Unlimited Glider Aerobatics in Vehicle Simulator & Real

This review shall give you a look into aerobatic gliding and show you the excellent working physic engine of Ilan Papinis great Vehicle Simulator (VSF): www.hangsim.com/vsf

To make a flight simulator useful for aerobatics, the physics must be handled correct not only during stable, laminar flight, it must also work correct beyond stall.

In VSF virtual wings, values for inertia on all axis, drag, lift and much more parameters define a flight model. The program calculates the combination of all those values very well, so very realistic behaviour of the aircraft in all aerodynamic situations can be imitated.

Aerobatics

Aerobatics are spectacular for the audiance. For the pilots aerobatics are a lot of fun, challenging, precision and a enormous gain in flight safety. An aerobatic pilots knows to handle his plane in any situation. Aerobatics have nothing to do with bolt flying. No wise pilot is interested in overstressing his plane or endanger himself or others. It´s about flying figures as accurate as possible. Especially in aerobatic gliding a good speed- and g-management is necessary to use the available height (1200 m...200 m GND in competitions) as efficient as possible.
Basically aerobatic figures are combinations out of angles, lines (horizontal, vertical and 45°, normal and inverted), turns, rolls (aileron rolls, flick rolls, point rolls), loops, spins, stall turns and tailslides. The „Aresti catalogue" contains all figures and allows their combinations.
So a good looking aerobatic program contains a variety of the different figures. When a pilot creates his program he must care for speeds, so that the speed of a figures exit matches to the next figures entry. Also spreading the figures allover the „Box" (airspace in which the aerobatics are flown: 1000 x 1000 x 1000 m) is important. Further the figures shall be seperated from each other. One or two seconds should split the figures from each other, so that it´s clear when a figure ends and when the next one begins.

Efficient flying

Figures can be flown hard, but it´s not necessary, because it disturbs the harmony of a aerobatic program and flying a hard style is not efficient. You can fly higher g-loads when you rise the g-forces moderate and not abrupt. If you pull/push too quick, a large angle of attack causes a lot of air resistance for a short time and slows down the plane. Further it´s necessary to practice the figures with a minimum of speed. The faster you fly, the more altitude you need/waste.

Comparing real aerobatics with simulation

I made a video, flying a program with many figures from the unlimited class of aerobatic gliding. In the video I fly the real SZD-59 Acro (belongs to the Förderverein für Segelkunstflug im BWLV, an aerobatic gliding club in South/West Germany: www.segelkunstflug.com) and repeated the figures with the Cirrus K in VSF.
Only two Cirrus K were built. The first one, D-4747 (as made by Marcel Aerni for VSF) was the first aerobatic single seater I flew over some years, also in competitions (Advanced/Unlimited). SZD-59 and Cirrus K have a very similar layout. Speeds and g-

loads (g-limits for both are +7 / -5 g) for the aerobatic figures are the same, so the two gliders can be compared very well.
In the video I use different views to make the figures as clear as possible.

This is the shown program with Aresti-symbols:
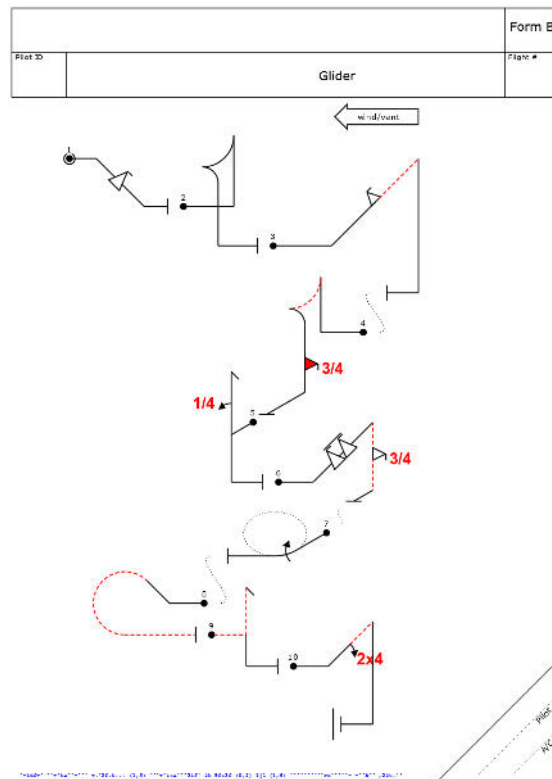
1. Full positive Flick 45° down
2. Tailslide, canopy up
3. Half positive Flick 45° up, Pulldown to vertical Downline,
Pullout upright
4. Tailslide, canopy down, 3/4 negative Flick on Downline
5. Stallturn, 1/4 roll on vertical Upline
6. Multiple positive Flicks on 45° Upline
7. 90° inward rolling Turn
8. Reverse half Cuban with 5/8 negative Loop
9. Stallturn, inverted Entry, upright Exit
10. 2/4 Roll 45° up, Pulldown to vertical Downline, Pullout upright

