Safe on the ridge

To be able to stay safe on the ridge the pilot needs to know about how terrain and weather conditions manipulate the airflow, be aware of the common traps and have the required practical flying skills to operate the aircraft accurately.

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The first part of this article focuses on what influences the strength and location of the best updrafts as well as the associated dangers and misconceptions that come with flying close to terrain. This knowledge is not only important for choosing the most efficient route on a cross-country flight, but only when we can predict what is happening, are we prepared. This results in fewer nasty surprises and increases our overall safety.

Terrain features such as the slope angle, shape, surface, height and the features upwind determine where lift can be found.
On a steep ridge the streamlines are also steeper and closer together meaning the expected updraft is stronger and closer to the hill in comparison to a shallow ridge. Inexperienced pilots often have the illusion that shallower mountains feel safer and therefore end up too close to the hill, while they tend to stay too far out from the steep but actually much safer ridge. It is the escape angle that is crucial in how close one can fly to a ridge – as demonstrated in ***picture 1***. Stay further out from a shallow mountain!

Assuming the wind is constant, a long straight ridge is not only easier to fly along but should also provide even lift all along. However, most mountains are more complex and so more challenging to follow. Conical and bend ridges mean that the wind blows around them providing no lift, same as at the end of the ridge. While in bowls the wind might get trapped and accelerated upwards in a local area, spurs, gullies and flat areas create turbulence which destroys the laminar flow and depending on the wind direction areas of sink. Stay out from the lee side of the spur to avoid the sink as shown in ***picture 2***.

Is the covering of the hillside rough – for example covered in trees – due to the resulting turbulent airflow near the surface, better lift is to be found further out.

Looking at the streamlines over a slope it becomes clear that ridges work in the upper half or third, while near or above the crest the climb rates drop off (***picture 3***). Depending on our altitude, we need to find a slope that is the right height – when we are low only a small hill will give us ridge lift not a big mountain. Once we climbed to the top of it, we can then head to a bigger slope and so step by step increase our altitude.

Also obstacles upwind set off turbulence or wave, which influences the lift on the downwind ridge – even when they are a long way apart.

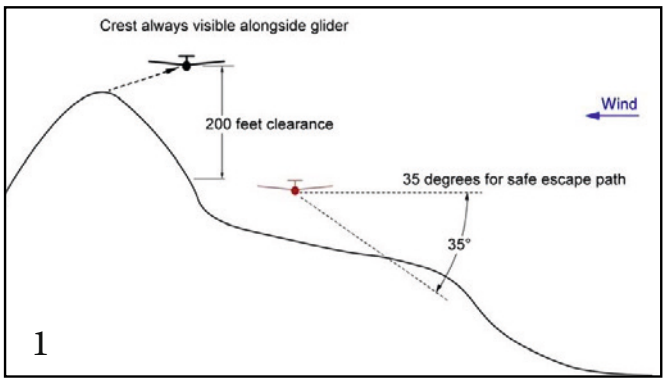
Other forms of lift and the wind itself have an effect on the airflow across the mountain.
The angle at which the wind hits the ridge, the wind speed and how the wind develops with height all influence the location and strength of the rising air. When the wind speed is constant with height the ridge can be expected to work all the way up. Great attention needs to be paid however, if there is an inversion close to the ridge top. As demonstrated in ***picture 4*** the inversion squashes the streamlines near the top together, resulting in sudden acceleration of the wind speed near the crest. Not only will the lift not exceed much beyond the mountain top but when the inversion goes unnoticed there is the hidden danger of getting blown behind the ridge unable to return to the upwind side or into it if the pilot decides to circle in that height band due to the sudden increased drift. Therefore, it is advisable on days with low inversion to be extremely cautious and not thermal anywhere near the tops. The same is true for gently rounded hill tops whether there is or isn't a low inversion.

