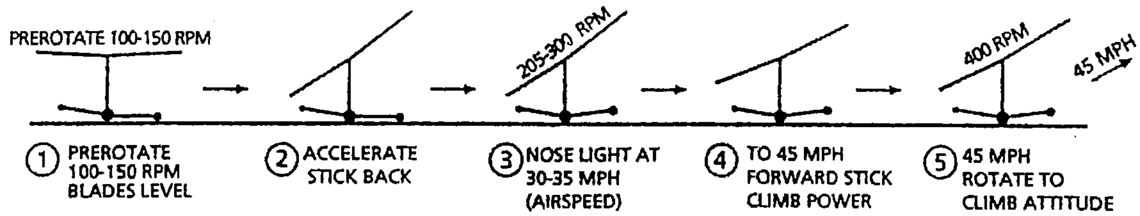
This has two distinct advantages: one, it holds the rotor system level while the blades are slowing down and two, it reduces the amount of time the rotor is at low rpm. It can also be used to hold the rotor system form turning while taxiing around obstacles or otheer aircraft. Use extreme caution here, remember that prop blast.

It is also recommended that you keep the rotor system tied down in some fashion while the aircraft is parked. The slightest breeze can cause the rotor to turn. I have more than once walked into a blade that I had left someplace else. After you have taken all the wonderful precautions discussed here, note just one more. Be sure that the puck on the rotor brake is in the vertical position again before you take off on that next flight. Hitting that unexpected restriction in control movement is a real attention getter.

THE NORMAL TAKEOFF

The takeoff is accomplished through a series of carefully defined steps. Primarily, two





things are required to make the takeoff: rotor speed and airspeed. Prerotation is required either by mechanical means or by hand prior to the takeoff roll. Once prerotation is accomplished and sufficient rotor rpm is reached to prevent rotor flapping, acceleration is started with a smooth, graduals application of power with the stick back against the stop and centered laterally. This „loads" the rotor system; that is , it gives the system its maximum angle of attack to the oncoming wind. This spins the rotor up to its maximum rpm that can be reached while the aircraft is still on the ground. This is indicated by the nose becoming light.

Now what is needed is more airspeed. To prevent the aircraft form becoming airborne too soon and to allow for adequate nose wheel steering, push the stick forward just enough to keep the nose wheel on the ground. This „unloads" the rotor slightly and an acceleration will be felt. Now climb power is applied and a further acceleration is felt. Continue the acceleration until best climb speed is reached. As that final acceleration develops, the stick is brought back to the neutral position or such a position that will put the aircraft in a slightly nose high attitude when proper airspeed and rotor rpm are reached.

Caution here: If too much airspeed is attained before rotor rpm has a chance to build, the result will be rotor flapping. If too much rotor rpm is attained before airspeed is reached, the aircraft will leap into the air in a very nose high attitude, slow down and flutter back to earth. If done properly, the aircraft should break ground in a normal climb attitude with sufficient power to maintain best climb speed.

Depending on cross-winds, runway heading must be maintained. Should the aircraft touch back down for any reason, it does not tolerate sideways landings well. Note that runway ahead of you is usable, and you may have to use if it something goes amiss. Keep it within reach as long as possible or until a safe maneuvering altitude is reached. Remember that takeoff is optional, landing is mandatory.

SOFT FIELD TAKEOFF

We must assume that not everybody is going to have a nice paved 5000 foot runway to use and many times it will become necessary to use a grass strip. Even though the aircraft will handle a rough runway very well, it's a good idea to spend as little time on it as possible, especially at takeoff speeds.

With that idea in mind, the procedure is very much the same as the normal takeoff discussed before, except that the acceleration to climb speed is accomplished after the aircraft is airborne. Start the takeoff as before with prerotation. Remember here that the more rotor rpm you can get with prerotation, the shorter the takeoff roll. Start the takeoff roll with the stick full back and accelerate until the nose wheel becomes light.

Now is where the procedure differs. Instead of putting the stick forward and accelerating, hold the nose up in a slightly nose high attitude and bring the throttle up to climb power. It may be necessary to „balance" the aircraft in this attitude for a second to wait for that last rotor rpm to build up. This attitude should be such that the aircraft is balanced on just the main wheels. There's no reason to get the tail wheel in on the rough ride.

As the rotor rpm builds up to flight speed, the aircraft will lift off. You will find that the airspeed at this time will be below best climb speed and if the attitude is maintained, the aircraft will probably slow down and settle back to the runway. So it becomes necessary to level the aircraft with climb power and accelerate to climb speed, then raise the nose to climb attitude and climb out. If you force the aircraft off the ground too soon or if you wait too long to level off and accelerate after lift off and the aircraft does settle back to the runway, it may be best to abort the takeoff and try again.

It's also very important to keep the aircraft heading under control so that no ground contact is made with any sidewards movement. There's a strong chance that the aircraft will roll over in such a situation. If all goes wrong and a landing is imminent after lift off, it usually ends up in a harder than normal touchdown and the aircraft bounces. Should that happen, the second touchdown is going to be harder than the first. Remember to keep the blades level at impact and keep the power on until the aircraft contacts the ground. Now get the power off and keep that stick centered laterally. Don't worry about bringing the stick back to stop the aircraft. The reason you're in this situation is that you were going too slow in the first place. The aircraft will take quite a hard landing and live, but those blades won't. "Keep those blades out of the dirt."

ABORTED TAKEOFF/QUICK STOPS

If for any reason a takeoff should need to be aborted prior to reaching the point of breaking ground, simply reduce the throttle to idle and, as the speed reduces, bring the stick straight back against the stop smoothly at a rate that will rock the aircraft back on the tail wheel but not cause it to break ground. This affords the best breaking action and slows the aircraft very quickly. If you have taken off and are below 15 feet of altitude, hold the aircraft in the takeoff attitude and reduce the throttle smoothly until an adequate rate of descent is established. Now hold the throttle position until ground contact is made. Then it's the same as before: throttle off, stick straight back against the stop.

If more than 15 feet of altitude is reached and you must abort the takeoff, you must evaluate the situation carefully. If enough runway is left to accomplish a normal approach and landing, do so. If not, a high rate of descent can be gained by reducing the throttle and lowering the nose. When about 6 feet of attitude is left, you must again apply power and adjust the attitude to slightly nose high for landing. At touchdown the procedure is again the same: power off, stick back. The brakes may be applied at any time after landing but you should put the nose wheel down on the runway first with forward stick. Normally the brakes will not be needed until the aircraft has slowed enough to settle onto the nose wheel naturally.

Pacticing the last aborted takeoff discussed should be avoided until such time that your proficiency has developed enough to handle the situation comfortably.

Straight and Level Flight

Though simple, this most fundamental of maneuvers is difficult because, being completely open, the aircraft has no attitude references to the horizon. From the start, the attitude of the aircraft ha to be "sensed" and not seen. This takes a little practice but will come with time. It is best to watch out ahead of the aircraft, where you're going, for instance, and develop your senses for the attitude and airspeed. There are some helpful indicators as to attitude and airspeed that your instructor should point out.

Turns

Turns are made unsing the stick to set up a bank angle. Remember that the rudder is used only as a trimming device to prevent skidding or slipping; this is, to "coordinate" the turn. Very little rudder input is required to fly the aircraft in the normal modes of flight. Naturally, the steeper the turn is, the more rudder required to keep the aircraft in trim. "Ruddering into a turn" will only cause the aircraft to fly sideways, requiring more power and, at high speeds or power settings, this could be hazardous.

During a turn, the same forces that are acting on the aircraft are acting on you. If the aircraft skids or slips in the turn (too much rudder), you will feel as if you are gaining weight, sitting heavier in the seat. This is a result of the centifugal force being developed. You will want to remain relaxed and sit upright in the seat. It is difficult to detect a slip or a skid if you are not riding along with the aircraft in the turn.

Initially, you will learn shallow bank angles of 30 degrees or less. You will find the aircraft has a tendency to "nose down" in a right turn and to "nose up" in a left turn. This is the result of "gyroscopic precession", which all rotorcraft are subject to. While hardly detectable in shallow turns, it becomes more and more pronaunced as the turns get steeper. A slight forward pressure in a left turn or a slight aft stick pressure in a right turn is all it takes to compensate and to keep the nose level. Good attitude control in the turns is necessary to maintain your airspeed. Remember, airspeed equals attitude.

LANDING

All flights of any kind end in the same manner - a landing. There are many ways that good landings habe been described, such as "any you can walk away from" or "throwing yourself at the ground and missing". We shall refer to it as normal. A normal landing is the end result of the approach we talked about earlier.

To accomplish the normal landing, the normal approach must be continued to an attitude of approximately 4 feel above the touchdown area. At that point, the aircraft is returned to a level flight attitude. If the proper power setting and airspeed have been established on the approach, this leveling should stop the descent and serve to slow the aircraft to touchdown speed. If the approach has been steeper than normal, very little power will be applied when this position is reached. Therefore, a slight power increase may be helpful just prior to leveling the aircraft to helb stop the descent. If the approach has been shallow, there will be less of an altitude change and more power applied at that point. It then becomes necessary to reduce the power appropriately to slow the aircraft to touchdown speed.

In either case, the aircraft should be in a level attitude and slowing when the 4-foot altitude is reached. As the aircraft slows, it begins to settle toward the runway. At I to 2 feet above the runway bring the nose up slightly but sufficiently to keep from touching down on the nose wheel but not so much that the tail wheel hits first. Three point landings are line as long as one of the points is not the nose wheel, especially in a crosswind condition. As the aircraft settled onto the main gear, reduce the throttle to idle and let the stick come back much the same as in the aborted takeoff procedure. Remember that even after the aircraft is in the ground, the rotor blades are turning fast enough to create lift sufficient to roll the aircraft over. Don't you stop flying before the aircraft does. If you assume a nose high attitude at the 4-foot level, the airspeed decreases and the aircraft will then sink from 4 feet rather than setting lightly to the runway, resulting in a bounce or worse.

Should you find yourself in this position, keep the aircraft level and apply power enough to turn the sink into a settle and make a normal touchdown. The aircraft can land with zero ground run even on a no-wind day. However, this takes precise timing and that comes with experience - in other words, later!

HELPFUL HINTS:

Airspeed - Remember that you need it for takeoff and landing, recovering from a sink and generally to keep you out of trouble.

Avoid even getting close to negative G's. Remembering the "power before altitude" rule will help. When propoising is encountered, a reduction of power may also be helpful.

Don't dive out of a sink. You may not be able to afford the loss of altitude. Always avoid slow speeds at low altitudes.

Never conduct downwind takeoffs or landings. And beware when flying downwind, even wiht altitude. Don't be fooled by your ground speed. Airspeed and ground speed are not the same. The aircraft does not require ground speed to fly: it demands airspeed.

Above all, fly the aircraft at all times. You're not a passenger, you're a pilot!

What about that ever present possibility of an emergency? There are a number of reasons for an emergency, such as mechanical failure or the FAA's favorite, "pilot error". Many emergencies can be avoided by a simple means such as a good preflight. You should never take off with a condition that you "think" will be okay. Good maintenance practices are imerative. If you "think" something is loose or may fail or is just plain worn out, it probably is and should be fixed.

Your engine is one of the most dependable on the market and, with proper care, will give you many hours of enjoyment. Maintenance that's other than normal should be left to a mechanic with adequate training to perform that maintenance. Primarily, all your engine should require is attention to details like proper fuel mixture with quality fuel and oil and a new set of plugs once in a while.

Thus far, there are no TBO items in this aircraft. It may be a good idea, however, to change the gear box oil or the fan belt on the air cooled version or any of a number of things that can be done easily and inexpensively often enough to preclude a problem at the wrong time. Keeping adequate records of flight time and maintenance preformed will also help in determining when certain things need attention. Emergencies such as an engine failure are all too often attributed to fuel starvation. A good pilot not only has the skill to fly but the sense not to run out of fuel.

If an emergency should befall you, especially while airborne, above all, keep you head. That will be the time when all you have learned and trained for comes into play, and compounding your problem by adverse reactions will have devastating results. If you're caught with an enginge failure over trees with nowhere to go, you've already made you first and biggest mistake.

Always keep in mind that something like that can happen at all times and you will have taken the first step in being prepared. You can be proud in reacting properly to an emergency that you did not cause, and in accomplishing the resulting landing without doing any further damage to your machine.