Here is the video:

https://www.youtube.com/watch?v=Q3qFzEJ7meg&feature=youtu.be

Successful aerobatic training in VSF

Generally in the simulator it´s more difficult to make accurate aerobatics because you just don´t feel the plane and the view angle you have on your screen is very limited compared to reality. If you don´t have a head tracker which is recommended for effective aerobatic training with the simulator, you have to handle the views by hand, which takes more time and some concentration you need for flying. As you have to fly accurate angles, you watch very often to the sides during the figures. You need to check the speed indicator often, too. When you fly figures with high g-loads you need to have an eye on the g-meter to avoid overstressing the plane. So you need to change the directions in which you look quickly.
For luck in VSF you can switch on little helpers like outside views or the HUD.
The HUD (H) shows the horizon (important angles are 45°/90°), speed (in kt), g-loads and altitude: All important values for aerobatics.
You can also change from „Normal view" to „Wide view" (F7). For aerobatics „wide view" is recommended.
Further you can turn on the visualisation of the controls in the options (→ Vehicle → „See controls") to see the actual inputs. The visualisation of the flight path can also be switched on here.
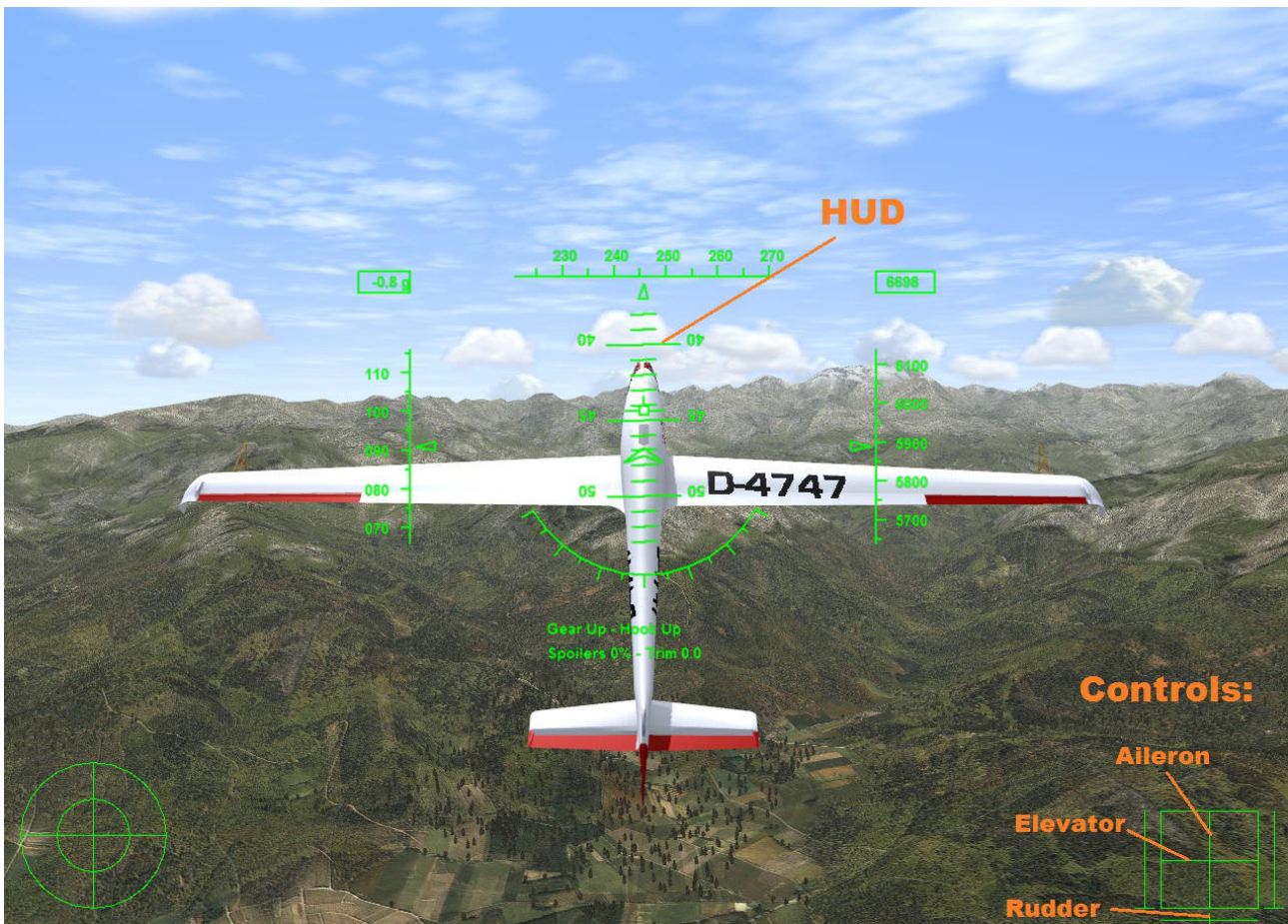
You can also change the sim rate (F3 / F4 ; Shift+F3 / Shift+F4) to find more time.