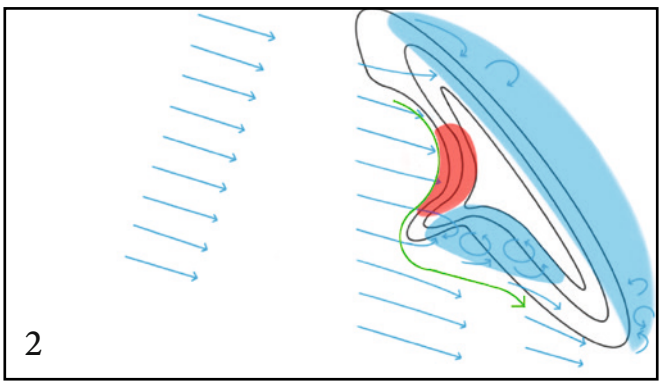
On most days a mixture of different forms of lift are present which all influence each other and so the lift on the ridge. The best climb rates can be found where the sun and the wind work in unison or where the wave is in phase with the ridge. When different kinds of updrafts work against each other turbulent conditions and weaker ridge lift will be present. For example is a ridge we expected to work giving us little or no lift, it might be that a wave is dumping on it. Therefore, it is important to not only focus on the micro details about what is happening at this ridge but also keep the bigger picture in sight too.

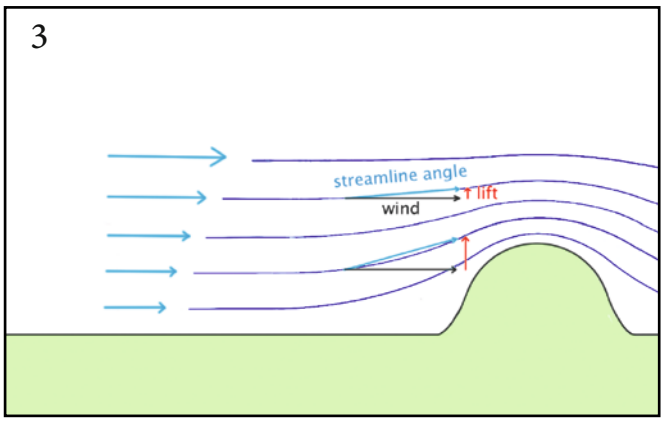
Optical illusions and lighting influence what we can or cannot see. We might get the illusion of a clear flight path while not seeing the spur sticking out close by because it blends in perfectly with the surrounding and background. There is a risk of seeing obstacles too late leaving not enough space to clear the terrain safely.

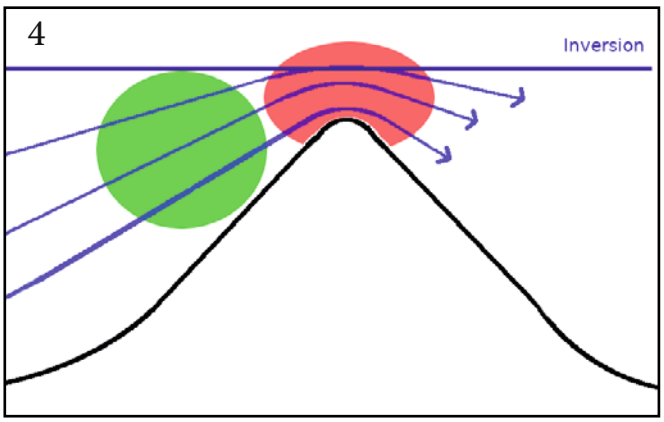
Also in poor light like when the slope is in the shade or on a hazy/ rainy day, it might be impossible for the pilot to make out the details of the terrain. It is not only hard to judge the distance from the hill but also to spot power-lines, cable cars or spurs (***picture right***).

Pilots new to mountain flying might make the mistake by unconsciously mistaking the side of the hill as the horizon when turning near mountain, meaning they raise the nose when heading towards the terrain and letting it drop when turning away from the slope.









1 Safe (black glider) vs unsafe (red glider) – the escape angle is key. **2** lightpath around a spur catching the lift (red) on the upwind side while staying further out to avoid the sink on the lee side (blue). **3** Airflow over a simple hil.l **4** extreme caution needs to be paid on days with low inversion as the air accelerates over the top.

In the second part of this article we explore the rules which enhance safety when flying with others. There is official rules for who as right of way and overtaking. Additionally some gliding clubs have their own guidelines for their local ridges which give you information about turnpoints, minimum heights etc.

The glider which has the right wing facing the hill has the right of way because they cannot move further to the right. The glider with the left wing to the hill has to divert into the valley (to their right) and let the other glider pass as shown in ***picture 5***. If you are the one who has to give way, alter your course early so the other one knows that you have seen them. In reality, if you suspect that the other glider has not seen you, but you have right of way, diving is the recommended option to avoid a collision.