Gyroplane Training Notebook - Part 3
By Tony Bolinger, Flight Instructor

CLIMBS

Now is a good time to mention a rule that I make my students practice and remember at all times: "POWER BEFORE ALTITUDE", meaning anytime you are going to change the attitude of the aircraft, change the power setting first. This not only assists in controlling airspeed, but will help keep the possibilities of negative G's to a minimum when recovering from a climb. The climb is initiated by increasing the throttle to climb power, letting the aircraft accelerate in a level attitude, then raising the nose to a climb attitude. Usually, adding about 5 mph to your cruise airspeed before the climb is started will give the best performance.

DESCENTS

A normal descent is the opposite of a climb. Remember, power before attitude. Start by reducing the throttle, then lowering the nose to maintain the proper airspeed. Good attitude control is important again and the airspeed in the descent should be controlled with the throttle and not the attitude. If you gain airspeed, reduce the throttle slightly and wait for the results. The steeper the descent, the less power required to maintain airspeed. Anticipate your recovery from the descent and lead by adding power leveling the aircraft. Leveling off first will result in a loss of airspeed and a slower throttle response. This can be hazardous at low altitudes in that a sink could develop.

SINKS

Sinks and recoveries are an important and enjoyable part of flying the gyro. That is, when done properly! A power-on sink is accomplished by starting with cruise power and raising the nose of the aircraft sufficiently to dissipate the airspeed. As the airspeed decreases below about 25 mph, the aircraft will enter into the sink. Rudder effectiveness is only slightly decreased and heading control is adequate. Recovery is made by returning to the straight and level attitude. The aircraft will accelerate and fly out of the sink.

A power-off sink is accomplished by holding the aircraft in the level attitude and reducing power to dissipate the airspeed. Again the aircraft will enter into the sink at about 25 mph. Sink rates are higher without power but by no means dangerous. Rudder effectiveness is decreased more with this type sink but the heading can still be maintained. Since the aircraft is already in a straight and level attitude, recovery is made by simply adding power back to at least a cruise power setting.

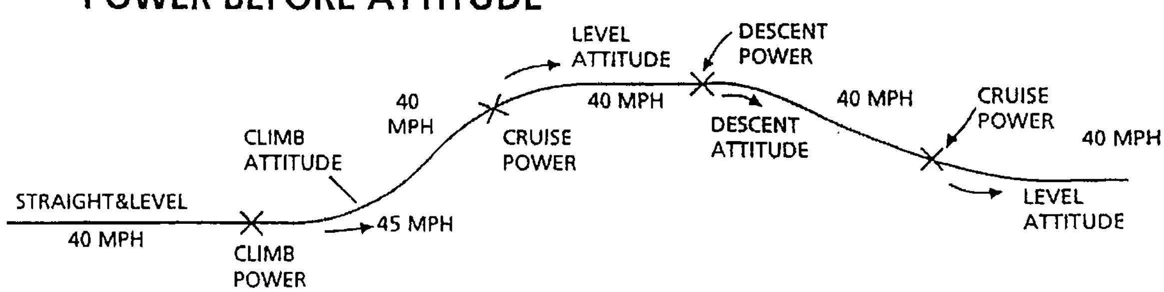
The important thing to remember for now is to minimize loss of altitude when recovery is initiated. "Diving" out of the sink will result in an excessive loss of altitude and a rapid increase in airspeed. It is also important to remember to give yourself sufficient altitude to recover should the engine not respond as expected.

GROUND REFERENCE MANEUVERS

I have found that during the first few lessons, most students get into the bad habit of staring at a point in space a few feet in front of them or concentrating on the airspeed indicator, if so equipped. In other words, they are not watching where that are going. Ground reference maneuvers are a good way of breaking this habit. Tracking in a crosswind ("crabbing") is simply keeping the wind from making you go someplace you don't want to go. If the aircraft is kept in trim, that is, pointed into the relative wind, it is quite easy to keep the aircraft flying along a ground reference if the reference is kept in sight.

"S"-turns are a serios of 180-degree turns alternating from left to right along a ground reference. The object here is to time the turn so that the 180-degree point of each turn is located directly over the ground reference. The turn should be at a constant rate with varying degrees of bank depending on the wind. If the angle of bank is held constant throughout the turn with a crosswind, the turn will not result in completion of the turn over the ground reference. A turn into the wind from crosswind to downwind done in this manner will cause the turn to come up short because the wind will hold you too close to the intended point of completion. The turn started from downwind and held at a constant angle of bank will result in the turn being

"POWER BEFORE ATTITUDE"



completed before the completion point is reached. Ideally, a turn into the wind first should be started at a shallow angle of bank and steepened as the turn progresses into the downwind side. A turn starting from downwind will have to start out steep and become shallower as the turn progresses.

Rectangular patterns are done around a point on the ground and are helpful in developing the skills of grabbing and maintaining a ground track. A constant distance from the reference can be maintained by keeping in mind wind drift and bank angles as discussed in S-turns.

360-degree turns are done so that the turn starts and ends at the same point with the same heading. Again, the wind will have certain effects on the aircraft as the turns develop. It will again be necessary to adjust the angle of bank throughout the turn to make it a well coordinated maneuver.

All the ground reference maneuvers should be done at a constant altitude and airspeed. Remember that the throttle is an important flight control and some coordination may be required to achieve your desired goal of mastering these maneuvers. The steeper the angle bank, the more power required. If a sink or excessive airspeed should develop at any point during the maneuvers, it is best to abort the maneuver, recover from the undesired condition and try again.

APPROACH

There are about four different types of approaches that you can make in the gyro: normal, shallow, steep or power-off. All types refer to the attitude of the aircraft. The airspeed required for each type is basically the same. Therefore, attitude control with a coordinated throttle or power setting is the secret to a good approach.

The idea is to arrive at your intended point of landing with an established attitude and airspeed. Enter into the approach by reducing the power, then establish the attitude for whatever type approach is desired. Then establish a power setting to give the proper airspeed. If you try to adjust the airspeed with the attitude of the aircraft, pulling the nose up to slow down, for instance, then the power requirements change and this too must be adjusted.

Remember to hold the attitude steady and use the throttle to maintain the airspeed. Remember too that an increase in airspeed with a constant attitude will decrease your rate of descent. So if you are getting shallower in the approach than you wish, add a little power. If the approach is getting steeper, reduce the power slightly.

Using the attitude to compensate for altitude or airspeed could result in porpoising close to the ground, which is a dangerous place to find yourself in that condition. A bad approach usually results in a bad landing, so make your decision early to either land or go around.

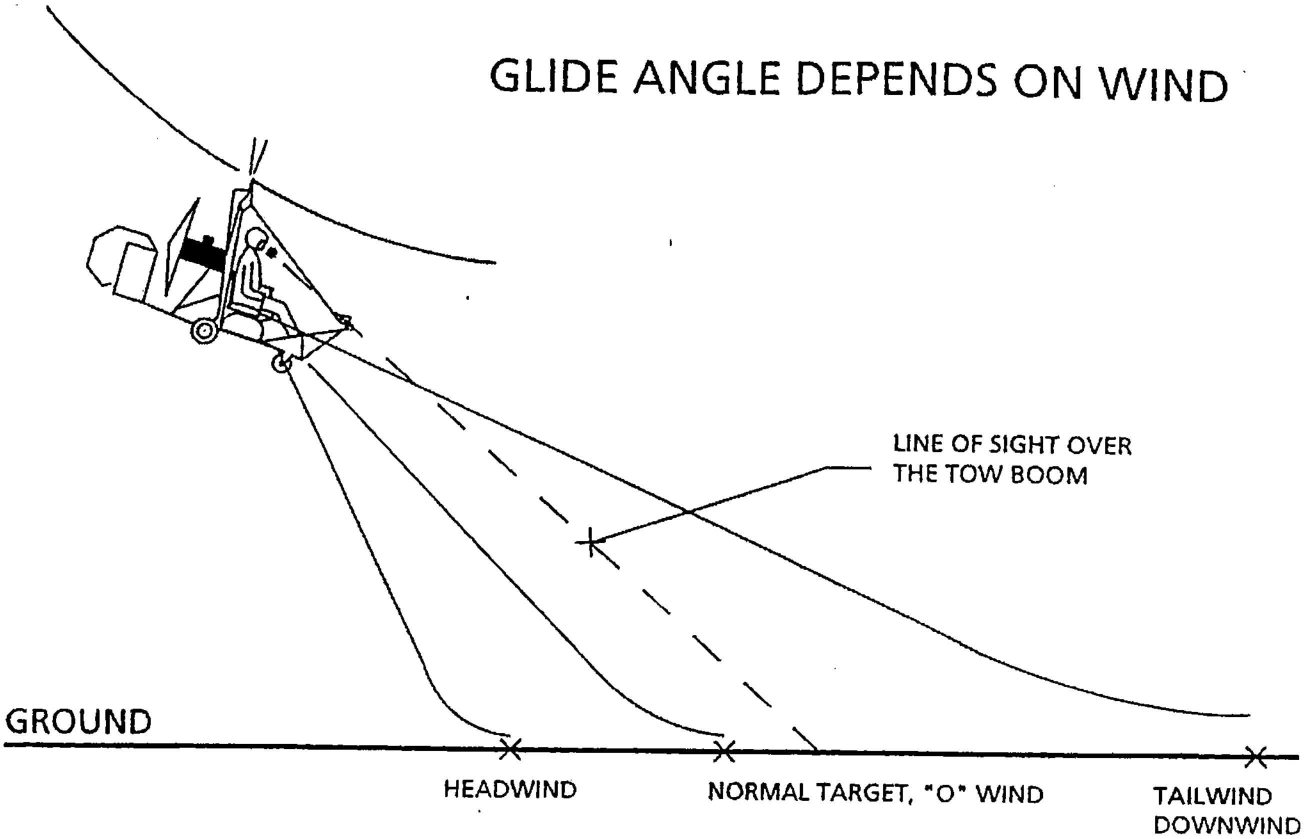
GOING AROUND

If your approach is not going well and you are not comfortable with it, then a go-around should be the answer. You can accomplish this task by adding climb power, leveling the attitude, letting the aircraft accelerate slightly, then climbing at best climb speed back into the traffic pattern and trying it again. If you should wait too long to make your decision to go around and find yourself too low and too slow, avoid over controlling the aircraft. Get the power on and get it level. If you have to give up most of the altiturde you have left to get the airspeed you need, do it! You need the airspeed more than you need the altitude.

If a hard landing is imminent, touch down in the same attitude you would normally, slightly nose high and let the airframe absorb the shock. "Flaring" or pulling the nose up to try to stop the descent will only result in the blades landing first, and you can imagine the results of that if the aircraft does touch down, stay there. Get the power off and stay in control of that rotor.

At any rate, an early decision to go around and anticipating your power requirements will give you a second chance and the practice you need at making that good landing.

GLIDE ANGLE DEPENDS ON WIND



Conclusions: (1) Landing into strong headwind follows steeper glide path than normal, produces shorter ground roll.

(2) Landing down wind requires longer distance than normal, higher speed for approach over ground, longer ground roll, than normal. Premature setting may result if "normal" glide path is attempted
requiring use of power to stretch glide.

Avoid making cross-wind and down-wind landings. The ground run of the Gyro is so short, you can always land into the wind and even land across the width of the runway, if needed, without any difficulty. The ground roll need not ever be longer than 20 to 40 feet.

Tere are several new things to look for when you start flying around the circuit. With the ground reference being further away below you as you climb to higher altitudes, **WATCH THE AIRSPEED INDICATOR** more closely and avoid getting into the "porpoising" flight. This alternate diving and climbing condition is known as "pilot induced oscillation". It stats with the lack of attention to the airspeed, which you must strive to hold constant at this stage of your learning. As soon as any oscillation begins, accompanied by alternating dives and climbs, **REDUCE THE THROTTLE AT ONCE!** Neutralize the stick, establish a smooth glide and then bring back the throttle slowly to maintain the chosen constant airspeed. Fly at 50 mph during all your first 25 hours of flight training. Higher airspeeds and higher altitudes are more prone to induce porpoising for lowtime Gyro pilots (purely from psychological unfamiliarity), so fly **"low and slow" during your first 25 hours of training**. Also, when flying your first circuits, avoid flying too slowly, "on the back side of the power curve" - (See Appendix for explanation). Flying too slowly requires more enging power and gives you less margin of safety should the engine "conk out". As we said before, 50 mph is your best speed, so watch your Airspeed!

Another thing to watch is a tendency of some fixed-wing pilots to "wheel-in" the Gyro on landings while the craft still rolls at considerable speed. This in an improper procedure that can result in a "ground loop" and the loss of a rotor. The rotor must remain tilted back all the way during landing and only when the nosewheel drops down itself from a lack of airspeed should the brake be applied.

BEWARE OF DOWNWIND TURNS CLOSE TO THE GROUND!