Another great feature of VSF is the replay function: Press F8 to open the replay dialog. If you want to fly a figure or a part of an aerobatic program again, you can jump back in time and repeat it. The replay shows also the flight path, so you can check the room you need for your aerobatics or see if lines, loops and angles were accurate. In the screenshot I made a 45° downward line to accelerate for a cuban eight. The flight path shows me that the radius of the first loop into the vertical is larger than the others.
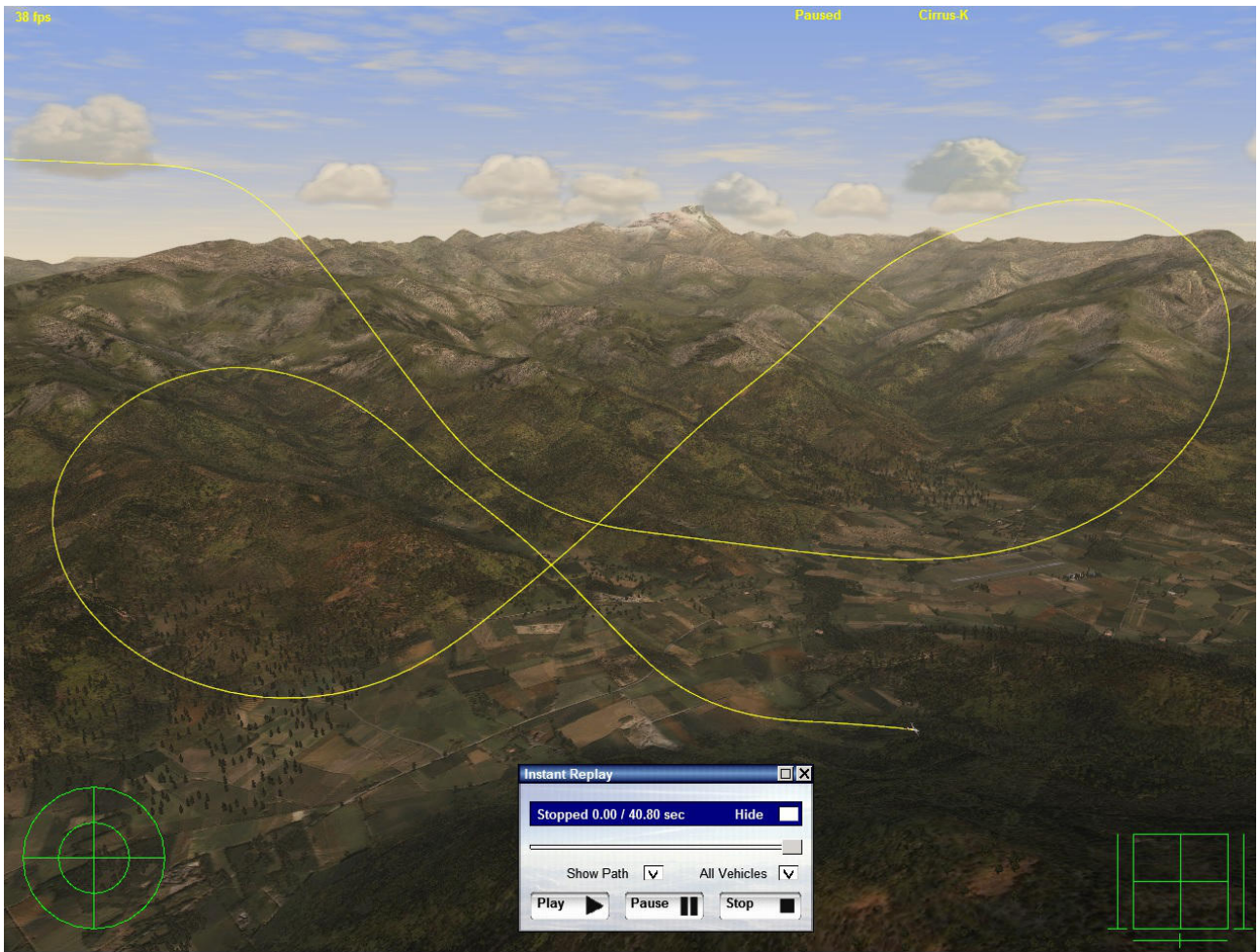
Futher you can watch the whole flight, save it and replay it (possibility to make formation flights „with yourself"!, see here: https://www.youtube.com/watch?v=KdpmnCCpLX0
) whenever you want .

How to fly the figures shown in the video

Figure 1: Full positive Flick 45° down (Time in video 0:50)

A flick roll is a wanted high speed stall with a rotation which is much faster than an aileron roll (Rollrate for aileron rolls of Cirrus K is about 80°/s, SZD-59 is about 100°/s).
The 45° downward flown flick roll is much easier than a horizontal flick roll, because you don´t lose so much speed and stopping the rotation is more accurate.
Entry speed is ~120 km/h. Push the nose down 45°. Check the angle by watching out to the side. When you pass ~150 km/h pull back the stick, move a bit aileron to the side in which you want to fly the flick roll and give a full rudder input to the same side. For the beginning better fly the flick roll without aileron, this slows down the rotation. All in the same time and all abrupt. If you pull too much or give too much aileron the rotation can´t be stopped in the right moment. If you move the inputs too slow the plane does not stall and instead a flick roll you fly a „high-g-barrel roll". It needs some practice to get a feeling for the figure.

