# LESSON 1 – THERMALLING TECHNIQUES

# How fast to fly?

- Primary object is to get to the top of the next thermal as fast as possible. The same requirement applies to both competition flying and cross country flight.

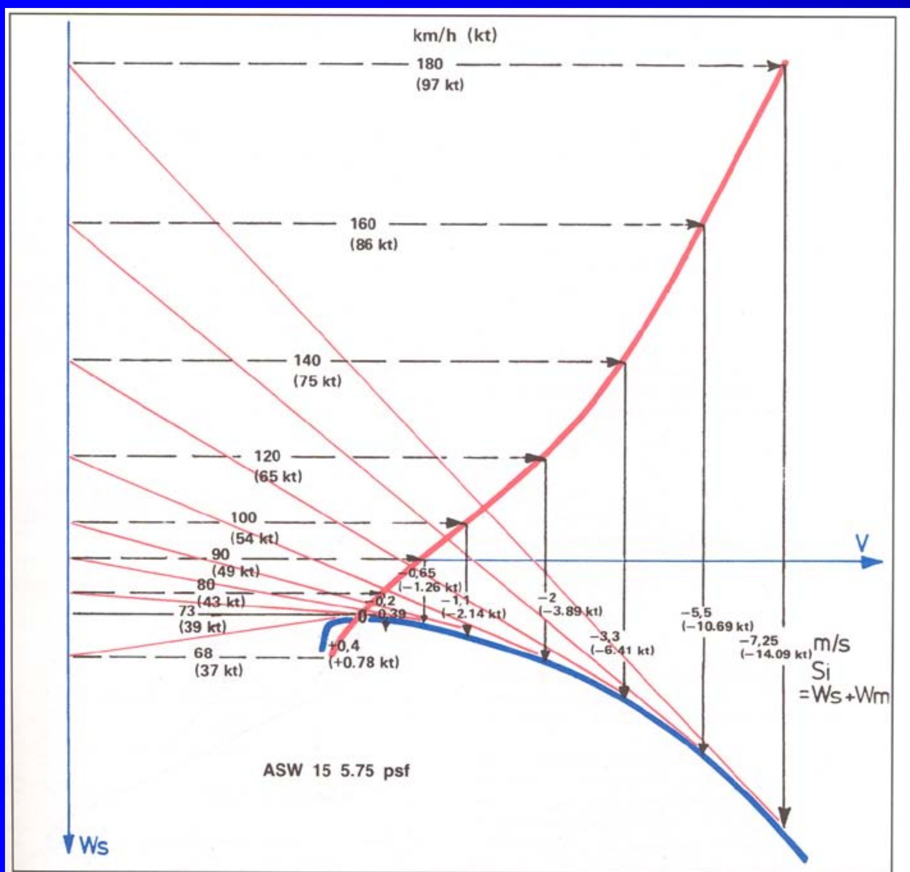
- Optimum inter-thermal speed depends on average rate of climb for the NEXT thermal plus the instantaneous sink rate of air. Speeds?.

- McCready setting should be the average climb rate for the complete thermal; about half the perceived climb rate

- Adjust McCready setting depending on height. Be conservative when low.

- Constantly be alert to changing conditions and be prepared to change gear

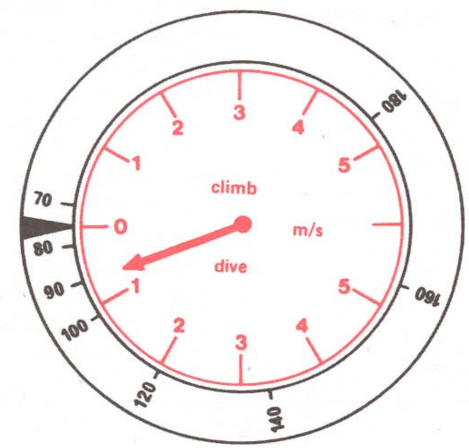
# Mc Cready Speed-to-fly theory




Speed-to-fly ring

ASW 15, 5.75 psf
Speed-to-fly table
expected climb of zero

| Speed-to-fly V in km/h (kt) | Sink Si in m/s (kt) |
|---|---|
| 180 (97) | − 7.25 (−14.09) |
| 160 (86) | − 5.3 (−10.30) |
| 140 (75) | − 3.3 (−6.41) |
| 120 (65) | − 2 (−3.89) |
| 100 (54) | − 1.1 (−2.14) |
| 90 (49) | − 0.65 (−1.26) |
| 80 (43) | − 0.2 (−0.39) |
| 70 (37) | + 0.25 (+0.49) |