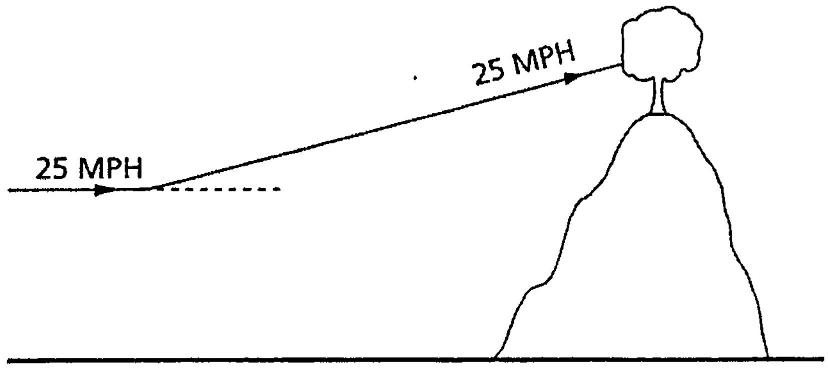
Unbeknown to yourself, you will fly by visual reference to the ground when flying low, as if driving a car, and will be unaware when the airspeed drops during a downwind turn. To maintain constant airspeed, which you must do during all normal turns, your ground speed must actually increase during downwind turns. Your best bet during early training is to watch your airspeed indicator and never permit the airspeed to drop below 45 mph during all turns!

Some beginners at first are puzzled by the seeming "pendulm" effect of their craft which seems to overshoot the commands of the control stick. Unlike an airplane that has its wings and tail surfaces rigidly attached to the airframe, helicopter airframes hang from its lifting surfaces, the rotor, by a universal pivot. Therefore, there is a time lag between the instant the pilot applies the control motion, and the time he notices the tilt of the airframe. This is somewhat akin to what happens to a free hanging pendulum when it is pushed by hand: It will always overshoot the initial motion imparted by the operator. Thus the pilot must learn to anticipate this over-shoot, or apparent time lag to his control command, and move the stick in the opposite direction about a half-a-second after the first control motion is made.

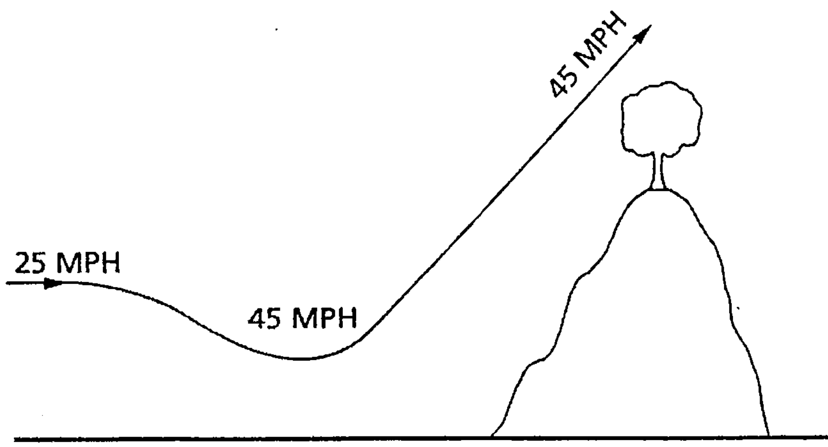
IT IS THE LACK OF ANTICIPATION OR UNFAMILIARITY WITH IT, THAT STARTS "PUMPING" OF THE STICK AND OVERCONTROL, OR "FREEZING" ON THE CONTROLS, AND LEADS TO PORPOISING". It is an abnormal reaction that happens only to "green" pilots with low time in Gyros. Don't let it happen to you. Take your time, work up to higher altitudes gradually, and learn to anticipate the control lag. Once you learn it, though, it will become automatic and you will give it no more thought than moving the handbars of a bicycle.

DON'T RUSH THIS PHASE OF YOUR TRAINING! You should not start on any new maneuver until all previous maneuvers have been executed flawlessly without any tension or effort on your part. If you are still tense, you are not ready for the next step: Use this test as your guide.

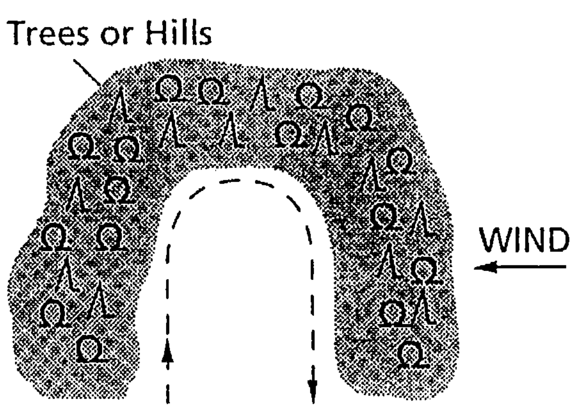
CLIMBS AND TURNS



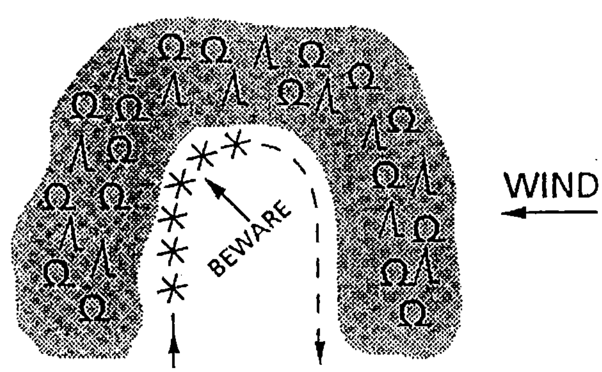
INCORRECT
Do not try to negotiate a tall obstacle at slow speed



CORRECT
When facing a tall obstacle at slow speed, open full throttle DIVE to again 45 mph airspeed, then climb at MAXIMUM angle.



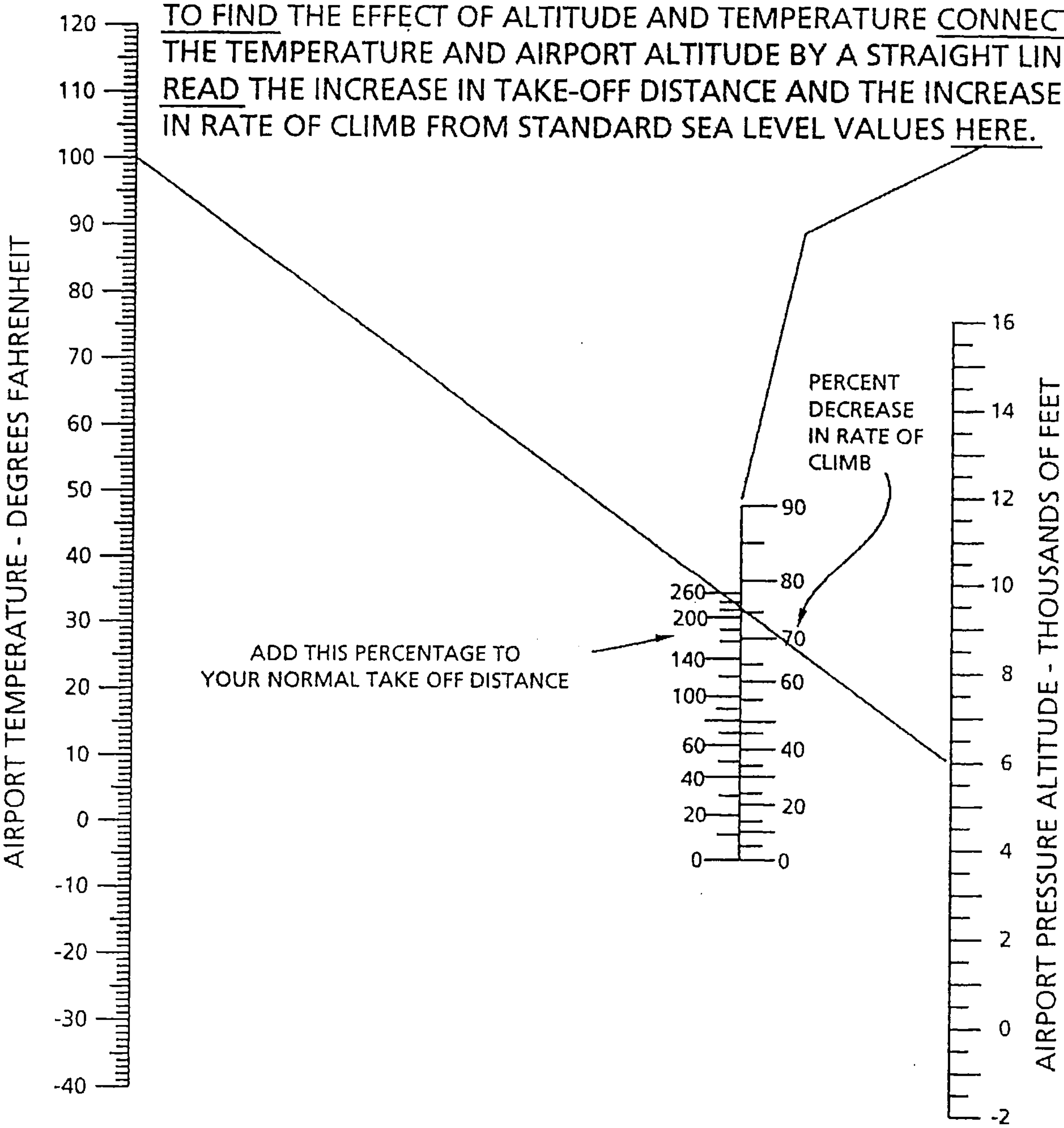
CORRECT
Always try to turn INTO the wind



INCORRECT
Downwind turn will require more bank and power, and may force you to settle