To stop the flick roll move all controls to neutral position at ~3/4 of the roll. When you reach the full roll push a bit and give a short rudder input in the opposite direction to stop it.

After you stopped the flick roll, check the 45° downward line again and accelerate to the speed you need for the next figure (in this case the tailslide: Minimum 200 km/h).

Figure 2: Tailslide, canopy up (1:55)

Entry speed: 200 km/h or higher. Pull up smoothly with 3...4 g.
For the „tailslide, canopy up" you need to pull up almost into the vertical, wait until speed is gone and when the plane falls backward (at least the length of the fuselage), pull back the stick and it will fall forward into the vertical downward line.
It´s absolutely necessary that wings are horizontal and the string is straight on the canopy when you reach 0 speed at the top of the figure. If not, the figure will fail.

Why not 90° into the vertical? Because the plane would fall into a „tailslide, canopy down", if you don´t have a plane with a symmetric wing. So try to fly ~87° upward instead 90° to make sure it falls to the correct side. If the angle is too small (e.g. 80°) there would be no slide and the figure is judged with a „hard zero".

If you reach the top and you realize the wings are not horizontal, there is still a chance to rescue the figure: As soon as the plane falls backward, step into the rudder on the side on which the wingtip is lower. The backward airflow hitting the rudder might force the plane in a straight postion and an unwanted twist to the side which kills the figure can be avoided. In the video you can see that my right wingtip is lower than the left one. Care for the rudder in the view from the wing and you will see that I make a full rudder movement to the right to compensate this (2:49). Also in the sim-scene I repeated this mistake to show you that you can save the figure in the same, realistic way (3:33).

The tailslide can not only be killed by wrong inputs. Around the highest point, when speed is 0 (no airflow over the control surfaces), you have no control over the plane. Wind gusts or thermals can disturb and bring the plane out of balance. The weather adjustment in VSF allows you to simulate those conditions very realistic.

After the slide stabilize the vertical downward line and gain the speed you need for the next figure (here: Minimum 220 km/h).

Figure 3: Half positive Flick 45° up, Pulldown to vertical Downline,
Pullout upright (4:02)

For the half flick roll 45° up enter the figure with ~220 km/h, pull up 45° and wait until 160 km/h is passed. Begin the flick roll like in Fig. 1. After ¼ rotation move aileron, elevator with ~ ¼ way of travel and almost full rudder in the opposite direction. Now the plane is out of direction. See the flight path in the screenshot: It shows the moment right when the flick roll is stopped. So after you stopped the flick roll you need to give a rudder input in the same direction you flew the flick roll. This needs a lot of practice, because all what´s happening happens very fast.
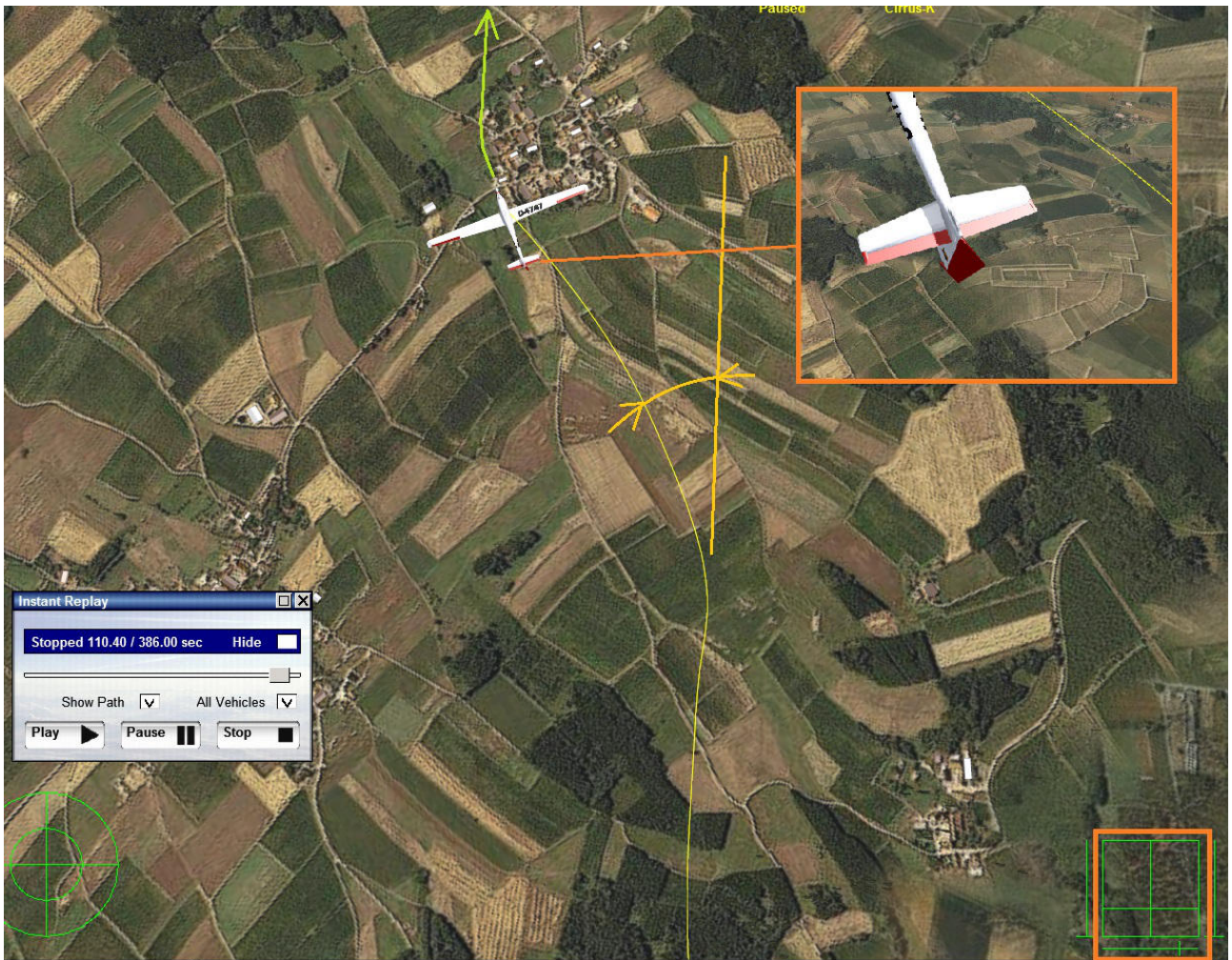
After the flick there is not much energy left to continue the (now inverted) 45° upward line. So you need to push some more to keep it. Shortly after that pull the nose into the vertical downward line. Accelerate to 200 km/h for the next figure.