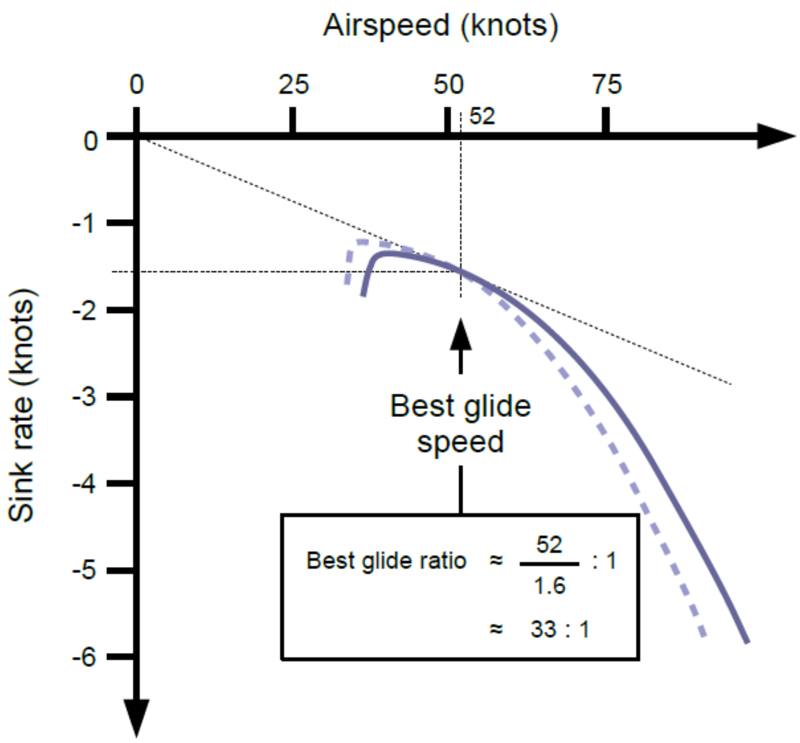
# Water Ballast

## [ Water ballast ]

1. Increasing the mass of a glider, by for example adding water ballast, shifts the glide polar down and to the right.

2. The minimum sink rate is therefore increased, so as you would expect, the extra weight makes it harder to climb in thermals.

   However the best glide ratio remains approximately the same, but now occurs at a higher airspeed. Therefore if the thermals are strong enough to compensate for the poor climb performance then water ballast allows a faster inter thermal cruise.



# Speed to Fly

- Often one of the biggest challenges is deciding just what speed or McCready setting to use to get to the next thermal and climb at the fastest overall time.
- Firstly, if you use a McCready setting within 25% of the ideal, you will incur a small delay from the optimum.  If the next thermal is 5 knots and you set somewhere more than 4 or less than 6, all is well enough.
- However, on a weak day the 25% rule becomes more critical. This means that if the next thermal is 2 knots then you must be within 1.5 and 2.5 or you will be inefficient/slow and tail end Charlie on the score board.

# Competition Flying

- It is important to have the right mind set for competition flying and this starts a couple of weeks before the first day. Be positive and that we always flying within our competency. Be motivated (I usually have a new music CD) and start thinking about cross country flying and the possible decisions which are going to be have to be made. There will be challenges but no undue risks. There is a high chance of landing out if the task setter, met man or we get it wrong! You should now understand reading the sky and practised at club level all the techniques that you might be called on to use, you need to understand the maps and an understanding of both the competition rules and local competition airfield rules.
- The glider, paper work, parachutes, batteries, chargers and trailer are correct and your crew know what you expect of them.
- The first day can be quite daunting so arrive in good time the day before and if the weather and opportunity is offered fly or at least rig if the weather allows to ensure you have everything!