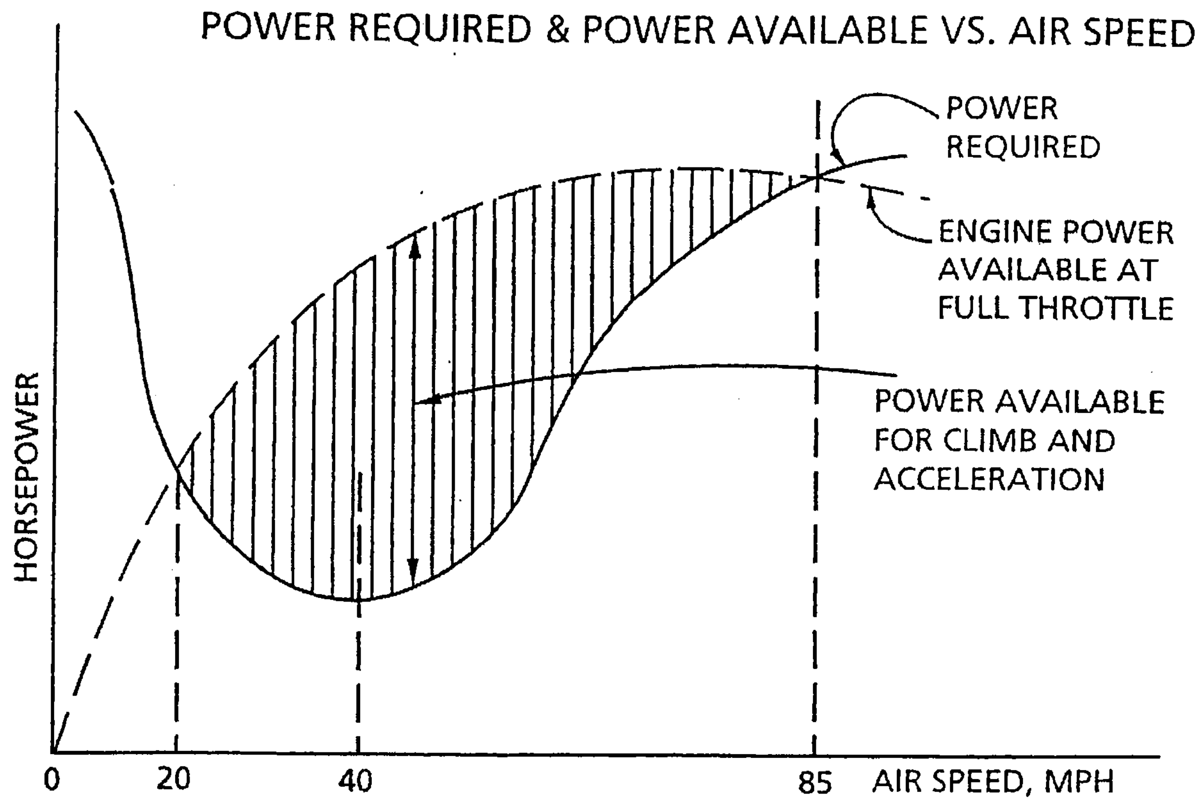
EFFECTS OF TEMPERATURE AND ALTITUDE

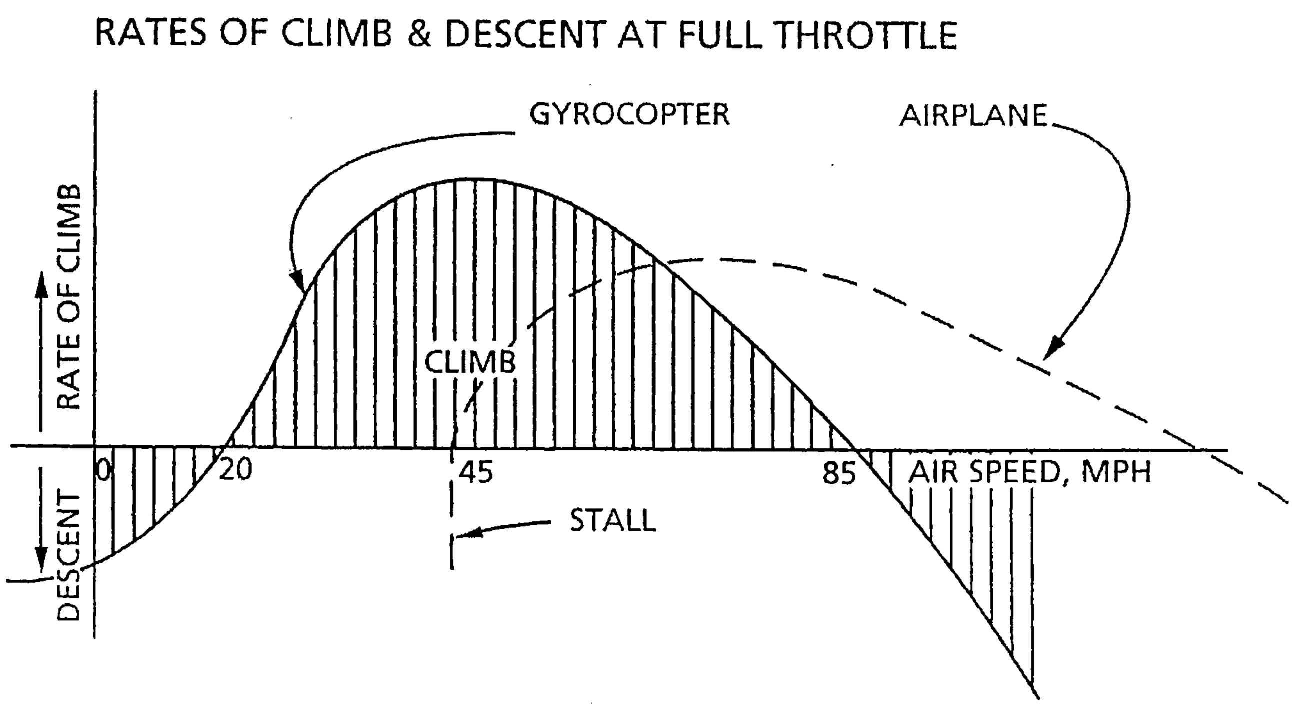
TO FIND THE EFFECT OF ALTITUDE AND TEMPERATURE CONNECT THE TEMPERATURE AND AIRPORT ALTITUDE BY A STRAIGHT LINE. READ THE INCREASE IN TAKE-OFF DISTANCE AND THE INCREASE IN RATE OF CLIMB FROM STANDARD SEA LEVEL VALUES HERE.



EXAMPLE: The diagonal line shows that 230% must be added for a temperature of 100 ° and a pressure altitude of 6,000 feet. Therefore, if your standard temperature sea level takeoff distance, in order to climb to 50 feet, normally requires 1,000 feet of runway, it would become 3,300 feet under the conditions shown. In addition, the rate of climb would be decreased 76%, meaning that if your normal sea level rate of climb is 500 feet per minute, it would become 120 feet per minute.

TYPICAL GYROCOPTER





BLADE FLAP

By: Bob Lindsay, St. Louis Rotorcraft Club

A lot of people slap a rotor blade on the ground at one time or another. Sometimes an accident can be avoided by knowing where that back blade is, so let's take a look at some examples.

Figure 1 shows the Gyro at rest, no pilot, and the rotor stationary or lazily turning in the breeze. The rotor can and will touch the ground, so TIE IT DOWN to the nose boom to keep the tips from dragging.

We all know that if too much wind gets into the rotor before it is up to speed, it will flap and can hit the ground if allowed to continue **(shown in Figure 2)**. Get the stick forward and slow down.

A normal taxi with the rotor at or near flight RPM provides plenty of rotor clearance as shown in **Figure 3**. Even as the Gyro is rocked back on its tail just before lift-off, **Figure 4** shows you still have plenty of clearance. Balancing on the "mains" gives you more clearance.

As the Gyro makes a normal lift-off from a "balanced on the mains" position, the rotor cones up from the load providing even more clearance **(Figure 5)**. However, if you really crank up the nose using lots of power to haul her off a tail-down position, you can wind up with rotor slap as shown in **Figure 6**. So, use a shallow climb at first.

Also, an extreme tail-down flare on landing can result in slapping blades just like **Figure 6**. So realize where the rear blade is when you are parked, taxiing, taking-off, and landing. It may save you a bent blade, the roll-over that usually follows, and a lot of grief.

NOTE: The drawings are to scale with a standard Gyro having a 22-foot rotor dia. Droop and coning are approximate for metal rotors. Larger diameter rotors will have less clearance than shown unless the mast height is increased.

Figure 1

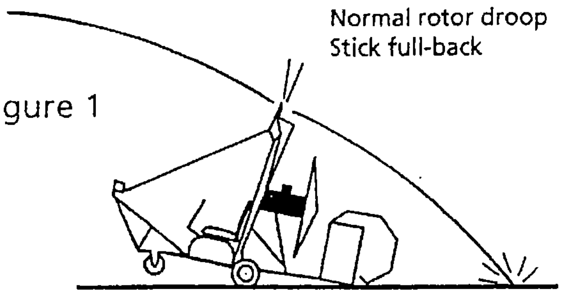


Figure 2

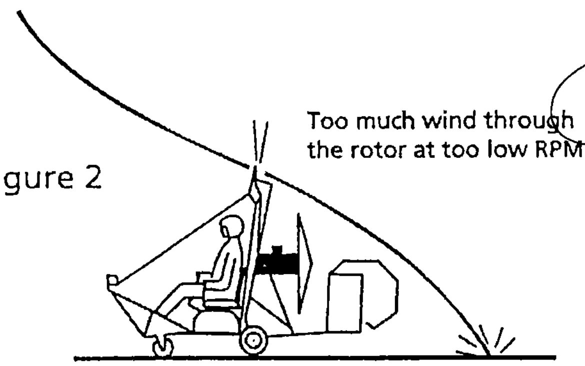


Figure 3

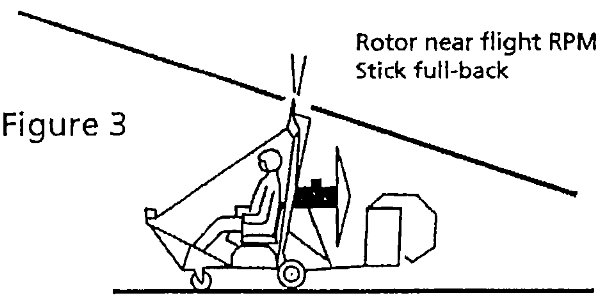


Figure 4

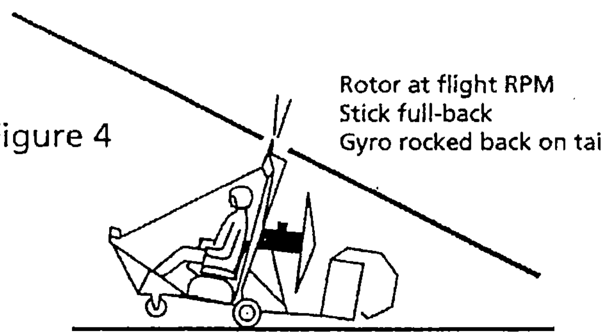


Figure 5

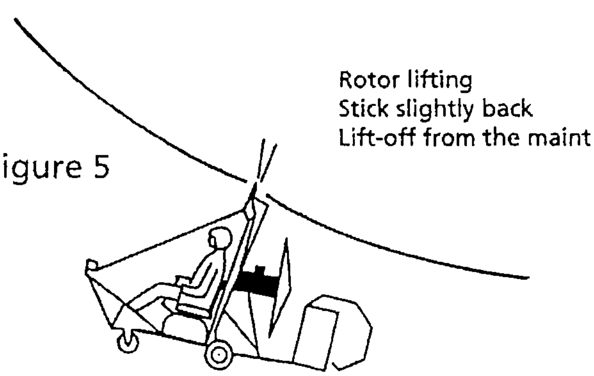
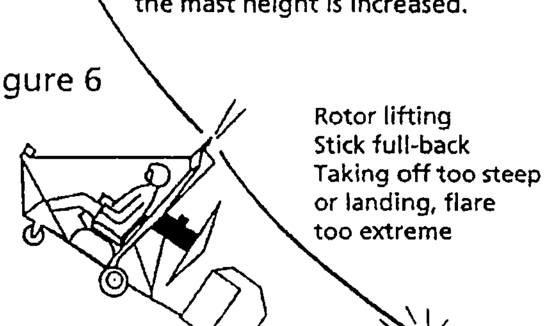


Figure 6



Gyroplane Testing, Those First Flights

by Jim Eich

This is written with the hope that it will remind the gyro pilot that is about to test fly his new kit aircraft or his own homebrewed gyro to proceed with caution. It is assumed that the pilot knows how to fly a gyro or has at least had enough instruction to warrant his instructor's confidence. If not, he should try to obtain the services of an experienced gyro pilot to do the honors.

The slant of this article is not to try to teach one how to fly but only to bring up the characteristics of the gyroplane and how to deal with them on the first flights. Everything here is basic, but in the interest of safety when flying your gyro for the first time, I think it is worth repeating.

The gyroplane has significant differences from a fixed wing aircraft that must be taken into consideration when first testing this type of aircraft. This will pertain to most all homebuilt gyroplanes but will focus on the most popular configuration, the open frame pusher type.

Watch your airspeed. The gyroplane is normally flown at fairly low altitudes. It is very easy to start using the ground as a speed reference when operating near it for extended periods so it is very important that one references an airspeed indicator.

The gyroplane should be thoroughly preflighted after assembling for the first flight. The trip to the airport can be harder on an aircraft than many hours of flight.

The instruments will vary on the different types of power plants installed in the gyroplane and they should be monitored closely during the testing stages. New engines tend to run hot so the head temperature should be closely watched. Two stroke engines are used extensively on gyroplanes so no other engine instruments are required for them besides a tach. Oil pressure and temperature indicators are required for four stroke type engines. An airspeed indicator is required but a rotor tach is of limited use.

STARTING THE ENGINE

Caution must be taken when starting the engine. With the pusher type, the operator usually stands astraddle the main gear to hand prop the engine, so extra care must be taken with the throttle setting and chocking as one might find it difficult to leap clear in case of a runaway engine. Most open frame gyroplanes do not have main brakes so chocking is imperative. An assistant to hold the nose of the aircraft should be obtained.

TAXIING

The gyroplane has its rotor mounted quite high on the aircraft and, combined with the narrow wheelbase, it is top heavy and subject to overturn if care is not taken in taxiing. Some gyroplanes have the capability of making very sharp turns on the ground, so care must be taken to avoid sudden steering input when taxiing faster than 2 or 3 mph. A gyroplane should not be taxied very fast without the blades turning, especially on rough ground, as it is bad for the rotor bearing. The air rudder is only effective at higher rpm settings and airspeeds, so there must be some method of positive ground steering. When the blades are turning during taxiing, care must be taken to clear the area all around the aircraft.

STARTING BLADES

The area around the aircraft should be cleared and an assistant should be on hand to keep any spectators at a distance. When starting the rotor by hand, the engine has normally already been started. The turning propeller is in close enough proximity to the rotor for it to be dangerous if the rotor is pushed toward the rear while being started. The rotor should be started by pushing across the front of the aircraft or reaching back and pulling forward to avoid putting one's hand in the porpeller on follow through. With a prerotator, it is important to remember to clear the area as the blades start up suddenly with no warning to spectators. The prerotator should be engaged smoothly but the speed of the blades should not be brought up until in a takeoff position unless it is desired to accelerate them while taxiing to the runway.