Figure 4: Tailslide, canopy down, 3/4 negative Flick on Downline (5:40)

Pull up with 3...4 g and care for horizontal wings like in Fig 2. As you fly a „tailslide, canopy down" now pull into the vertical or even a bit more (~93°). In the moment the plane falls backward push the elevator fully and wait until the slide is finished.

Stabilize for a short moment the downward line and fly a negative flick toll when ~145 km/h is passed. The negative flick roll is much easier to fly. Move elevator foreward and aileron and rudder crosswise rapidly to their limits, all in the same time (see the controls in the screenshot). After a ¾ rotation move all controls quickly a bit to the opposite direction and the flick roll stops at once.

During flick rolls (positive or negative) and spins, the rotation follows always the movement of the stick (aileron). This is important when you fly ¾ flicks or spins to leave the figure in the right direction.

Stabilize the downward line before recovering. The speed for the next figure is 250 km/h.

Figure 5: Stallturn, 1/4 roll on vertical Upline (7:32)

For the stallturn with a ¼ aileron roll in the upward line a good energy management is necessary. Enter the figure with 250 km/h. Pull up speedy but not abrupt into the vertical line with 4...5g. Watch out to the side and make a ¼ roll with the aileron (also speedy but not abrupt). If you see that the wingtip comes up or down, make a correction with the rudder to keep it close to the horizon. Make only very little movements with the rudder. When the roll is finished, check the string on the canopy. Step in the opposite rudder on the side to which the string has moved. In the screenshot the string points to the right side, so the turnaround must be flown to the left (rudder left).

Wait until 50 km/h is passed and give a full rudder input, also here: Speedy but not abrupt.

During the turnaround you can stabilze the plane a bit by pushing the elevator slightly and move the aileron just a bit to the opposite direction you´ve moved the rudder. Note the controls in the screenshot.
Stabilize the vetical downward line and recover. For the next figure again 250 km/h are necessary.

Figure 6: Multiple positive Flicks on 60° Upline (9:16)

This is not a real aerobatic figure for competitions. It´s a spectacular airshow figure, relatively simple to fly and looks very cool with smoke (thats why I show it with the Lo-100, Cirrus K has – like the real one - no smoke).
Pull up to 60° and fly a ¼ roll. At 160 km/h (→ Cirrus K; Lo-100: 140 km/h) fly a positive flick in opposite direction you made the ¼ aileron roll. Move all controls in this case abrupt to the limits: Pull the elevator and move rudder and aileron into the same direction simultaneously. Keep the controls in the limits and just wait until the plane falls downward after some flicks. Return the inputs to neutral and recover with the right speed for the next figure (here: 180...200 km/h). There is no accuracy necessary in this figure: It´s just fun!