# Racing

Remember that the competition is a race and it is about fastest average speed, not survival! Although far too often it seems there is a need to survive most tasks set in this country! If anyone finishes the task, then you must be that person. 600 points to complete the task and the rest (400) are speed points, so the fastest finisher scores 1000 points.

It is more important NEVER FLY TOO SLOW IN SINK than to fly too fast in lift.

Street flying allows high average speeds and occur especially when there is10-20 knots of wind to penetrate, therefore the glider needs to be at max weights to optimise into wind legs (and the glider flies further at high speed if heavy) and ballast must be entered in the LX for the correct polar curve.

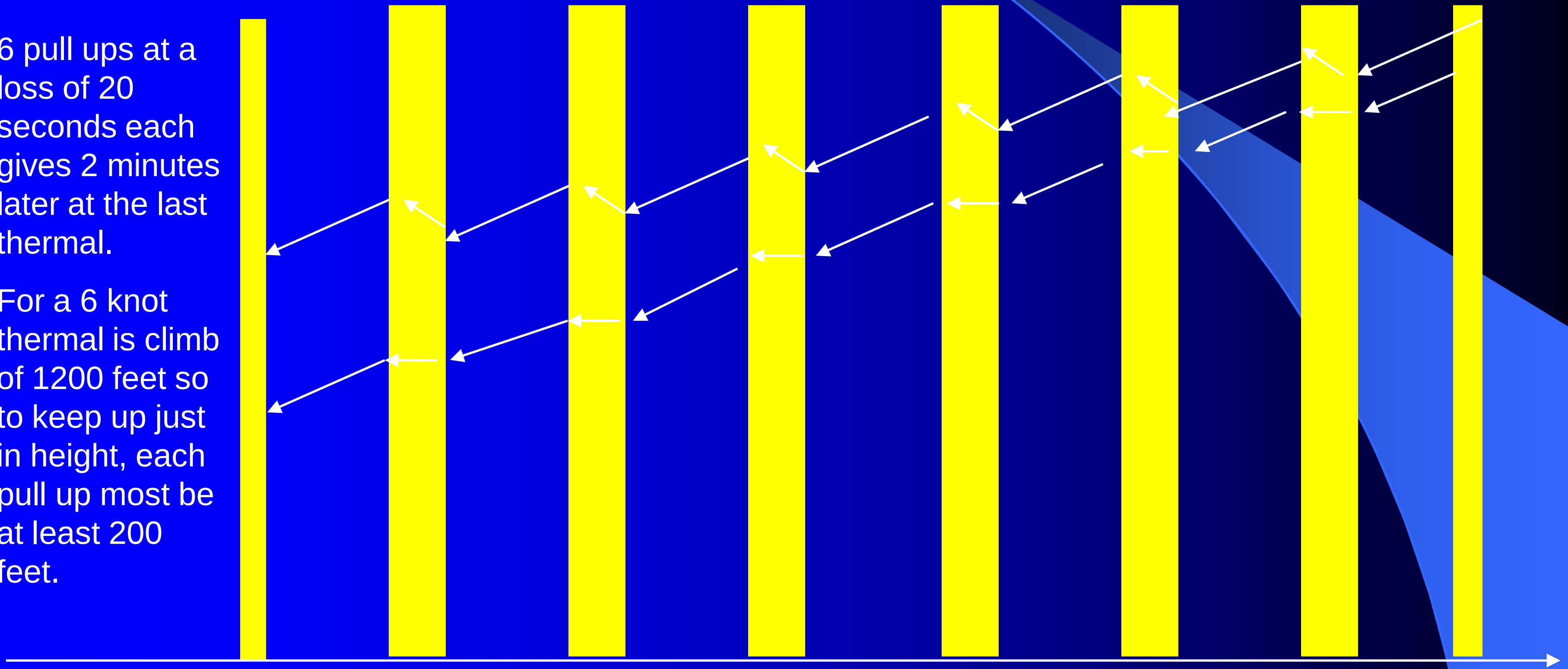
Meanwhile non street flying needs climbs to be made in only the strongest thermals and will often demand significant differing cruise speeds on each glide. The glider C of G is important (rearwards). You can only cruise at the McCready speed of the NEXT anticipated climb rate and you do have to make it to that next thermal. Climb rates must include all parts of searching turns etc. Watch out for spread out, gaps and high cirrus cooling the day down, but always start at max weight if you can get it up there.