Depending on the country there is different rules for overtaking. In the UK and NZ the faster glider has to overtake between the ridge and the slower glider, while in the European Alps the faster glider has to pass on the valley side. One should be especially careful when there is the risk of the slower glider altering its course at the same time.
Therefore one always needs to allow for enough space when overtaking on the valley side, in case the slower glider starts turning at the same time right in front of you. It might be safer instead of overtaking to turn earlier before reaching the usual turnpoints to create more space between both aircraft rather than trying to pass them.

A key to staying safe on the ridge when flying with others is to always maintain a good lookout especially when turning, minimize time flying in blind spots and fly predictably. Common sense applies – if you are uncomfortable with the traffic, leave the ridge. Maybe wait till they have out-climbed you and then return to join them underneath.

Tips on how to fly safely in the mountains are found everywhere but why are they crucial for our safety? In the final section of this article we look into the most common tools to make good decision as well as the necessary personal flying skills and explore the reasons behind them.

Choosing a safe speed
As a rule of thumb the speed we would fly the approach under the given conditions is the same we can fly close to terrain. This depends on our glider type, ballast, wind speed and a margin for gusts, turbulence or extra safety if the conditions are not very predictable.
We calculate the safe speed near the ground in knots by multiplying the stall speed by 1.5 and add half the wind speed plus 10 kts for safety/gusts etc.
What we consider and choose as a safe speed depends on our observations – what is the wind doing? How have conditions been so far – rough or smooth? We know we have approximately the right speed when we fly over the ground parallel to the ridge and our nose does not point massively away from the ridge – in other words the drift angle is not too big. When

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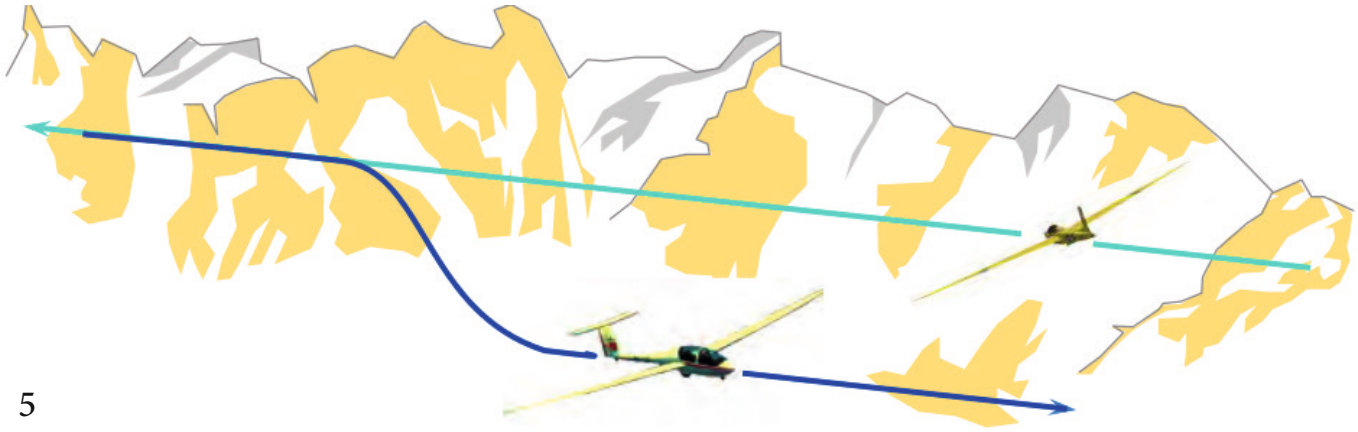

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5 Right of way for the glider which has its right wing facing the terrain (light blue). The other glider (dark blue) needs to veer to their right.

we approach a slope for the first time, we use a little extra safety which we can let bleed off after a few lapses when we are sure that conditions are smooth.

Fly accurately

Only when we fly precisely can we guess the wind drift and so how much space we need – for example for a turn. Flying accurately involves being able to fly a constant attitude for the chosen safe speed and flying a balanced turn.

