HOW TO FLY 3D MANEUVERS

If you are a competent pilot who enjoys living life on the very edge of the envelope, then 3D is for you. Your plane is always just moments away from disaster. Spectators get thrills from near disasters, and so does the pilot! 3D flying is one near disaster after the next, with a crash inevitable with one slip of the finger, one burble of the engine, one wrong move, one mechanical failure, or one gust of wind. Not all 3D maneuvers are at just above stall speed, but all 3D put the plane at more risk than sequence flying. This is very difficult, and takes a special (meaning more expensive) aircraft and equipment to do it right.

NOTE: If your plane is heavy (high wing loading) and it must dive to pick up speed before it can fly out of an aborted maneuver without snapping, then you have the wrong plane. Either lighten your plane or get a new plane. If not, you will be forced to fly too high to have fun or you will crash. If you have a 40% plane over 36 pounds or a 35% plane over 26 pounds, your plane is heavy, so be careful.

KEYS TO 3D FLYING
- The lower (lighter) the wing loading the better: lower stall speeds and better knife edge capability. The ability to fly away from a botched maneuver is important.
- The higher the power to weight ratio the better: blast out of trouble or jump out of a hover.
- The more the control surfaces move the better: faster maneuvering.
- The larger the control surfaces the better: more control of the air.
- The more powerful the servos the better: to prevent flutter.
- Digital servos: precise motion throughout the range and tighter centers.
- The faster the servos the better: faster corrections.
- The larger the fuselage side area the better: better yaw control.
- The larger the size the plane the better: less sensitive.
- A computer radio: mix out quirks, switch rates easily using one flight condition switch.
- The correct amount of right thrust: the plane must go up straight in a hover.
- Lots of money: buy the best, stretch the envelope, have a backup.
- Nerves of steel: the lower the better.
- Bulletproof airframe: don't have a mechanical failure, especially servo linkages.
- Bulletproof engine: hovering on the deck has an unhappy ending if the engine quits.
- Rearward CG: flies inverted virtually hands off for better maneuverability.
- Extensive preflight: you can't afford a mechanical failure in the air which should have been caught on the ground.

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FLAT SPINS

Explanation of the Flat Spin: This is not really a 3D maneuver, but they don't fly it in IMAC either, though large throws help, so I'll classify it as 3D. Use high rates on all surfaces. When you are high up, pull to the vertical upline. When you are really high, slow the airplane to a halt. Let the plane fall

over. Then push both sticks to the upper corners and together. In about a second or two the plane will be spinning violently. At that time, move the aileron from the far left corner to the middle (neutral) keeping the elevator at full down.

While in the spin you need to play with the controls to find the right spot:
1) To flatten the spin, use some right aileron instead of keeping the aileron neutral. More throttle helps flatten the spin. If the plane is not flat enough, it will lose altitude quickly. You will have to play with the ailerons and throttle to keep it rotating. It the plane is too flat it will stop rotating. Find the angle the plane will stop rotating, and stay just a little more angle than that, say like 20 degrees.
2) If the plane stops rotating and tries to flip over forwards, use less elevator and/or less throttle, and keep the plane at more of an angle with the ailerons.

To release, just neutralize the controls and go to low throttle. Once the plane stops rotating and is heading down, apply 1/4 throttle and a little bit of elevator to pull out. The pull out can take a lot of altitude, so exit pretty high until you're an expert. It's OK to exit too high, it's really bad to exit too low. If your plane doesn't like coming out of the spin, use opposite rudder and that should stop the spin right away.