See the airshow figure at 1:42 with smoke here, flown with the SZD-59:
https://www.youtube.com/watch?v=X36zzOUg_Q0

<u>Figure 7: 90° inward rolling Turn (11:04)</u>

This figure is a full aileron roll spread over a 90° turn.
To fly a 90° inward rolling turn first find a reference point in the landscape 45° and 90° from your actual position. In VSF you can break the simulation therefor (Alt). Begin the figure with an input of the rudder in the according direction you want to fly. After the yaw movement starts add the aileron and pull the elevator carefully. Keep the rollrate low, so it ´s easier. After 22,5° you should be in the first knife edge position, now change the rudder to the other side. After 45° you reach inverted flight and your first reference point should be ahead. Now push the elevator and care always for a constant rollrate. After 67,5° you should be in the second knife edge position. Change the rudder again. When the wings are horizontal and you have not finished the 90° turn, just keep the rudder in its position to finish the figure right. A small aileron input into the opposite direction might be necessary to avoid rolling over. During the rolling turn always try to keep the nose on the horizon, so that no variations in height can disturb the figure. Try to forget the aileron, concentrate on rudder and elevator inputs to fly the figure well.
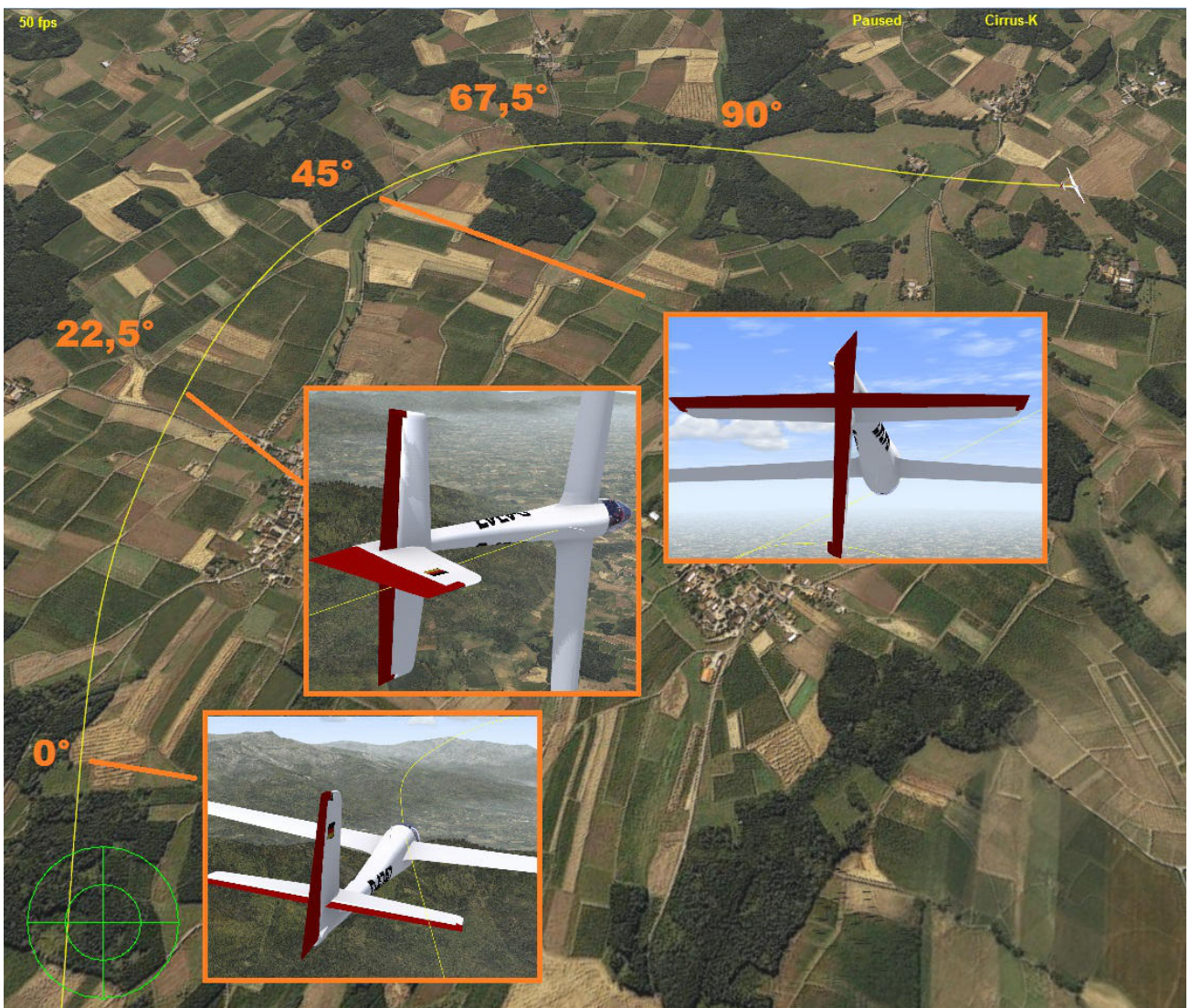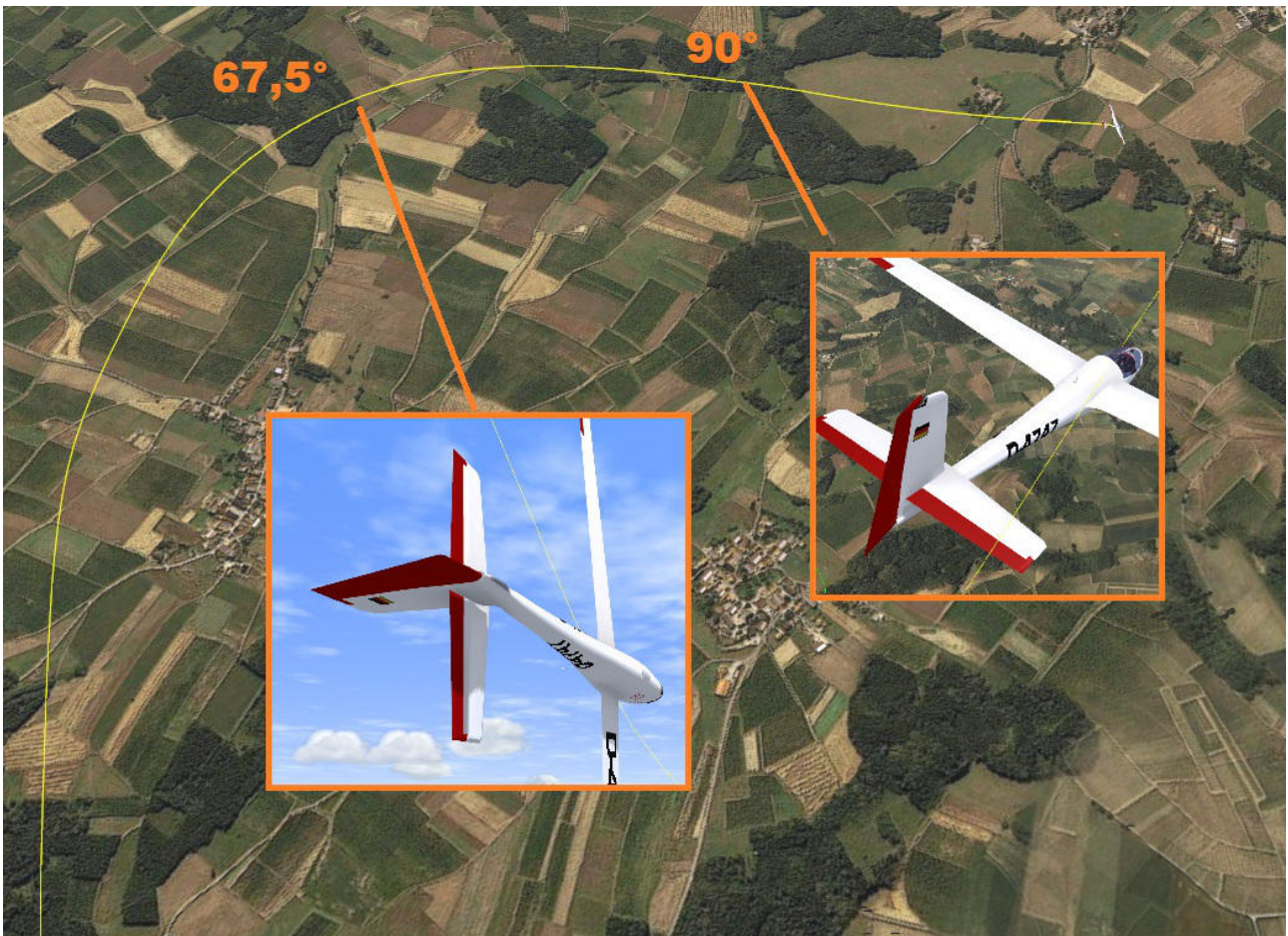
Figure 8: Reverse half Cuban with 5/8 negative Loop (12:12)