We loose our horizon or might unconsciously fall victim to the illusion of mistaking the hillside for the horizon when flying close to terrain. Fluctuations in the indicated airspeed happen naturally due to the wind change from head to tail-wind when we turn but also when hitting a thermal or turbulence. It is therefore important to not chase the airspeed indicator. Instead imagine where the horizon would be if the mountain was not there, keep the attitude (position of the nose in relation to the imaginary horizon) constant and check the speed occasionally.

We enter into a coordinated turn using stick and rudder together. The string should not deflect to the inside of the turn as this would indicate a skidding turn which makes the glider significantly more prone to a wing-drop stall. We can optionally use a bit of top rudder which deflects the string slightly to the outside of the turn. This slightly slipping configuration is safer since the glider is more stable.

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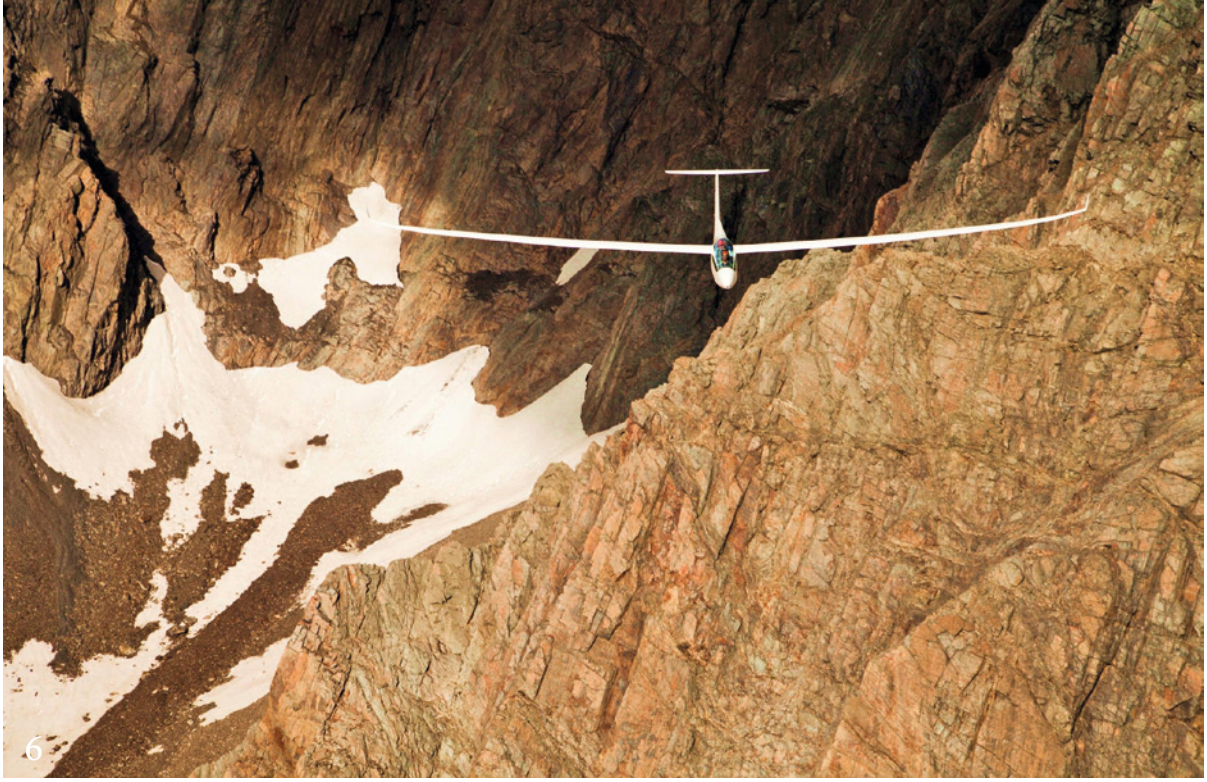