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HOVERING

Explanation of the Hover: This is the first 3D maneuver you should try to master. It is fairly easy to do without jeopardizing your aircraft. It will test the capabilities of your airplane, and show you its strengths and weaknesses. If the plane is too heavy it will tip stall back and forth when it is slow (called wing rock). Hovering is simply holding the nose almost vertical and the plane does not rotate like it does in a torque roll. The altitude stays the same. Even heavy planes will hover as long as the thrust of the prop is just a bit more than the weight of the plane.
Radio/Airplane Setup:
- Lots of control throw on all surfaces.
- It is necessary to have ailerons which come in close to the fuselage so that they are in the prop blast. If not, you won't have any roll control.
Hovering - step by step:
- Fly towards the center of the runway from the left or right but into the wind. Altitude should be as low as you dare. The lower it is the easier it is to see what is happening. I prefer about 20 feet at a minimum to start with. Slow the plane down, and as it starts to lose lift and drop, give it just enough elevator and throttle to not lose altitude, then keep pulling the nose up with elevator and throttle until the plane is almost vertical and is stationary. Before losing control, add enough power to slowly climb out so that you are ascending, but not moving forward or backwards. If you ascend, even very slowly, the plane is much, much more stable than when the plane is not climbing. Repeat this so that you can maintain the same altitude longer and longer. As you get better, then get lower and closer to you (a little at a time!).
- You will need to lean the plane into the wind for the best results. The higher the wind speed, the more the plane leans into the wind. I prefer it when the wind is a direct crosswind, blowing directly

into my face. This way the plane is not sideways to me, but is in full view, canopy towards me. Keep the plane from rotating using a lot of aileron throw. You primarily need right aileron to counteract the torque rolling effect, though don't be bashful about using left aileron if necessary. The more horizontal the plane is, the less of a tendency it has to roll.
- If you really lose control, punch it and level the wings using ailerons before using elevator.

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TORQUE ROLLS

Explanation of the Torque Roll (TR) maneuver: Pull to vertical, maintain vertical position without ascending, plane rotates around to left under it's own power (due to the torque of the engine). End maneuver by pushing (or falling) out to level flight, or powering vertically upwards.
Radio Setup:
- Maximum rudder and elevator throws.
- None or opposite exponential.
- No flaps
- Throttle curve if necessary to have soft throttle at TR rpm so you can make slight variations to the rpm easily.
TR Basics:
- This is an extremely difficult maneuver which takes many, many, many hours of practice with the right plane which is trimmed out correctly.
- Enter the TR near yourself and just a little upwind.
- The lower the better because it's easier to see the plane and make corrections.
- Calm days are easier than windy days.
- Enter a TR by flying to the TR starting spot in a Harrier or do a wall.
Techniques to master the TR:
- When first learning to TR, cheat in any way you can. Do whatever it takes to make it easier at first, then remove any cheats one at a time.
- Best Cheat: A gyro on the rudder or the elevator or both will help. Set the gain very high, and use the gyro only when in the TR as the gain will be too high for normal flying. This is cheating because a gyro is not allowed in competition.
- Use separate trims on flight modes. Set up a flight mode for TR. Use the trims to make TR easier. Usually a little up and a little right is needed.
- Blip the throttle and the control surfaces simultaneously to get the airplane to correct any lean without ascending.
- A steady throttle is more difficult than blipping the throttle.
- Get the plane vertical. It looks like the plane is on its back. You shouldn't be constantly holding any up. If you are constantly inputting up elevator, add upthrust to the engine instead.
- If you are constantly giving right rudder, add right thrust to the engine.
TR flying tips:
- Be sure the fuel tank is above 1/4 full. The fuel may slosh around and cause the engine to burble when the fuel is low.

- When you are learning, slowly ascending will help. When you are good do not ascend. When you are awesome, descend.

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PARACHUTES

Explanation of the Parachute maneuver: While heading vertically downwards at idle, pull full up elevator so that the airplane instantly pitches to a slightly nose up condition and instantly stops descending (if the plane is light). Heavier planes will continue to descend in a flat, slightly nose up position until enough throttle is added to arrest the descent. A parachute at full throttle is called a terminator (for good reason).

Radio Setup:

- Full throw elevator - 40 - 50 degrees.
- Flaps in flaperon mode will arrest the descent more abruptly which is better for light planes which won't snap. Spoilers will aid heavier planes to reduce wing rock/snappiness but the plane will lose a lot of altitude in a flat attitude, so parachute up high. Light planes can parachute virtually right down on the deck because they won't lose any altitude once the elevator is pulled.