BLADE MANAGEMENT

The slower the rotor is turning, the more difficult it is to get it to accelerate. A rotor will not autorotate much under 40 rpm. The faster the rotor is going, the faster it will accept incoming air to accelerate it. The faster it is going, the more centrifugal force is created and the more stable the rotor becomes. If the rotor is going too slow in relation to the incoming air, the incoming air will act on the underside of the advancing blade and blow it upward, causing the rotor to flap up in a fore and aft movement. Blade flap is caused when either excessive engine power or too much headwind causes the blades to move through the air without enough rotational speed. The blades have a great deal of inertia and they must be allowed to accelerate with the increasing incoming airflow. When the blades do not have sufficient rotational speed, centrifugal force has not acted upon the blades to give them effective stiffness and they can flap in the incoming air. If unchecked, this will cause the rotor to hit the limiting stops quite violently. Even though the stops keep the rotor from striking the ground or the rear parts of the gyroplane, the blades can bend enough to make ground or aircraft strikes. If this flapping occurs. the speed should be reduced and the stick immediately pushed full forward. Unless the excessive airflow is reduced quickly, the blades may strike the ground or part of the aircraft. In either case, the blades may be damaged or destroyed.

Although it is strongly recommended that the testing of an aircraft be done on a mild day, the following can be applied to taxiing too fast in relation to rotor speed on the takeoff run.

In the case of starting the rotor by hand in a strong headwind, the rotor should be started with the stick full forward and patted up as fast as possible. Ease the stick back a bit at a time to allow the rotor to accelerate. If flapping occurs, the stick should go back to full forward and the easing back process should start again. If the wind speed proves too great, the gyroplane can be moved to a sheltered area such as in the lee of hanger. With a prerotator this problem is not as pronounced and in most cases eliminated.

Flapping can still take place eben when the blades are rotating near flying speed. In this. condition, called a high speed flap, the rotor will enter into a flapping condition suddenly and with some violence. A high speed flap is capable of ground and/or tail strikes and can cause a turnover. This high speed flapping is usually associated with sudden acceleration and ground speeds of over 30 mph. This condition can be avoided by opening the throttle smoothly in increments and not increasing power until the rotor is observed to accelerate at each step.

The major difference between a gyroplane and a fixed wing takeoff is that full power is not applied at the beginning of the gyroplane takeoff run. The power is only applied as fast as the rotor will accept the incomming airflow.

TAKEOFF

The major difference between a gyroplane and a fixed wing takeoff is that full power is not applied at the beginning of the gyroplane takeoff run. The power is only applied as fast as the rotor will accept the incoming airflow.

Line up with the runway and start the rotor. With the stick in a neutral or somewhat back of neutral position, increase power slowly using the air rudder for steering. In some machines the pilot's foot must change from the ground steering machanism to the rudder control. As the rotor increase its rpm, the power can be increased. Advance the throttle a little at a time and let the aircraft stabilize and make sure that the aircraft is under control before increasing power again. Increases of 100 propeller rpm have been found satisfactory. As the rotor gains speed, the stick can be moved to a full back position.

At this point, one will find the rotor increasing speed, but quite a bit of additional power is required to increase the ground speed. When the nose wants to lift, the stick should be moved forward enough to set the nose back down and to increase the ground speed of the gyroplane. It is the airspeed through the rotor that is the important factor, so the ground speed will vary with the intensity of the headwind.

The first flight should be made at minimum airspeed, slightly in a mush, and set back down again before the end of the runway. Usually the aircraft will settle in if the power is not increased within 100 yards. This should be repeated until one feels comfortable and in control on the takeoff run. This slow flight procedure will aid in keeping the aircraft within 5 feet of the ground on its first flights.

If the runway is long enough, the first normal flight can be made over the runway. A takeoff can be made and the stick moved slightly forward to gain airspeed to about 50 mph. Add throttle to climb to about 25 to 50 feet altitude and level off. Do not let the airspeed build to over 55 mph, as the stick gains in sensitivity as airspeed is increased. Smoothly bring back the power enough to allow the aircraft to sink. Maintain 45 to 50 mph.

The use of power on landing slows the sink rate and maintains rudder effectiveness. Arrest the descent when approaching the ground and then let it settle to about one foot altitude and maintain it with a smooth application of back stick until the aircraft settles in. The use of power allows more time for the landing. Do not cut power until you are on the ground, as a change of power in the air will change the directional attitude of the gyroplane.

For the first flight to altitude, around the pattern, the takeoff should be executed and the climb speed should be set up at around 50 mph. The climb speed is very critical at the low range. At full power and about 30 to 35 mph the gyroplane can be in a climb attitude but it may be sinking. Pulling the stick back further will slow the gyroplane even more and increase the sink rate. The aircraft is „flying behind the power curve". The stick must be moved forward enough to regain flying speed and some altitude will be lost.

The gyroplane should climb at full throttle at 50. If it does not, land, as there is something wrong. Perhaps the blades need a bit more pitch, but whatever the case, find the problem. When the desired altitude is reached, decrease the power and level off. The airspeed should be kept at 55 or below. Remember the pitch sensitivity at higher airspeeds. The altitude reached shouldn't be too high, as first flights in an open frame aircraft make even experienced pilots extremely nervous. Make gentle turns to feel out the roll sensitivity. The roll sensitivity is much less than the pitch sensitivity.

Landing

Line up with the runway and decrease the power a little. The rate of descent is determined by the reduction of power. With power full off, the descent is quite steep and the nose must be pointed quite far down to maintain 45 or 50 mph. The use of power on landing slows the descent rate and allows more time for the flare and landing.

The flare should be initiated 10 or 15 feet higher than where you want to end up. Before the rotor can respond to the additional G load it experiences while stopping the descent, the blades must gain speed. This means an additional loss of altitude for a fraction of a second until the blades can speed up. This is minimized by carrying power, but it is still noticeable.

Leveling off a bit too high is not objectionable, as the ship will still sink as it slows. Let it settle to about one foot and maintain it with a smooth application of back stick until touchdown. Cut the power after it is solidly on the ground. A change of power just before touchdown affects directional attitude and could even result in an upset in the worst case.

As you begin to feel more at ease on landing, start decreasing the power setting on the approach and landing until you are making your approach and landing with the power at idle. This should be done in stages to get used to the steepening approach angle gradually.

FLIGHT

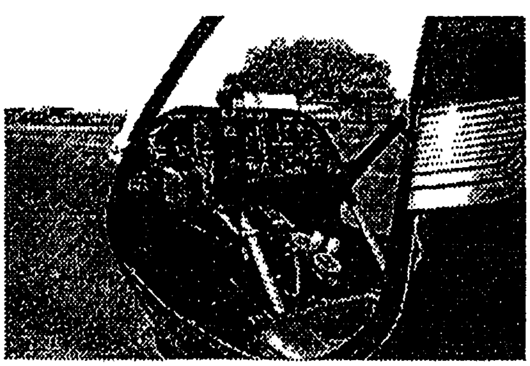
Watch your airspeed. Operating close to the ground can result in using the ground for reference, with the possibility of operating at too low an airspeed. While the gyroplane will not stall and dive into the ground, it will start to sink, and if airspeed is not regained, the gyroplane could strike the ground before recovery can be effected.

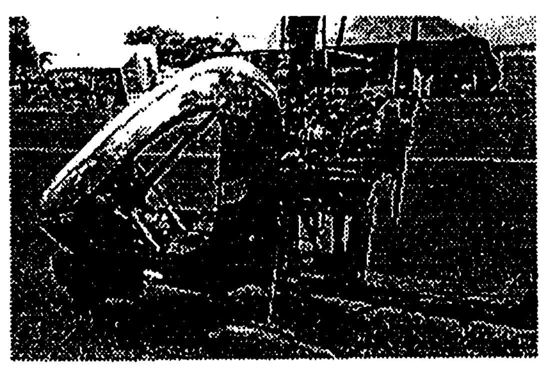
Climb to a comfortable altitude and make familiarization turns using stick and rudder, then stick only. The steeper the turn the more power required. Try turns without adding power and notice that the nose has to be lowered to maintain airspeed. Note how much altitude is lost.

Climb to 100 feet to check for directional stability. Reduce the throttle to fast idle and slow the gyroplane to about 15 mph. See if the aircraft will stay straight without excessive use of the rudder. If it will not, add power until it is stable and do not attempt a landing with any less power. This will be very close to a vertical descent, which takes about 200 feet to recover from, so abort this test if you are getting too low. To recover, the nose should be lowered with application of forward stick and the power smoothly restored. Level out when cruise speed is attained.

The gyroplane is very manageable at speeds under 60 mph, but be aware that the pitch control becomes more sensitive as airspeed increases. Increases in speed should be worked up to in increments and flown long enough to feel comfortable with. If pitch instability is encountered, the throttle should be reduced immediately and the stick eased back slightly to slow the aircraft to a more manageable airspeed. Do not attempt any kind of inverted flight or quick forward stick movements which would result in a negative gravity situation. If the effective weight of the gyroplane is reduced (negative gravity), the airflow through the rotor decreases. The rotor will slow rapidly and the gyroplane can fall. The gyroplane requires very little control input at flying speeds but does need the much larger control range for takeoff and landing.

This type of aircraft can be operated safely as long as its characteristics and limitations are understood and adhered to.





The Power Pushover
Power before pitch

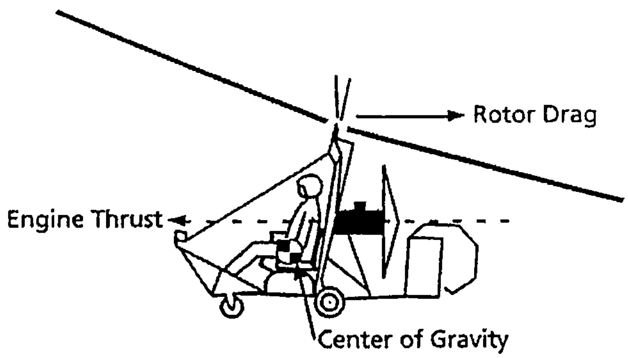
by Doug O'Connor, PRA Safety Editor

In August of 1990 I returned to active gyro flying when, after receiving several hours of dual instruction, I finally soloed my own gyroplane. I was well informed of the dangers of pilot-induced oscillation (PIO) and how to avoid it or recover from it. I was also quite knowledgeable of the nasty effects that negative "G" can have on rotorcraft and I promised myself I would never get into that situation.

I had spent the last four years reading every book and magazine article on gyro flying I could get my hands on and had flight and ground instruction from a gyro CFI. I had done everything by the book to be soft. Yet within one month and less than ten hous after my gyro solo, I stumbled across a dangerous phenomenon in my gyro that no one had warned me about or I had ever read about.

During my initial dual training my instructor and I would go up and do air work before any training in takeoffs and landings. So after solo and I felt comfortable with my landings, I departed the traffic pattern for solo practice of those maneuvers we had performed earlier in training. In addition to steep turns and slow flight, these maneuvers included zero-air-speed vertical descents with recovery with and without power.

I climbed to 1000 feet, reduced the power back to idle and maintained altitude by increasing back pressure until all airspeed was lost. I held this back pressure on the control stick while I descended vertically in a flat attitude. For recovery I moved the stick forward to get the nose down steeply and to regain the airspeed necessary to recover without power. When sufficient airspeed was acquired, I eased back on the stick to level off, then increased power to maintain altitude. No problem. I then climbed back up to 1000 feet to repeat this maneuver, but this time I would use full power in the recovery.



Now, much of the written and verbal instruction I had received stressed the need for power to be applied or reduced before any pitch control input. No one said why this was necessary, just that it was the proper way to fly a gyroplane. Power before pitch.

For this first attempt alone, I intended to perform this maneuver exactly as instructed, but I suspected that a quicker recovery could be done by movement of the control stick forward at the same time I would quickly move the throttle forward to full power. This is the proper technique for stall recovery in airplanes to minimize altitude loss. I figured the same technique would be proper for recovery from a slow airspeed vertical descent in a gyroplane. But for now, power before pitch.

I put my gyro into a vertical descent, then I shoved in full throttle before pushing the stick forward. The nose dropped sharply before I even moved the stick forward! The application of power alone shoved the nose down.

The thought of what would have resulted if I had moved the control stick forward at the same time or a moment before shoving the throttle forward raced through my head. The cumulative effect would have shoved the nose straight down or worse.

I flew back to the airport and quickly landed. I needed to think about this before I attempted any more flight in a gyroplane. I stood back from this strange machine and tried to visualize the forces at work here.