This figure should be flown with an entry speed of minimum 180 km/h. The faster you are, the longer you can show the 45° upward line. Pull up 45° and stabilize the line until you reach ~140 km/h. Now push the stick foreward to fly the outside loop.
When you are in the vertical (90°) you need to decide if you are getting too fast for the outside loop into inverted flight or not. This is the last chance to recover positive. So begin flying outside loops with a very low speed and push some more negative g´s to see how much speed is left to Vne. Never exceed the red markings on the g-meter or speed indicator! A aerobatic plane will not fall apart at once when it´s a bit overstressed, but for a longer lifetime and safety you should stay inside the limits.
See the speeds and negative g-loads on the screenshots. The highest speed and negative g-load you reach in the end of the figure.
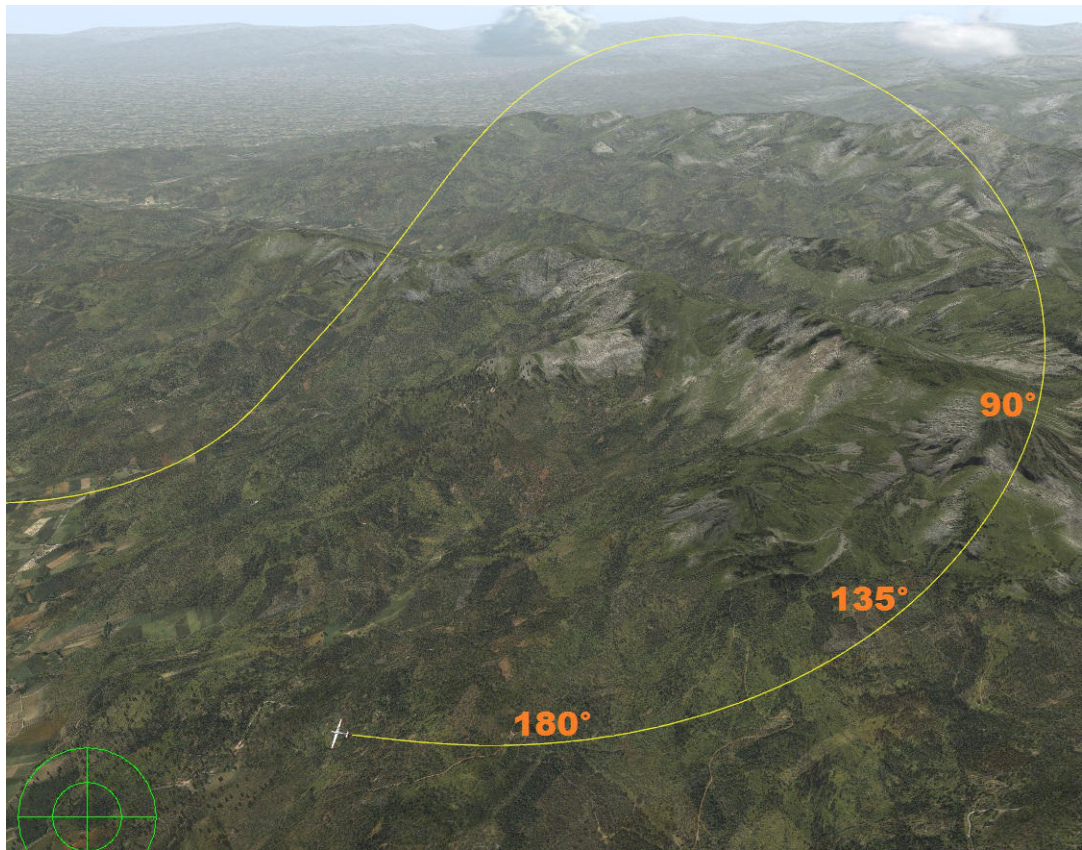
Figure 9: Stallturn, inverted Entry, upright Exit (13:46)