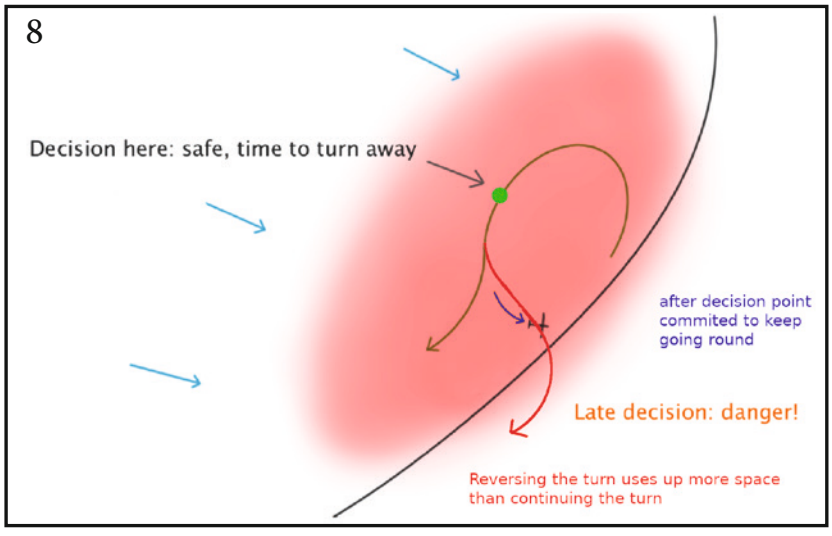
6 On a steep slope a glider pilot can fly in closer.

Appropriate distance to terrain

While we compensate for drift by pointing the nose into wind, it is important to fly parallel to the ground and not to drift closer in without noticing, because only then can we estimate the wind speed and if our safe speed is sufficient. Which minimum distance we need to keep to stay safe varies even in the same conditions from slope to slope, depending on the angle we need for our escape route, which should be 35° or more. In general, we stay out further in strong and gusty winds, to avoid obstacles, when we cannot guarantee smooth conditions, on shallow ridges and also depending on our own flying skills (***Picture 6 and 7***).

Avoid circling near terrain

Even experienced pilots should do a couple of figure of eights to get a feeling for the drift. When you decide to thermal make the decision early – as illustrated in ***picture 8***. Have you got enough space even if the lift turns into sink? Only go



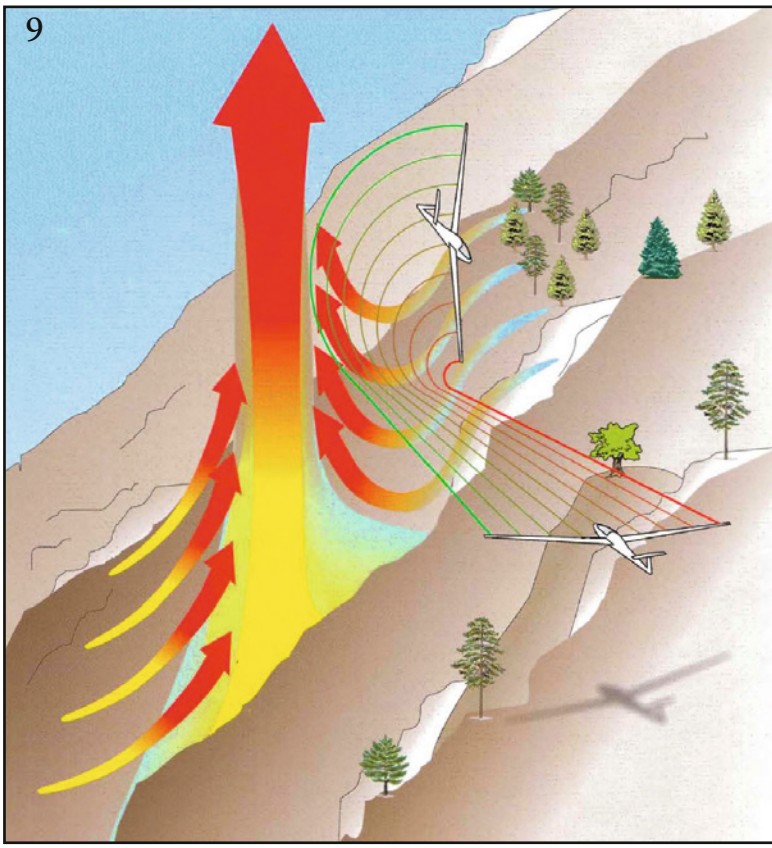
8 Make decision early (at the green point). Once decided to keep thermalling one is committed (blue) as reversing the turn will require more space (red).