All movements of any flying machine are going to be about the center of gravity. It was only the application of engine thrust which revolved the nose down. Then the thrust line must be above the center of gravity because if the thrust line passed through the center of gravity there would be no pitch change.

I remembered watching a video of a club member's crash before I received any dual training in gyros. The club member, an experienced fixed wing aerobatic and commercial pilot, was new to gyros but had received over six hours of dual training and had read several books and magazines on gyro flying (sounds familiar).

The video showed him taking off to the south and climbing steeply to about 300 feet. He then turned left until he was pointing almost directly at the camera as he continued to climb at full throttle. I saw the nose come up slightly and then the gyro pitched down so suddenly that in less than a second the gyro had flipped forward completely upside down.

The audio portion of the video indicated that the engine stayed at full power until after the gyro started its fatal inverted plunge to the ground. I watched the video over and over and frame by frame. As the gyro nosed down steeply, I could see the luckless victim pulling full back on the control stick but to no avail.

I was told that this accident was caused by a PIO leading to zero or negative "G" and loss of control, but I was never comfortable with this explanation. The video didn't show the classic PIO of three increasing oscillations. I also couldn't believe that an experienced aerobatic pilot would induce negative "G" on his gyro when he well knew the danger of that. Now I understood what happened.

On most of the sport gyroplanes flying today, the engine thrust line is higher than the center of gravity. Engine thrust will push the nose down as well as drive the craft forward. In flight this is resisted by the drag of the rotor disc. Everything balances.

But if you unload the rotor and tilt the rotor disc forward, then that balancing force is greatly reduced and the engine thrust pivots the gyro forward around the center of gravity. Chuck Beaty calculated how fast a typical gyro would flip inverted with the engine at cruise power and the rotor was unloaded (June-July '93 Rotorcraft). He figured it would only take 0.6 of a second! That certainly jibes with what I saw on that video.

Once I understood this phenomenon, I went back to learning to fly my gyro. I learned to use the throttle as my main pitch control and then use the control stick movement to adjust the airspeed. If I wanted to climb or stop a descent, I would first add power and then adjust the pitch control for the desired airspeed. If I wanted to descend, I would first reduce power then adjust the control stick to obtain the desired airspeed.

Power before pitch. Power controls pitch, and vertical speed and fore-and-aft movement of the control stick fine tunes my airspeed. I soon learned that normal gyroplane flight required very little fore-and-aft movement of the control stick.

I talked with several other gyro pilots about this phenomenon. I called a power pushover (PPO). Several confirmed my observations when they consciously looked for it. However, Art Evans told me he could not duplicate this power pushover on his machine. Art has a Mac-powered Bensen with a 50" prop. My gyro is Rotax powered with a 60" prop.

I now realized why I had not read anything about this power pushover before. Dr. Bensen got it right with his original machine (48" prop) with the thrust line very close to the vertical CG.

The McCulloch turned a small prop at high speed, but propeller efficiency increases if you can turn a longer prop at a slower RPM. That's why gear or belt reduction units are so popular. But a longer prop means a higher thrust line. If the center of gravity is not also raised, then the power pushover can become quite a strong effect.

Some designer have addressed the problem by raising the pilot's seat up to raise the vertical CG in line with the thrust line. The Dominator and Carl Schneider's gyro are examples of this solution.

Some designers have gone from one extreme to another. I remember one real slick-looking gyro that showed up at the 1990 Hearne, Texas national convention. The designer was concerned with the poor ground handling of most gyros (they make lousy go-carts), so he lowered the seat as low as he could get it. It sure made for racy-looking machine, but I doubt if it ever flew like that, because the next time I saw the same machine it had tall landing gear and a dropped keel to get the CG and thrust more in line.

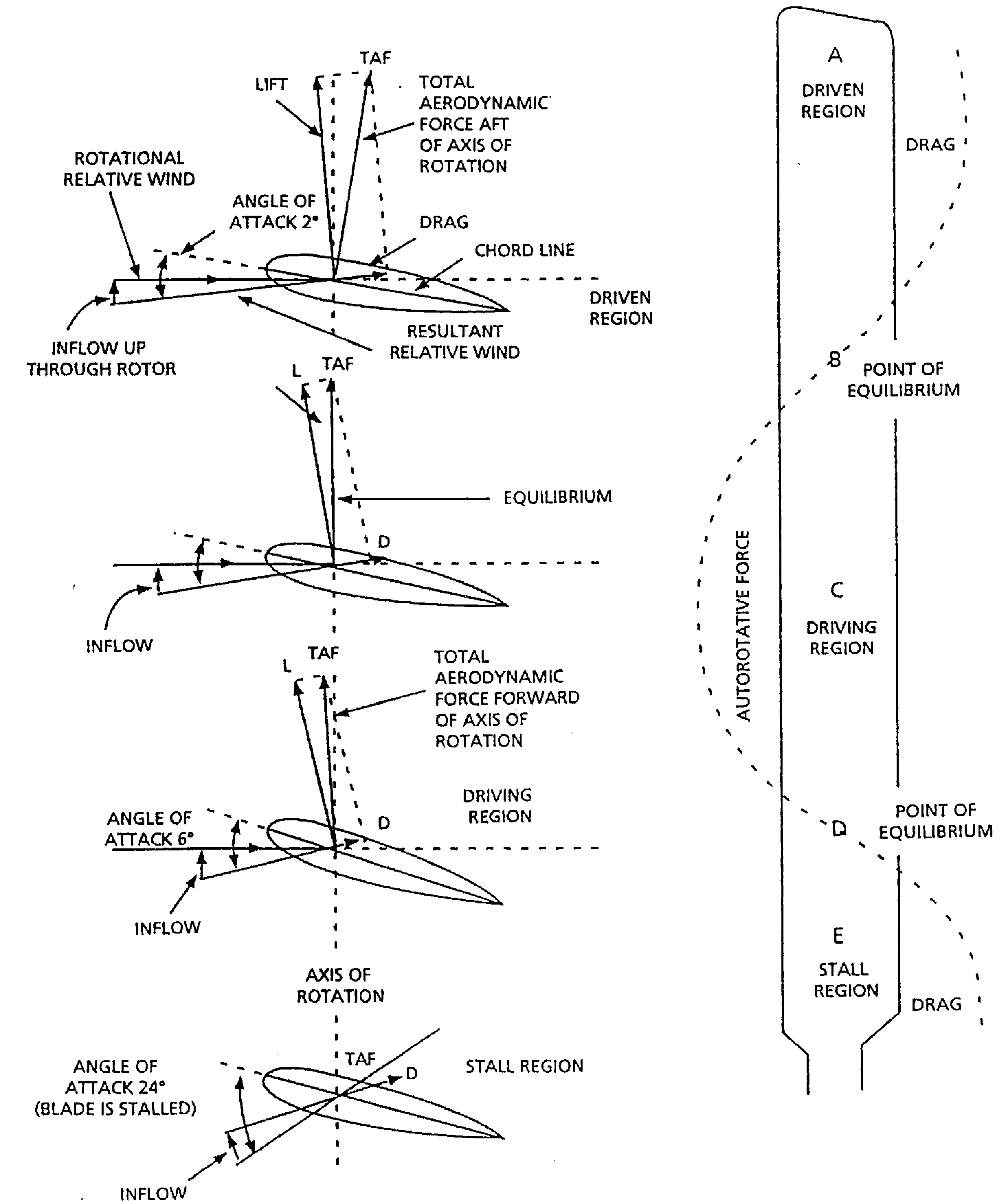
A horizontal tail will help dampen PIO and will slow down the PPO at cruise speed, but a fixed airodynamic surface depends on airspeed to be effective. If the gyro pilot unloads the rotor with a high power setting and little or no airspeed, then the horizontal tail will be of little help. This could occur at the top of a zoom climb when the pilot pushes over the top at low speed. If the pilot doesn't first reduce the power, he could find himself looking up at the ground.

Beware of anything that lowers the CG or raises the thrust line. I see where people are putting 66" 68" and even 72" props on sport gyroplanes. This necessitates raising the thrust line. A Bensen with a Rotax engine and a 66" super thruster conversion will have a thrust line 9" higher than the gyrocopter was designed for. If the builder does not compendate by raising the pilot's seat, then that gyro will be very susceptible to PPO.

The same effect will occur if the pilot replaces a set of heavy rotor blades with lighter ones or he adds extra fuel tanks mounted low. When I rebuilt my Sno-Bird gyro, I noticed that Sno-Bird had raised the seat 1 1/2" higher than the original Sno-Bird. I was amazed at how much improvement in handling such a little change made. I'm quite happy with it now.

Remember, if an uncommanded pitch diversion begins, pull back on the throttle. You can't get a power pushover without power. Also remember power before pitch. It worked for me.

AERODYNAMIC FORCES IN AUTOROTATION



RECREATIONAL PILOT LOGBOOK SUPPLEMENT SHEET

PILOT NAME____________________ **DOB**________________ **S/S OR PASSPORT**__________
GYROPLANE PILOT CERTIFICATION

The applicant for a recreational pilot certificate must have logged instruction from an authorized flight instructor or present evidence that he/she has satisfactorily completed a course of instruction or home study in at least the following areas of aeronautical knowledge.

DATE HOURS GROUND INSTRUCTION SUBJECTS - FAR 61.97 CFI

(a) The accident reporting requirements of the National Transportation Safety Board.
Federal Aviation regulations applicable to recreational pilot privileges, limitations, and flight operations for rotorcraft.
The use of the "Airmans Information Manual" and FAA advisory circulars.
(b) The use of aeronautical charts for VFR navigation using piloting with the aid of a magnetic compass.
(c) The recognition of critical weather situations from the ground and in flight and the procurement and use of aeronautical weather reports and forecasts.
(d) The safe and efficient operation of aircraft including collision and wake turbulence avoidance.
(e) The effects of density altitude on takeoff and climb performance.
(f) Weight and balance computations.
(g) Principles of aerodynamics, powerplants, and aircraft systems.
(h) Stall awareness, spin entry, spins and spin recovery techniques.

"I certify that I have received all of the above listed instruction as described"
Trainee Signature________________________Date____________________

"I certify that I have given the above checked listed instruction as desccribed"
Date__________CFI Signature_________________________Cert#__________________Exp__________

Endorsement for aeronautical knowledge: FAR 61.97 (a) through (h).
I certify that I have given the above named person the ground instruction required by FAR 61.97 (a) through (h).
Date__________CFI Signature__________________________Cert#__________________Exp__________

FAR 61.98 FLIGHT PROFICIENCY REQUIREMENTS FOR RECREATIONAL GYROPLANE PILOT CERTIFICATION.

The applicant for a recreational gyroplane pilot certificate must have logged instruction from an authorized flight instructor on at least the following pilot operations. In addition his logbook must contain an endorsement by an authorized flight instructor who has found him competent to perform each of them as a recreational pilot. The entrys do not have to be made in oreder and more than one entry may be made for a flight.

DATE A/C# HOURS MANEUVERS & PROCEDURES FAR 61.98 CFI

(c)(1) Preflight operation including weight and balance determination, line inspection, servicing, powerplant operations, and aircraft systems.
(c)(2) Airport and traffic pattern operations, collision and wake turbulence avoidance.
(c)(3) Flight maneuvering by reference to ground objects.
(c)(4) Pilotage with the aid of a magnetic compass.
(c)(5) Maneuvering at critically slow airspeeds and the recognition of and recovery from high rates of descent at low airspeeds.
(c)(6) Emergency procedures including maximum performance takeoffs and landings.
(c)(7) P.I.O. avoidance including airspeed and attitude configuration changes.
(c)(8) Ground taxi operations including rotor blade management.

* All hours logged above represent total flight time all of which is dual instruction conducted in day VFR conditions unless noted.

"I certify that I have received all of the above listed instruction as described"
Trainee Signature______________________________Date______________

"I certify that I have given the above checked listed instruction as described"
Date________________CFI Signature______________________Cert#__________Exp________

Endorsement for flight proficiency: FAR 61.98 - I certify that I have given the above named person the flight instruction required by FAR 61.98c 1 through 8 and find him/her competent to perform each pilot operation safely as a recreational pilot.
Date________________CFI Signature______________________Cert#__________Exp________

PREREQUISITE FOR A FLIGHT FOR 61.39 AND 61.100b (1) through (11). Endorsement to certify completion of prerequisites for a practical test..