After the last figure you´ll surely be fast enough. Recommended minimum speed for this figure is 200 km/h. Push vertical up and handle the turnaround like described under Fig. 5. Watch out to the side to stabilize a good vertical downward line. The minimum speed for the final figure is 230 km/h.

Figure 10: 2/4 Roll 45° up, Pulldown to vertical Downline, Pullout upright (15:20)

The faster you fly into this figure, the easier it is. Pull up to 45°. Fly the 2/4 roll with large but not abrupt aileron-inputs. Stop the roll in knife edge position. You can move the rudder a bit to keep the nose on the 45° line but keep in mind that the rudder input causes a roll moment and the stop in knife edge might not be seen. So it´s safer for the beginning to fly the 2/3 roll with rudder in neutral position. Finish the roll after the stop. Here we fly an aileron roll. This means the 45° line before and after the roll must have the same length to get a good mark for the figure. After the 2/4 roll you are slow, that means you need to push the stick more foreward to stay on the line.
Pull from inverted flight into the vertical line and recover.

Finally...

I´ve shown very challenging aerobatic figures to you. If you have not much experiance with aerobatics don´t wonder if your first attempts will fail. It takes a lot of practice to fly those figures accurate, no matter if real or in the simulator.
I have chosen those difficult figures because they show the aerodynamic limits of real aviation and of the Vehicle Simulator.
So I have to say VSF is a flight simulator I waited many years for. I can try new figures with it, get them in my mind before I try them in the real plane and save a lot of training flights and money to reach the equal standard. Also new created aerobatic programs can be checked in VSF: It gives me clarity about positioning and orientation, I can see if speeds are matching to the following figures.... So for me VSF is much more than a game, that makes such a lot fun and gives so many possibilities to it´s players. VSF has really earned the name „Simulator".

Special thanks to:

Manfred Echter (Chairman for glider aerobatics in the CIVA), he gave me the correct translations for the 10 figures in my program.

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Förderverein für Segelkunstflug im BWLV (Aerobatic gliding club in south/west Germany): Thanks to this club I am aerobatic glider pilot and I have access to the best aerobatic

gliders ever made! Visit our website: www.segelkunstflug.com

Ilan Papini: Without him and his genious transfering reality into a simulator we wouldn´t have the Vehicle Simulator http://www.hangsim.com/vehicle-simulator/, MicroFlight www.hangsim.com/micro-flight/ (both work with the same physic engine, so you can install the Cirrus K and Lo-100 also in MF7 without disadvantages!) and some more nice programs you can find under www.hangsim.com.