# Dolphin

- **Another misnomer**
- **Following the MacCready religiously, it is efficient but slow.  Like driving a formula one car for best fuel efficiently does not win races.  All these little climbs are at nearly half the cruise speed and if any accelerations are late then it is a case of accelerating in sink – huge mistake.  Simply use the lift as a gymnast uses  a spring board. A gentle short pull up and bounce to maintain never less than 20 knots slower than cruise.  More commonly only about 10 knots.**

6 pull ups at a loss of 20 seconds each gives 2 minutes later at the last thermal.

For a 6 knot thermal is climb of 1200 feet so to keep up just in height, each pull up most be at least 200 feet.



If you want to think about how much time is lost, try driving down the motorway and slowing down from 80 to 40 every couple of minutes!  Hopeless!

# SPEED!

| Manufacture Model | Wing Span (m) | Wing Area (m²) | Wing Loading (kg/m²) | Max Water Ballast (Litres) | Reference Weight when polar data was measured) (Kg) | Max Glide Ratio | Best L/D Speed (km/hr) (knots) | (Speed at which polar crosses 2 m/s of sink) (km/hr) (3.7 Knots) | Handicap |
|---|---|---|---|---|---|---|---|---|---|
| K 21 | 17 | 17.95 | 31.75 | 0 | 570 | 33 | 90 (45) | 157 (78) | 85 |
| **Discus b** | **15** | **10.58** | **30.72** | **184** | **325** | **42** | **100 (50)** | **170 (85)** | **98** |
| | | | | | | | | | |
| LS 8 (18) | 18 | 11.5 | 32.2 | 180 | 370 | 48 | 90 (45) | 170 (85) | 106 |
| Discus 2c | 18 | 11.39 | 33.1 | 200 | 377 | 48 | 108 (54) | 170 (85) | 106 |
| | | | | | | | | | |
| **LS 8 (15)** | **15** | **10.5** | **34.29** | **180** | **366** | **44** | **112 (56)** | **172 (86)** | **100** |
| Duo | 20 | 16.4 | 38.29 | 201 | 628 | 45 | 128 (64) | 181 (90) | 101 |
| ASG 29 | 18 | 10.5 | 33 | 195 | 388 | 52 | 105 (53) | 183 (91) | 111 |
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| **Duo** | **20** | **16.4** | **38.29** | **201** | **628** | **45** | **128 (64)** | **181 (90)** | **101** |
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# SPEED

- Three aspects slow us down;
- 1 Saturday afternoon flying techniques.

  2 Poor decision making.

  3 A non competitive attitude.

- Consider specifically why we might be slow around a task?