I certify that I have given the above named person flight instruction in preparation for a recreational pilot rotorcraft gyroplane practical test within the preceeding 60 days and find him/her competent to pass the test and to have satisfactory knowledge of the subject areas in which the applicant was shown to be deficient by his/her airman written test.
Date________________CFI Signature______________________Cert#__________Exp________

INSTRUCTOR ENDORSEMENTS FOR STUDENT PILOTS

Endorsement for presolo aeronautical knowledge: FAR 61.87(b) - The above named student pilot has satisfactorily completed a presolo written examination demonstrating knowledge of the portions of FAR Parts 61 and 91 applicable to student pilots, and the flight characteristics and operational limitations for a ____________________ Gyroplane.
Date__________ CFI Signature________________ Cert#________ Exp________

A - USE THIS FOR STUDENT PILOTS ONLY (NO OTHER PILOT RATING): Endorsement for presolo flight training: FAR 61.87(c). I have given the above named student pilot the flight instruction required by FAR 61.87(c) in a ____________________ Gyroplane. He/She has demonstrated proficiency in the applicable maneuvers and procedures listed in FAR 61.87 (d) through (j) and is competent to make safe solo flights in a ______________ Gyroplane. This endorsement expires 90 days from issuance.
Date__________ CFI Signature________________ Cert#________ Exp________

B - USE THIS FOR HOLDERS OF AN FAA PILOT CERTIFICATE: Endorsement for a pilot who does not hold an appropriate Category/class rating to act as PIC of an aircraft in solo operations: FAR 61.31(d)(2) - I have given the above named pilot the instruction required for the first solo in a rotorcraft Gyroplane and find Him/her competent to solo __________ Gyroplane. This endorsement expires 90 days from issuance, is valid for Gyroplane only and does not authorize cross country flights over 25 miles from the point of departure without a specific endorsement.
Date__________ CFI Signature________________ Cert#________ Exp________

Endorsement for solo (each additional 90-day period): FAR 61.87(m) - I have given the above named student pilot the instruction required by FAR 61.87(m) He/she has met the requirements of FAR 61.87(m) and is competent to make safe solo flights in ______________ Gyroplane.
Date__________ CFI Signature________________ Cert#________ Exp________

Endorsement for each solo cross country flight: FAR 61.93(D)(2)(1) - I have reviewed the preflight planning and preparation of the above named student pilot and attest that he/she is prepared to make the solo flight safely under the known circumstances from (location)________ to (destination) ____________________ via (route of flight) ____________________ with landings at (names of applicable airports) ______________________________ in a ____________________ Gyroplane on (date) ______________ Note: The instructor may want to stipulate additional conditions in the above endorsement.
Date__________ CFI Signature________________ Cert#________ Exp________

Endorsement for each solo cross country flight: FAR 61.93(d)(2)(1) - I have reviewed the preflight preparations of the above named student pilot and attest that he/she is prepared to make the solo flight safely under the known circumstances from (location)______________ to (destination) ____________________ via (route of flight) ____________________ with landings at (names of applicable airports) ______________________________ in a ____________________ Gyroplane on (date)____________ Note: The instructor may want to stipulate additional conditions in the above endorsement.
Date__________ CFI Signature________________ Cert#________ Exp________

STUDENT PILOT LOGBOOK SUPPLEMENT SHEET

PILOT NAME ____________________ **DOB** ___________ **S/S OR PASSPORT#** _____________

STUDENT GYROPLANE PILOT PRE-SOLO FLIGHT TRAINING REQUIREMENTS

Before being authorized to conduct a solo flight, a student pilot must have received and logged the flight instruction required by FAR 61.37(c). The following endorsements indicate that this required instruction has been received. Policy requires that this form be attached to the students logbook. The entries do not have to be made in order and more than one entry may be made for a flight.

DATE A/C# HOURS MANEUVERS & PROCEDURES FAR 61.87 CFI

(d)(1) Flight preparation procedures.
(d)(1) Preflight Inspections, powerplant operations & aircraft systems.
(d)(2) Taxiing or surface operations, including runups.
(d)(3) Normal takeoffs and landings.
(d)(3) Crosswind takeoffs and landings.
(d)(4) Straight and level flight.
(d)(4) Shallow and medium banked turns in both directions.
(d)(5) Climbs and climbing turns.
(d)(6) Airport patterns including arrival and departure procedures.
(d)(6) Collision and wake turbulence avoidance.
(d)(7) Descents with & without turns using high & low drag configurations.
(d)(8) Flight at various airspeeds from cruising to minimum controllable airspeed.
(d)(9) Emergency procedures and equipment malfunctions.
(d)(10) Ground reference maneuvers.
(g)(1) Autorotatial descents with a power recovery or a running landing.
(g)(2) At least 3 successful flights in a Gyroplane under the observation of a qualified instructor.

*All hours logged above represent total flight time all of which is dual instruction conducted in day VFR conditions unless noted.

"I certify that I have received all of the above listed instruction as described"
Trainee Signature____________________________Date__________________

"I certify that I have given the above checked listed instruction as described"
CFI Signature________________________ Cert#_________________Exp_______________

PRIVATE PILOT LOGBOOK SUPPLEMENT SHEET

PILOT NAME__________________________DOB__________S/S OR PASSPORT________

FAR 61.105 AERONAUTICAL KNOWLEDGE REQUIREMENTS FOR PRIVATE GYROPLANE PILOT CERTIFICATION.
The applicant for a private pilot certificate must have logged instruction from an authorized flight instructor or present evidence that he has satisfactorily completed a course of instruction or home study in at least the following areas of aeronautical knowledge.

DATE HOURS GROUND INSTRUCTION SUBJECTS - FAR 61.105 CFI

(a)(1) The accident reporting requirements of the National Transportation Safety Board.
(a)(1) Federal Aviation Regulations applicable to private pilot privileges, limitations and flight operations for rotorcraft.
(a)(1) The use of the "Airmans Information Manual", and FAA advisory circulars.
(a)(2) VFR Navigation using pilotage, dead reckoning and radio aids.
(a)(3) The recognition of critical weather situations from the ground and in flight.
(a)(3) The procurement and use of aeronautical weather reports and forecasts.
(a)(4) The safe and efficient operation of rotorcraft including high density airport operations.
(a)(4) Collision avoidance precautions and radio communications.
(a)(5) Basic aerodynamics and the principles of flight that apply to rotorcraft.

"I certify that I have received all the above listed instruction as described"
Trainee Signature______________________________Date_____________________
"I certify that I have given the above checked listed instructions as described"
CFI Signature_________________________Cert#__________________Exp________

Endorsement for aeronautical knowledge: FAR 61.35(a)(1) and 61.105(a) - I certify that I have given the above named person the ground instruction required by FAR 61.105(a)(1) through (5).
Date__________CFI Signature_________________________Cert#___________Exp_______

B. USE THIS FOR HOLDERS OF AN FAA PILOT CERTIFICATE: Endorsement for an airman seeking an additional rating (other than airline transport): FAR 61.63 (b) or (c) - I have given the above named person the instruction required by FAR 61.63 and find him/her competent to pass the private practical test for the additon of a rotorcraft - gyroplane rating.
Date__________CFI Signature_________________________Cert#___________Exp_______

Endorsement for restesting within 30 days of first failure of a written or practical test: FAR 61.49 - I have given the above named person additional (flight / ground) (circle one) instruction and find him/her competent to pass the private pilot rotorcraft - gyroplane written/ practical (circle one) test.
Date__________CFI Signature_________________________Cet#____________Exp_______

Note: The instructor may also complete the endorsement in the space provided at the bottom of the applicant's airman written test report in the case of a first failure on a written test. The instructor must sign the block provided for the instructor's endorsement on the reverse side of FAA Form 8710-1 for each retake of a practical test. An applicant may retake either a written or practical test within 30 days of a first failure. If he or she has received additional instruction and an instructor's endorsement. For subsequent failures of both practical and written tests, the applicant must wait until 30 days after he/she failed the test before applying for retesting.

FAR 61.107 FLIGHT PROFICIENCY REQUIREMENTS FOR PRIVATE GYROPLANE PILOT CERTIFICATION.

The applicant for a private pilot certificate must have logged instruction from an authorized flight instructor in at least the following pilot operations. In addition, his logbook must contain an endorsement by an authorized flight instructor who has found him competent to perform each of them as a private pilot. The entries do not have to be made in order and more than one entry may be made for a flight.

DATE A/C# HOURS MANEUVERS & PROCEDURES - FAR 61.107 CFI

(c)(1) Preflight operations including the line inspection and servicing of gyroplanes.
(c)(2) Flight maneuvering by ground reference.
(c)(3) Maneuvering at critically slow airspeeds, and the recognition of and recovery from high rates of descent at low airspeed.
(c)(4) Airport and traffic pattern operations, including collision avoidance.
(c)(5) Cross country flying by pilotage, dead reckoning, and the use of radio aids.
(c)(6) Emergency procedures including maximum performance take offs and landings.
(c)(7) Cross country flight operations.
(c)(8) Emergency procedures such as power failures, equipment malfunctions, max performance take offs and landings and simulated lift offs at low airspeed and high angle of attack.

* All hours logged above represent total flight time all of which is dual instruction conducted in day VFR conditions unless noted.

" I certify that I have received all of the above listed instruction as described"
Trainee Signature_________________________________ Date______________
"I certify that I have given the above checked listed instruction as described"
Date_________ CFI Signature_________________________ Cert#______________ Exp________

Endorsement for flight proficiency: FAR 61.107c - I have given the above named person the flight instruction required by FAR 61.107c 1 through 7 and find him/her competent to perform each pilot operation safely as a private pilot.
Date_________ CFI Signature_________________________ Cert#______________ Exp_________

A. USE THIS FOR STUDENT PILOTS ONLY (NO OTHER PILOT RATING): Endorsement to certify completion of prerequisites for a practical test: FAR 61.39(a)(5) - I have given the above named person flight instruction in preparation for a private pilot rotorcraft gyroplane test within the preceeding 60 days and find him/her competent to pass the test and to have satisfactory knowledge of the subject areas in which the applicant was shown to be deficient by his/her airman written test.
Date_________ CFI Signature_________________________ Cert#_____________ Exp________

Note: The instructor's signature in the endorsement block on the reverse side of FAA Form 8710-1. Airman Certificate and/or Rating Application will be accepted in lieu of the above endorsement provided all appropriate FAR Part 61 requirements are substantiated by reliable records. However, the above endorsement without the instructor's signature in the endorsement block of FAA Form 8710-1 is not acceptable.

CFI GYROPLANE LOGBOOK SUPPLEMENT SHEET

PILOT NAME________________________ DOB____________ S/S OR PASSPORT______________

FAR 61.185 AERONAUTICAL KNOWLEDGE REQUIREMENTS FOR CFI ROTORCRAFT-GYROPLANE CERTIFICATION.

To be eligible for a flight instructor certificate, a person must present evidence showing that he/she has satisfactorily completed a course of instruction in at least the following subjects:

DATE HOURS GROUND INSTRUCTION SUBJECTS FAR 61.185 CFI

(a)(1) The learning process.
(a)(2) Elements of effective teaching.
(a)(3) Student evaluation, quizzing, and testing.
(a)(4) Course development.
(a)(5) Lesson planning.
(a)(6) Classroom instructing techniques.
(b) Have logged ground instruction from an authorized ground or flight instructor in all of the subjects in which ground instruction is required for a private and commercial pilot certificate (These are listed below).

FAR 61.105 AERONAUTICAL KNOWLEDGE REQUIREMENTS FOR PRIVATE GYROPLANE PILOT CERTIFICATION.
DATE HOURS GROUND INSTRUCTION SUBJECTS FAR 61.105 CFI

(a)(1) The accident reporting requirements of the National Transportation Safety Board.
(a)(1) Federal Aviation Regulations applicable to private privileges, limitations and flight operations for rotorcraft.
(a)(1) The use of the "Airman's Information Manual" and FAA advisory circulars.
(a)(2) VFR Navigation using pilotage, dead reckoning, and radio aids.
(a)(3) The recognition of critical weather situations from the ground and in flight.
(a)(3) The procurement and use of aeronautical weather reports and forecasts.
(a)(4) The safe and efficient operation of rotorcraft including high density airport operations.
(a)(4) Collison avoidance precautions and radio communications.
(a)(5) Basic aerodynamics and the principles of flight that may apply to rotorcraft.