7 Shallow hills might appear safer but one needs to stay further out to be safe.

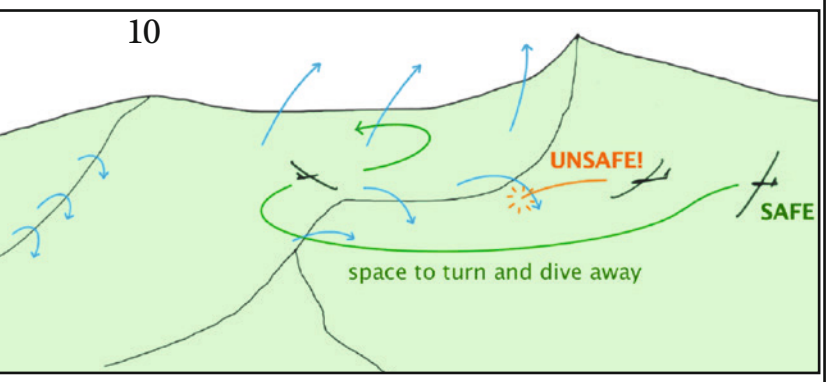
round if you are absolutely sure, otherwise continue with figure eights. Reversing the turn requires more space. Therefore when one is past the point where the glider flies parallel to the ridge (green dot), one is committed to finishing the turn. Thermalling beside the hill or just above the crest requires great concentration and is only advisable for experienced pilots who can fly extremely accurately, on calm and predictable days with no inversion near the tops.
In some countries the guideline exists that thermalling should only take place when the glider has climbed 200 ft or more above the peak.

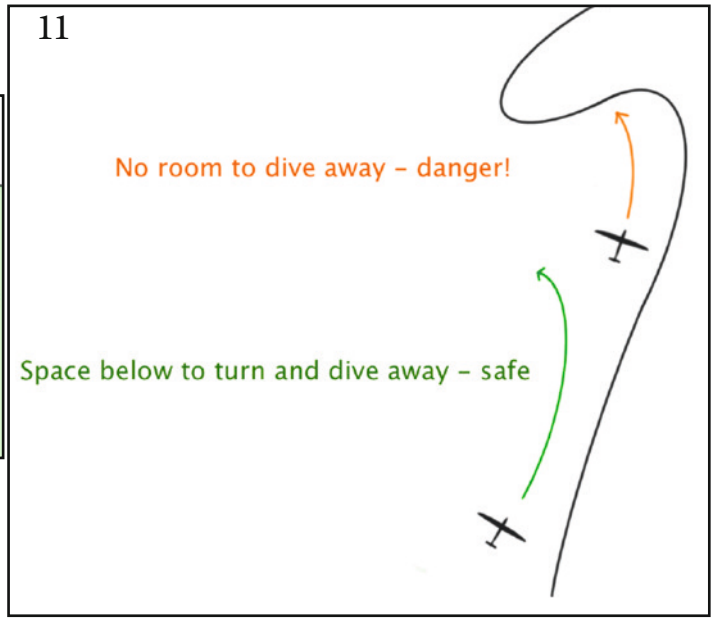
Always have an escape available

When mountain soaring it is essential to have an escape option available to us at all times even when we hit severe sink or the headwind/ drift is stronger than expected.
For starters this means that we never start changing our course by turning towards rising ground. We always start by turning away from the hill, because we follow the terrain as it drops away. Should the anticipated lift then turn into sink, we will continue to have plenty of space between us and the mountain below.
For example at the end of a laps it is OK to use a tight radius to initiate the turn but roll the wings level with a shallow AoB (angle of bank) Using only a little bit of bank when reversing the turn leaves the pilot a safety margin to tighten up the turn by using more AoB. should a thermal roll the glider towards the hill or the drift be stronger than anticipated (***picture 9***).



9 A strong thermal can roll a glider towards the hill.





10 Safe (green) flight path around a spur which leaves easy escape options available as seen from the side.
11 Safe (green) vs unsafe (red) flight path as seen from above.

Approaching terrain – this includes spurs – at a shallow angle means that a small change in direction will create a significant ground clearance in a short time. So it is wise to avoid heading perpendicular towards any obstacles, since this will require a much greater alteration in course and more time before we are clear of terrain as demonstrated in ***picture 10 and 11***.