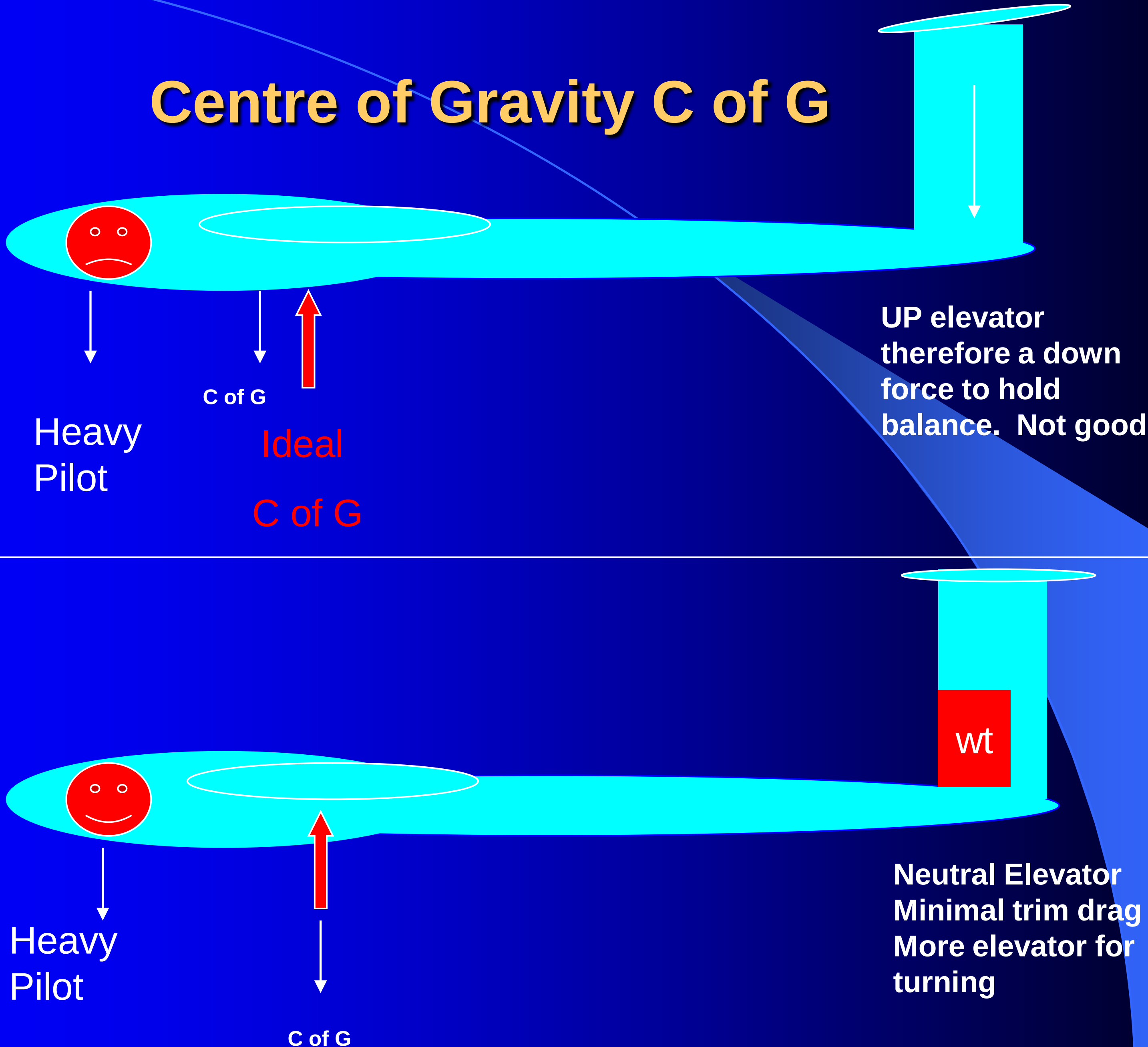
# Time Lost

- Initially it would appear obvious where 'we' think we lost time but look more closely at all the contributors and it becomes clearer.
- A poor start.  (Slow + low + not at max weight + poor line)
- A poor time to start. (too early or too late)
- Flying too cautiously. (slow cruise speeds)
- Climbing in weak thermals.
- Dithering at making decisions. (wasting time)
- Flying slow when you should be fast.
- Flying fast when you should be slow.
- Struggling to centre. (tired, distracted, poor techniques)
- Poor flying in thermals. (fast + shoddy sideslip)
- Poor Thermalling. (not in it)
- Poor link lines. (on track in bad air and not off track and linking the thermals)
- Over dolphin. (slow)
- Poor discipline at turning points. (flying further than the task)
- High at into wind turn points.
- Low at down wind turn points.
- An overly cautious final glide.
- Pressing on when you actually need to survive.
- Giving up.
- If all of the above, it becomes disturbing.

# Speed Verses Angle of Bank
# Turn Radius Achieved in Metres
# BANK = SPEED Elevator often fully up!

| | 40 kts | 45 kts | 50 kts | 55kts | 60 kts | 65 kts |
|---|---|---|---|---|---|---|
| 35 | 61.7 | 78.1 | 96.4 | 116.6 | 138.8 | 162.9 |
| 40 | 51.5 | 65.2 | 80.4 | 97.3 | 115.8 | 136.0 |
| 45 | 43.2 | 54.7 | 67.5 | 81.7 | 97.2 | 114.1 |
| 50 | 36.3 | 45.9 | 56.6 | 68.5 | 81.6 | 95.7 |
| 55 | 30.2 | 38.3 | 47.3 | 57.2 | 68.1 | 79.9 |
| 60 | 24.9 | 31.6 | 39.0 | 47.2 | 56.1 | 65.9 |