Parachute Basics:

- This is an easy maneuver to perform which is very hard on your plane. The faster you are going when you yank, the harder it is on your plane.
- Start by going down only a short distance/time, like one second. Pull full up. If you aren't going fast enough, the plane won't pitch up past the horizontal. Keep trying until you gain just enough speed for the plane to quickly and abruptly come to level.
- Parachute into the wind.
- A split second after the parachute, apply power and fly into the next maneuver.

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ELEVATORS

N/A

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KNIFE EDGE

Explanation of the Knife Edge maneuver: This is when the airplane is flying on its side for an extended period of time without ascending or descending. Initially you will start to your left or right, and then fly along the runway. This is a key maneuver and is the basis for many of the best maneuvers in 3D. Once you master the standard knife edge, you can then move on to knife edge loops, knife edge circles, knife edge circles with snaps, and the death drop. These are exciting maneuvers that few people know how to do, and if you do them, you'll be up there with the best pilots in the world.

Radio Setup:

Radio set up is extremely important for knife edge. You may need an engineering degree to get it right.

- Full throw rudder - 40 - 50 degrees.
- Most airplanes will roll in the direction of the rudder and will pitch towards the belly. It is extremely important to mix this out using a computer radio. Most likely the mixes must be different for different throttle settings and speeds therefore it is important to choose a speed that you will pretty much always be flying knife edge. For now, just set it up for full throttle. So, fly by at full throttle on knife edge while applying just enough rudder to maintain altitude. Do not climb or descend! When you apply let's say right rudder, most likely the plane will roll to the right (proverse roll coupling) and it will pitch down toward the landing gear. Fly in both directions and check that this is true. Then land, and then use the computer radio to add a small amount of up elevator and left elevator when applying right rudder, and up elevator and right aileron for left rudder. About 1/8" of deflection is good to start with. Then fly again and see if the computer is doing too much or too little. Keep landing and making adjustments until simply applying the rudder results in pure yaw. Now it will be simple to do knife edge! Just fly at full throttle, roll to knife edge, and hit the rudder. The plane should track in pretty much a straight line with little adjustment. Keep in mind that you will always have to do some corrections. You probably don't fly straight and level without doing corrections. The wind will blow you around, and depending on the airspeed and the amount of rudder you apply you will need to do corrections. so be prepared. ALWAYS leave the mix on.

Knife Edge Basics:

- Once the computer radio is set up, flying knife edge is a simple task except for the corrections due to wind, airspeed and other minor stuff. Just fly by and roll to knife edge and apply the rudder. ZOOM! there you go.
- Practicing corrections: It seems weird at first, by when on knife edge, apply the elevator to do corrections. Fly in a zig zag pattern using the elevator. Fly in a circle using the elevator. Do some motions in and out with the elevators to get used to it. it takes some getting used to, so keep trying it and after a long while it won't seem so weird. Of course as you use the elevator the plane will lose speed and you must use more rudder which then will cause you to use the throttle (if it's not fully open already) and then you will use the ailerons as the plane will start to roll a little. You should fly knife edge at least one time every time that you fly! Once you get comfortable with that, we will add some more difficult stunts.

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KNIFE EDGE LOOPS

This is a lot easier to do than it looks. You just need guts to pull out at the bottom (and a good plane helps). This is the basis for the death drop and the knife edge loop with snaps which you can try later. Let's break it down into steps:

1) Be proficient in performing standard knife edge flight.
2) Your plane must have its mixes for pitch and roll with rudder mixed out with the rudder at full deflection and the engine at full throttle.
3) Set up: The standard knife edge loop of course just needs some rudder and throttle management, with some pitch and roll adjustments along the way. Get lined up with the runway from a good distance away, into the wind, and at full throttle. Keeping the plane a hundred yards out makes it easier to do than if it is in close. Start the loop at the bottom, about 50' high.
4) Roll to knife edge well before you are in front of yourself so you have time to make any adjustments to be parallel to the runway before starting the maneuver.
5) Start the maneuver when the plane is directly in front of you.
6) You will be at full throttle for a little more than the first ? of the loop.
7) You will not need full rudder in the first part of the loop because you need more rudder in the last ? of the loop.
8) Larger loops are harder to perform than small loops, especially if your plane doesn't have a lot of power to weight. Make the smallest loop you can to begin with, then make the loop larger as you gain proficiency.
9) The second half of the loop, on the way down, uses a lot more real estate than on the way up, so take your time on the way up. At the top of the loop, you may need to apply opposite rudder to drag it out. For instance if you are flying left to right, you apply left rudder for the first 120 degrees (1/3) or so, and then you may need to apply a little right rudder to maintain the circular path and gain altitude.
10) The highest point of the circle must be directly in front of you for the circle to be round.
11) Once passing the top, back off the throttle to about ?. You may not need much rudder input for the next (3rd) quarter of the circle.
12) Now comes the 4th quarter and it's the hardest part by far. If you don't think that you're going to make it, don't press it. Just roll to upright and it is easy to pull out. Some planes just can't make it. If you can't pull out, but believe that your plane is capable, you may need to change your set up. You may need more powerful rudder servo(s) or more battery power to the servo.
13) The 4th quarter is where you need full throttle and full rudder. Give it all it has. You will learn to feather out the rudder as you get back to horizontal, but keep the throttle at full.
14) I hope that this helps you through your first knife edge loops. Once you do it a few times and you have the confidence that your plane will pull out without stripping a servo or breaking a cable, you can practice larger diameter circles. The larger they are the more finesse is required and the more impressive it looks (and is).
15) There are other variations. You can start the loop from the top or downwind or you can put in snaps at 90, 180, 270 and 360 degrees to add some difficulty.
16) When practicing, I always stay high enough to be able to save the aircraft in case the rudder cable or rudder servo fails. Save the low stuff for shows. J

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DEATH DROP

This is a lot easier to do than it looks. The tricky part is the exit. A death drop is basically just going to knife edge at idle. It is usually done similar to a landing approach, into the wind and lined up with the runway. The plane comes down like an elevator, though a lot faster.

Just start up high, roll to knife edge, and then bring the throttle to idle. The plane will fall pretty much straight down. You may have to fight it a bit to keep it on knife edge and keep it lined up with the runway. Add more throttle to slow the descent and give you more control.

When the plane falls as low as you want, then you have two ways to exit. 1) If your plane is really good on knife edge, you can power up and transition into knife edge flight. The problem is that the sudden engine torque and higher air speeds over the control surfaces will cause the plane to pitch and roll and you better be ready for it. Also the plane will continue to fall quite a bit until the forward motion of the plane is fast enough to maintain knife edge flight. Some planes just can't recover. The drag from the rudder being fully deflected can't be overcome quickly enough. 2) Just level the wings and increase the throttle and you should be flying in short order. HOWEVER when you roll to level with the ailerons, get off of the rudder first or transition into the ailerons very slowly. Simply cranking in the ailerons to level the aircraft will cause the plane to snap with rudder and ailerons to their max. Being low and slow and then going into an inadvertent snap will ruin your day. Try your exit strategy up high so that you can recover from a sudden snap.

With practice you will see that controlling the exit is very important to make the maneuver look good.

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BLENDER

Explanation of the Blender: Airplane starts high, then it is pointed straight down. The plane is rolled with ailerons only until it is snapped into a flat spin. The flat spin can be extremely fast which emulates the blades of a blender.

The speed build up of the plane determines how fast the plane spins when entering the flat spin. It is quite easy to break the fuselage in half, lose the canopy, lose the rudder, snap a wing, or snap a wingtube if you are too fast in the downline. If you are too slow on the downline it is boring. To be exciting, you want to spin just a little slower than when your plane flies apart.