Becoming aware of setting up inadvertently the perfect spin entry

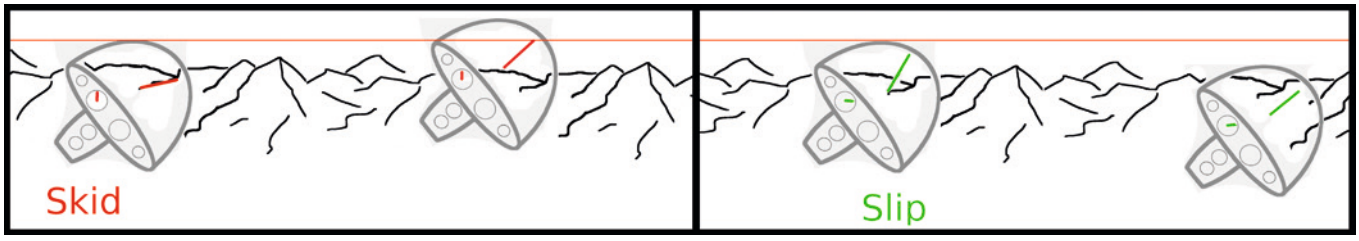
Stalls and spins are so treacherous because pilots are often unaware of the danger they are in. Hopefully with the description below, you will be more aware of the hidden traps, look out for the warning signs and know what to do to stay safe.

It is usually a mix of causes creating a dangerous situation. Potential factors which increase the likelihood of a stall near the ridge are:

- not leaving enough margin for gusts and other eventualities by choosing a too low safe speed
- more wind drift than expected and making decisions too late resulting in running out of room to escape
- unbalanced, over-ruddered turn increases the risk of getting a stall on one wing, because the nose will appear to in the correct position due to too much rudder it gives the pilot a false sense of safety (***Picture12)***
- hitting sink instead of lift meaning losing height and not having enough space to the terrain
- not flying a constant attitude

Let's look at how those factors create a perfect set up for a spin using the following scenario: We are turning near the hill and find ourselves getting too close to the hillside either because the thermal is not as strong as or because the drift is stronger than anticipated. We attempt to keep the distance by increasing the AoB to reduce the radius. We miss to notice

12 The hidden danger in a skidding turn: the attitude appears normal. Only when the skid is corrected will the nose-high attitude and the low speed become apparent; when correcting a slipping turn the nose will come down – meaning the glider in a slip has a higher speed than what it seems.



that because the ground comes closer, we over-rudder the turn using not enough AoB for the radius and instead "kick the glider around" with the into-turn rudder. In this skidding configuration our attitude towards the horizon seems to be OK. In reality, because of too much rudder, we are actually much slower than we think and are unaware of it. As the terrain comes now even closer and our escape path gets narrower we might unconsciously or due to illusions raise the nose a bit more. And voila we find ourselves in a wing-drop stall.

Luckily there is plenty of options to avoid such a scenario. In the first place, obey the rules for flying safely in the mountains and fly accurately.

Should you find yourself in an emergency situation use ALL the space available to you but make sure your speed is OK. The speed is what keeps your aircraft controllable. So even when it is really scary, it is better to be a meter away from the rocks but the glider is flying, than it is to be 100 m above the hill but due to low speed in a stall configuration because you have pulled the speed out.

Even at higher speed a stall is still possible when the G-force caused by a strong gust or thermal suddenly increases. As soon as you find your controls are a bit sloppy or if you think you stalled move the stick centralized forward. Any aileron movement near a stall might create a wing-drop stall in the opposite direction because to angle of attack increases further on that wing. Do not attempt to pick up a dropped wing before you have not gained safe speed first. Remember: nose down first and wait, then correct direction of travel and increase your chosen safe speed for the rest of the flight to avoid another stall.

Fly by your own safety margins

I wish to finish this article by stating the most obvious and yet, in my experience with students often the most fundamental part of flying safely in the mountains: Use your own judgment to decide if something is safe for you or not. If it makes you feel uncomfortable – like too much traffic, poor light, turbulence or strong winds on a ridge - leave it. Do not follow others blindly. Just because you see somebody else doing it does not mean it is safe for you – or even for them – to do so. Fly to your own standards! ♦