FAR 61.125 AERONAUTICAL KNOWLEDGE REQUIREMENTS FOR COMMERCIAL GYROPLANE PILOT CERTIFICATION.
DATE HOURS GROUND INSTRUCTION SUBJECTS FAR 61.125 CFI

(b)(1) Federal Aviation regulations which aply to the operations, privileges, & limitaions of a commercial rotorcraft pilot.
(b)(1) The accident reporting requirements of the National Transportation Safety Board.
(b)(2) Meteorology, including the characteristics of air masses & fronts.
(b)(2) The procurement and use of aeronautical weather reports and forecasts.
(b)(3) The use of aeronautical charts & the magnetic compass for pilotage & dead reckoning.
(b)(3) The use of radio aids for VFR navigation.
(b)(4) The safe and efficient operation of gyroplanes.
(b)(5) Basic aerodynamics and the principles of flight that apply to rotorcraft.
(b)(5) The significance and use of performance charts.

"I certify that I have received all of the above listed instruction as described".
Trainee Signature________________________________ Date_____________

Endorsement for aeronautical knowledge: FAR 61.185(a) and (b) - I certify that the above named person has satisfactorily completed the course of instruction required by FAR 61.185(a) (1) through (6) and has logged the ground instruction required by FAR 61.105(a) and 61.125(b) in preparation for the flight instructor gyroplane rating.
Date_________ CFI Signature_______________________ Cert#____________ Exp_________

FAR 61.187 FLIGHT PROFICIENCY REQUIREMENTS FOR CFI ROTORCRAFT GYROPLANE CERTIFICATION

An applicant for a flight instructor certificate must have received flight instruction, appropriate to the instructor rating sought in the subjects listed in this paragraph by a person authorized in FAR 61.187(b) The entries do not have to be made in order & more than one entry may be made for a flight.

DATE A/C# HOURS MANEUVERS AND PROCEDURES FAR 61.187 CFI

(a)(1) Preparation & conduct of lesson plans for students with varying backgrounds & levels of experience & ability.
(a)(2) The evaluation of student flight performance.
(a)(3) Effective preflight and postflight instruction.
(a)(4) Flight instructor responsibilities & certifying procedures & maneuvers appropriate to the rating sought.

*Note: All hours logged above represent total flight time which is dual instruction in day, VFR conditions unless noted.

"I certify that I have received all the above listed instruction as described".
Trainee Signature__________________________ Date_______________________

Endorsement for flight proficiency: FAR 61.187(a) - I certify that I have given the above named person the flight instruction required by FAR 61.187(a) through (6) and find him/her competent to pass a practical test on those subjects. I certify that I have held a flight instructor certificate during the 24 months immediately preceeding this date and that I have given at least 200 hours of flight instruction.
Date_____________ CFI Signature_____________________ Cert#___________ Exp_______

Endorsement to certify completion of prerequisites for a practical test: FAR 61.39(a)(5) -
I have given the above named person flight instruction in preparation for a certified flight instructor rotorcraft-gyroplane rating practical test within the preceeding 60 days and find him/her competent to pass the test and to have satisfactory knowledge of the subject areas in which the applicant was shown to be deficient by his/her airman written test.
Date_____________ CFI Signature_____________________ Cert#___________ Exp_______

DO NOT ATTEMPT THESE EXERCISES UNTIL YOU HAVE COMPLETED YOUR FLIGHT TRAINING WITH A CERTIFIED FLIGHT INSTRUCTOR.

RECOMMENDED OPERATING GUIDELINES & LIMITATIONS FOR NEW SOLO SIGN-OFF GYROPLANE PILOTS

The most important & most critical phase of your training is just beginning now that you have practiced all the required maneuvers. It's time to apply this experience with your own gyroplane. You must be aware that control **stick movements will be very slight & most important, responses will be much more sensitive compared to what you learned on the two-place trainer.**

The following operational training sequence is based on many years of experience that will provide you with a safe continued training program.

ALL PRACTICE MUST BE CONDUCTED IN NO WIND, CALM AIR CONDITIONS FOLLOWING A PROPER & THOROUGH PREFLIGHT OF YOUR GYRO !!!

EXERCISE 1 - Begin by starting & running the engine. If you have to hand prop for starting, be sure you have the gyro secured. Don't hand start the first few times without qualified assistance.

CONDITIONS - No wind - calm air.

EXERCISE 2 - Spend a few hours taxiing your gyroplane with rotorblades spinning, get used to the steering, braking, & other differences.

EXERCISE 3 - Practice pre-spinning the rotorblades.

CONDITIONS - No wind - calm air.

EXERCISE 4 - You are now ready to get the feel of what take-off attitude is like in a few runs down the runway just raising & lowering the nose wheel, **main wheels kept on the runway.** This exercise will show you how much stick movement is needed for proper take-off attitude.

CONDITIONS - No wind - calm air.

Only after you are fully comfortable practicing exercise 4 and you can keep a straight line taxiing, placing the nose wheel in the take-off attitude the full length of the runway several times should you continue to exercise 5.

CONDITIONS - No wind - calm air.

EXERCISE 5 - Now you should be ready to make some very short, low level hops. It's very important to reduce the throttle as you take-off & immediately land. Continue these short hops, extending the length of each flight keeping within a few feet above the runway. Practice this for a few hours until you feel comfortable.

CONDITIONS- No wind calm air.

EXERCISE 6 - Now you can continue flights over the runway at different heights. Maintain your airspeed and stay over the runway. Don't get so high up that you will not have enough runway to land.

Conditions - No wind - calm air.

EXERCISE 7 - Once you can comfortably fly the length of the runway at various heights, begin to make shallow "S" turns. The proper procedure is as follows:

Take off.
Climb to approx 100 feet.
Reduce throttle before leveling off.
Maintain 45 MPH airspeed.
Proceed to make a shallow turn to the right & return to the centerline of the runway to land.
Practice all the same procedures you were taught in the two-place. Continue shallow "S" turns one direction at a time. Remember, maintain your airspeed, and proper flight attitude while making shallow turns.

CONDITIONS - 5 MPH MAXIMUM WIND STRAIGHT DOWN THE RUNWAY.

EXERCISE 8 - You must be capable of safely landing your gyroplane in the event of an engine failure. The length of your runway will determine the maximum altitude you can climb to and land before getting to the end of the runway:, You should allow room at the end of the runway in the event you overshoot your landing spot. And you must stay over the runway.

Climb to your pre-determined altitude and slowly reduce the throttle a little more each time for each landing. Continue this until you can reduce the throttle to idle. Remember, lower the nose and maintain your airspeed.

CONDITIONS - No wind - calm air.

EXERCISE 9 - Now that you have accumulated several hours of the previous maneuvers, it's time to determine if you are ready to make your first flight around the Airport Traffic Pattern. **When you can fly the length of the runway at various speeds holding 2 to 3 feet altitude and do this without any up and down movements consistently several times, YOU HAVE PASSED THE TEST.**

CONDITIONS - No wind - calm air.

EXERCISE 10 - Your first flight around the Airport Traffic Pattern. Choose an early morning or late afternoon, when there is little or no airplane traffic.
Remember, perform a thorough pre-flight. After take-off, climb to 500 feet and continue to fly the pattern staying close to the runway, while watching for other traffic. After landing and securing your gyro you may now congratulate yourself on your first solo around the pattern in your gyro.

If you have any questions about the above information, please contact Steve Graves or your current Gyro CFI.

I have read and discussed all the above with my instructor **and fully understand all details.**

INSTRUCTOR____________________________
STUDENT______________________________
DATE_________________________________

COMMERCIAL PILOT LOGBOOK SUPPLEMENT SHEET

PILOT NAME______________________ DOB______________ S/S OR PASSPORT________

FAR 61.125 AERONAUTICAL KNOWLEDGE REQUIREMENTS OF FOR COMMERCIAL GYROPLANE PILOT CERTIFICATION

The applicant for a commercial pilot certificate must have logged instruction from an authorized flight instructor or present evidence that he has satisfactorily completed a course of instruction or home study in at least the following areas of aeronautical knowledge.

.DATE A/C# HOURS GROUND INSTRUCTION SUBJECTS FAR 61.125 CFI

(b)(1) Federal Aviation Regulations which apply to the operations, privileges, & limitations of a commercial rotorcraft pilot.
(b)(1) The accident reporting requirements of the National Transportation Safety Board.
(b)(2) Meteorology, including the characteristics of air masses & fronts.
(b)(2) The procurement and use of aeronautical weather reports & forecasts.
(b)(3) The use of aeronautical charts & the magnetic compass for pilotage & dead reckoning.
(b)(3) The use of radio aids for VFR navigation.
(b)(4) The safe and efficient operation of gyroplanes.
(b)(5) Basic aerodynamics & the principles of flight that apply to rotorcraft.
(b)(5) The significance and use of performance charts.

"I certify that I have received all the above listed instruction as described"
Trainee Signature________________________Date____________________

"I certify that I have given the above checked listed instruction as described"
CFI Signature_____________________Cert#__________________Exp_______________

Endorsement for aeronautical knowledge: FAR 61.35(a)(1) and 61.125(a) - I certify that I have given the above named person the ground instruction required by FAR 61.125 (b) (1) through (5).

Date__________CFI Signature_____________________Cert#______________Exp____________

Endorsement for retesting within 30 days of first failure of a written or practical test: FAR 61.49 -
I have given the above named person additional (flight/ground)(circle one) instruction and find him/her competent to pass the commercial pilot rotorcraft gyroplane written/ practical (circle one) test.
Date__________CFI Signature_____________________Cert#______________Exp____________

***Note - The instructor may also complete the endorsement in the space provided at the bottom of the applicant's airman written test report in the case of a first falure of a written test. The instructor must sign the block provided for the instructor's endorsement on the reverse side of FAA Form 8710-1 for each retake of a practical test. An applicant may retake either a written or practical test within 30 days of a first failure of he/she has received additional instruction and an instructor's endorsement. For subsequent failures of both practical and written tests, the aplicant must wait until 30 days after he/she failed the test before applying for retesting.**

FAR 61.127 FLIGHT PROFICIENCY REQUIREMENTS FOR COMMERCIAL GYROPLANE PILOT CERTIFICATION. The applicant for a commercial pilot certificate must have logged instruction from an authorized flight instructor in at least the following pilot operations. In addition, his logbook must contain an endorsement by an authorized flight instructor who has given him the instruction certifying that he has found the applicant prepared to perform each of those operations competently as a commercial pilot. The entries do not have to be made in order & more than one entry may be made for a flight.

DATE A/C# HOURS MANEUVERS AND PROCEDURES FAR 61.127 CFI

(c)(1) Preflight operations including the line inspection and servicing of gyroplanes.
(c)(2) Flight maneuvering by ground reference.
(c)(3) Maneuvering at critically slow airspeeds, and the recognition of and recovery from high rates of descent at low airspeed.
(c)(4) Airport & traffic pattern operations, including collision avoidance.
(c)(5) Cross country flying by pilotage, dead reckoning, and the use of radio aids.
(c)(6) Emergency procedures including maximum performance takeoffs and landings.
(c)(7) Cross country flight operations.
(c)(8) Emergency procedures such as power failures, equipment malfunctions, max performance takeoffs and landings and simulated lift offs at low airspeed and high angle of attack.
*All hours logged above represent total flight time all of which is dual instruction conducted in day, VFR conditions unless noted.

"I certify that I have received all the above listed instruction as described"
Trainee Signature______________________Date__________________

Endorsement for flight proficiency: FAR 61.127(c) - I have given the above named person the flight instruction required by FAR 61.127(c)(1) through (8) and find him/her competent to perform each pilot operation safely as a commercial pilot.
Date_______________CFI Signature____________________Cert#____________Exp__________

A. USE THIS FOR PILOTS WHO DO NOT HOLD AN FAA COMMERCIAL PILOT CERTIFICATE:
Endorsements to certify completion of prerequisites for a practical test: FAR 61.39(a)(5)
I have given the above named person flight instruction in preparation for a commercial pilot rotorcraft-gyroplane practical test within the preceeding 60 days and find him/her competent to pass the test and to have satisfactory knowledge of the subject areas in which the applicant was shown to be deficient by his/her airman written test.
Date_______________CFI Signature____________________Cert#____________Exp__________

Note: The instructor's signature in the endorsement block on the reverse side of FAA Form 8710-1, Airman Certificate and/or Rating Application, will be accepted in lieu of the above endorsement provided all appropriate FAR Part 61 requirements are substaniated by reliable records. However, the above endorsement without the instructor's signature in the endorsement block of FAA Form 8710-1 is not acceptable.

B. USE THIS FOR HOLDERS OF AN FAA COMMERCIAL PILOT CERTIFICATE:
Endorsement for an airman seeking an additional aircraft rating (other than airline transport): FAR 61.63(b) or (c)- I have given the above named person the instruction required by FAR 61.63 and find him/her competent to pass the commercial practical test for the addition of a rotorcraft-gyroplane rating.

Date_______________CFI Signature____________________Cert#____________Exp_________