It is very simple to do a blender. Anyone can perform the maneuver with just a few seconds of instructions. Performing the maneuver and having your plane intact afterwards just takes a little trial and error, which is easy to do. To be really exciting, you may bend or break something eventually.

Radio Setup:
- Full throw elevator - 40 - 50 degrees, full throw ailerons (30 degrees or more), and full throw elevator.

Elevator Basics:
- If you have a strong and heavy plane, you can do the best blenders. The plane will spin like a... well like a blender! It will be a blur it spins so fast. The high weight of the plane will keep the momentum of the spin high for a long period of time. I spun my 40%, 210cc, 50 lb. SD-Models Yak so fast that it was a blur, so just because the plane is big doesn't mean that it can't spin really fast. I really didn't want to spin it that fast, and didn't do that again. The plane did live to fly again, though I did apparently crack the hatch hold downs and a few flights later that day, off went the canopy/hatch. My pilot had a headache, but he was ready for more the next weekend.
- The faster the downline, the faster the rotation. Typically the longer the downline, the faster the vertical speed.
- If your plane is very light, it will not build up speed as quickly as a heavy plane, and may never build up enough speed at idle to obtain a high rotation. With my 35% Extra at 21 lbs, I go to full throttle on the downline. You MUST work your way up slowly on the downline speed. Your first blender must be at idle, and it should drop for one second or so. You must start the decent from close to stall speed, not at full or even 1/2 throttle. Let the plane slow as much as possible before pushing over. If the plane rotates slowly or won't even get into a spin, then enter the same way (near stall speed), but drop for 2 seconds. Continue to enter the decent near stall speed, but let the plane drop longer to build up more speed. If the plane breaks in half, you went down too fast. Unfortunately, this is about the only indication you will receive that you exceeded the limits. If the plane spins around so fast it looks like it will break, it probably will break eventually. If you do several blenders, the stress builds up on the plane and is more likely to break in the future. Once you have determined a downward vertical speed that you are comfortable with, you can obtain repeatable results by always starting from a near stall and using a time or distance to determine the speed built up.

Now that you understand the importance of the speed going into the blender, and the consequences thereof, following is the stick movements:
- Once you push the plane vertically downward, apply full left aileron.
- Once to obtain the speed required, push both sticks up and together. This will put you into full throttle, but the engine will not be at full throttle until after the plane is in the flat spin.
- After the plane has entered into a flat spin, move the aileron stick towards the middle or to the right to flatten the spin. See the article above on flat spins.
- To exit the maneuver, go to idle and neutralize the controls. The rotation will stop and the plane will nose over and enter a dive. The higher the wing loading of your plane the longer it will take to pull out of the dive. It is best to pull out into the wind, if you are not pointed into the wind be prepared for a longer time to pull out. It is usually difficult to predict when the plane will stop rotating, so counting on pull outs into the wind is not a good move.
- Advanced exit: As the plane is in a flat spin, go to idle and neutralize the elevator and ailerons, but apply full opposite rudder. The plane will stop rotating instantly. You always want to stop rotating into the wind. You do not want to pull out downwind unless you have to and you have lots of altitude. If you have a light, 3D plane, you can halt the rotation into the wind using opposite rudder and just fly out pretty much horizontal.

Important - manufacturers do not have a blender (or other stress related issue) warranty. If you overstress the plane, it may fail immediately but it also may fail several flights later (like when my hatch blew off) when you are flying a long at 1/2 throttle straight and level. Telling the manufacturer that you were just flying along straight and level and the plane failed does not give you any type of warranty. Typically any manufacturer will only replace a plane if lots of them fail for exactly the same reason. Almost every manufacturer has had planes fail due to a building or design issue and replaced the wings (usually) with a new design at no charge under warranty. SD-Models, Aeroworks, Quique, Precision Aerobatics and others have had wing failures in one particular airplane and replaced all the wings at no charge under warranty.

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