# Centre of Gravity C of G



# Wasted Opportunity Climbing

- Imagine climbing in your thermal with 45 degrees of bank and 45 knots dry / 50 /55 knots wet (50/55 degrees of bank) in perfect BALANCED flight.
- Will this really give the best rate of climb?
- Well the answer is categorically NO.
- In a turn keeping the string straight actually has the rest of the glider in a small side slip which is producing lift – downwards.  This in itself is a bad thing.

# Wasted Opportunity Climbing

Exaggerated picture.

Turn radius is about 60 metres.

Distance along the fuselage is only about 2 metres from the string on the canopy to the centre of pressure on the wing.

1:60 rule means 1 metre at 60 metres is equivalent to an angle of 1 degree.

So small as to be unimportant as the side slip is therefore only 2 degrees.

HOWEVER!

# Wasted Opportunity Climbing

It would clearly appear that you need the string pointing out to the high wing by 2 degrees.

But can we do better?

On a normal 300 km day we need about 30,000 feet of climb.

If we can climb just 5% faster, so 4 knots becomes 4.2, on every thermal then we save 1500 feet of climbing time.  At 4 knots then that is 4 minutes faster or 12 kms further down track in the same time.

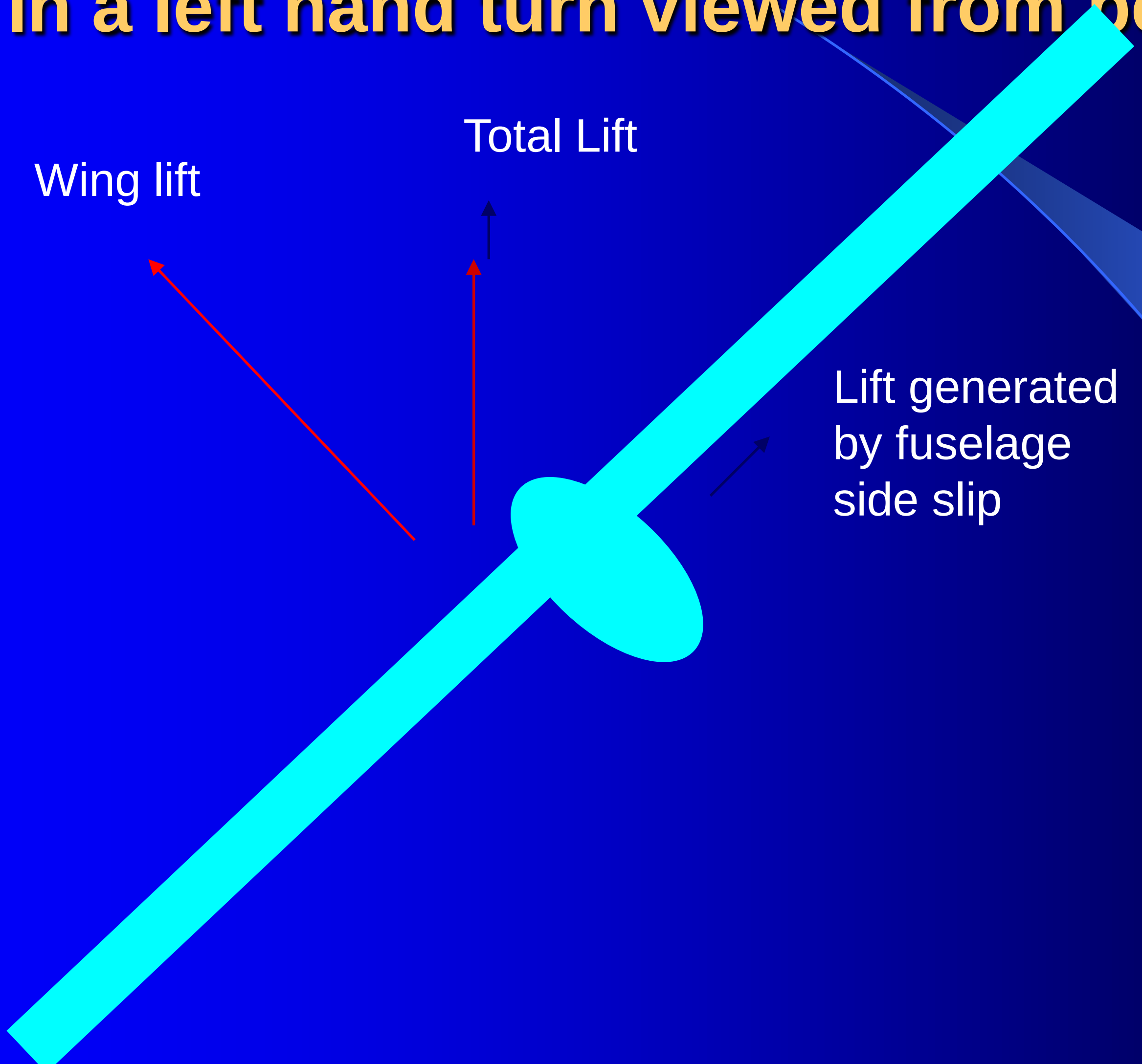
# Wasted Opportunity Climbing
# In a left hand turn viewed from above


**Viewed from above the fuselage is in the shape of a symmetrical wing. It is an aerofoil viewed at any angle. Therefore if we apply a positive angle of attack to it, it will produce lift off the fuselage, which actually has about two thirds the surface area of a wing (but sadly not that efficient!)**

**So the question is how much side slip should we use? This depends on a few things but a simple rule of thumb is the tighter you turn (the fuselage is more on its side) and the stronger the thermal, the more sideslip, but not beyond the limit of efficiency. The actual optimum is 15 degrees but the string will exaggerate this.**

**To find out just how far we can go on a smooth flat day simply fly straight and monitor the increase rate of descent on the vario as you fly more and more out of balance. The 'limit' will be obvious and the same right or left. Now practice turning with the string held just short of the limit towards the top wing.**

# Wasted Opportunity Climbing
# In a left hand turn viewed from behind

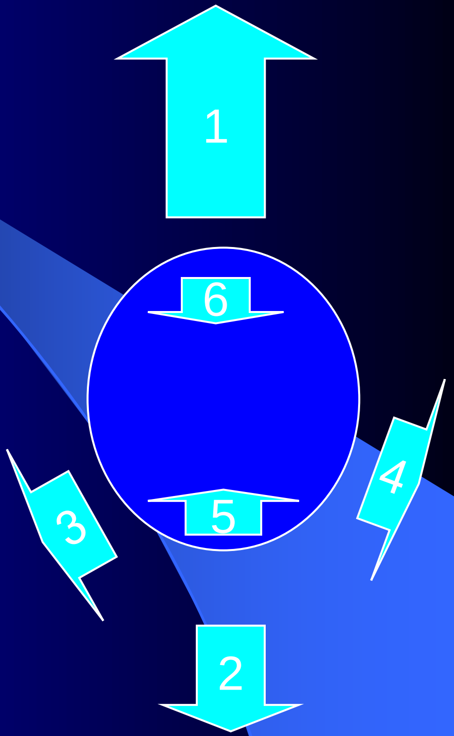


# Wasted Opportunity Climbing Whilst entering a thermal

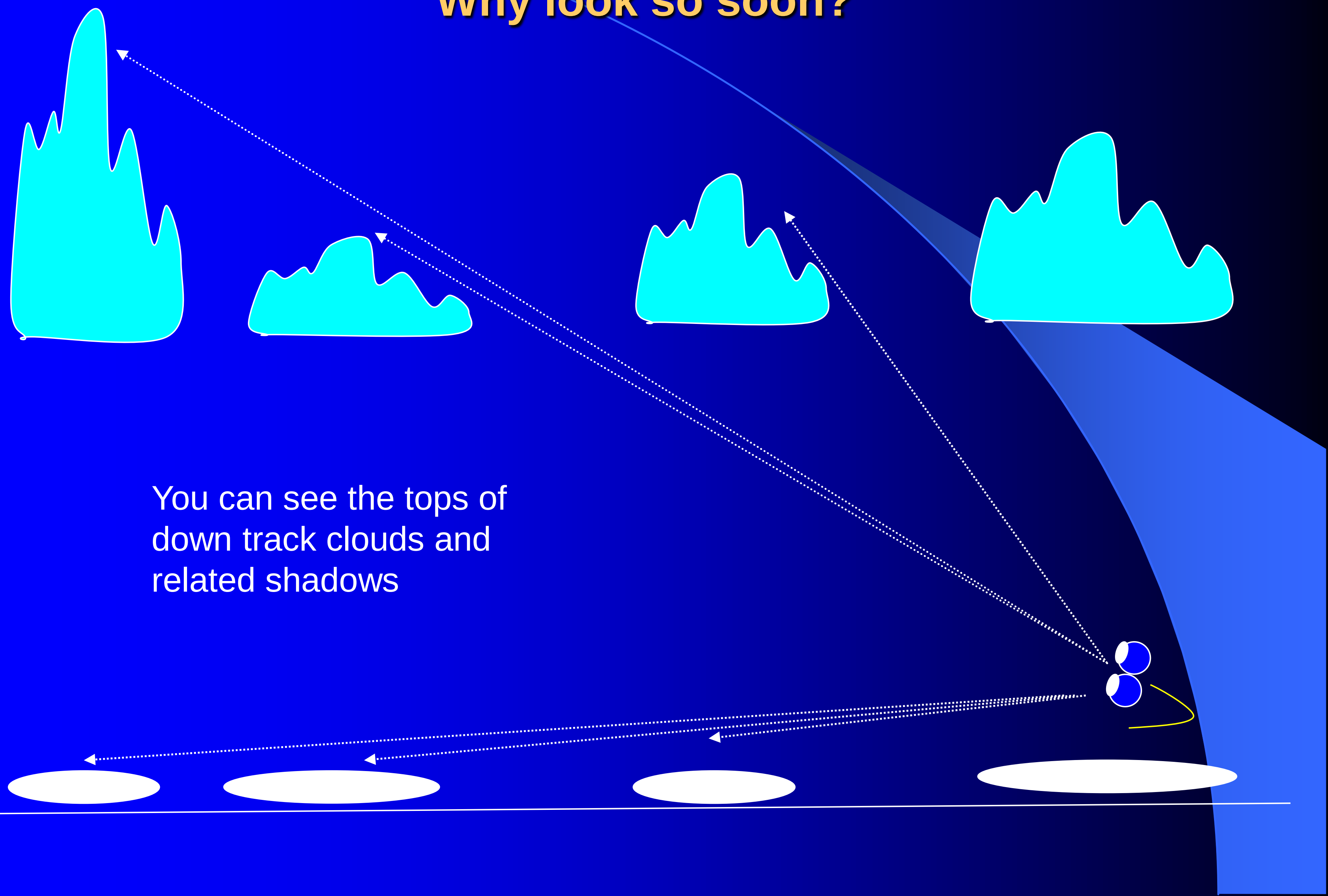
- Finally with all this in mind as you enter a thermal which is strong enough to justify stopping and turning in, then as speed reduces towards the end of the pull up and roll allow the glider to slide out of balance, by using too little rudder.  This means that you finish entering the turn under-ruddered and then maintain it even whilst centring, so long as there is a significant angle of bank the lift generated by the fuselage is beneficial.

# Time lapse lookout!

- In normal flying our lookout emphasis is correct in looking for hazards, especially other flying machines.
- However, to read the sky you must include all those aspects which give a clue as to the energy lines on the task route.
- Having established that you are going to stay and climb in this thermal, (if newly established in a thermal look for and relate to birds and other gliders) then you now have to start thinking about where next.
- To stay orientated use the biggest unique feature down track.
- Point 1; On track. Cloud shadow and how they relate your position
- Point 2; Where you came from and compare.
- Point 3 or 4; Sky on next leg.
- Point 5; Down. Possible thermal source and gliders below
- Point 6; Up. What the cloud your climbing under looks like and where the best position appears to be.
- It takes 7 seconds to fly a quarter of a turn!

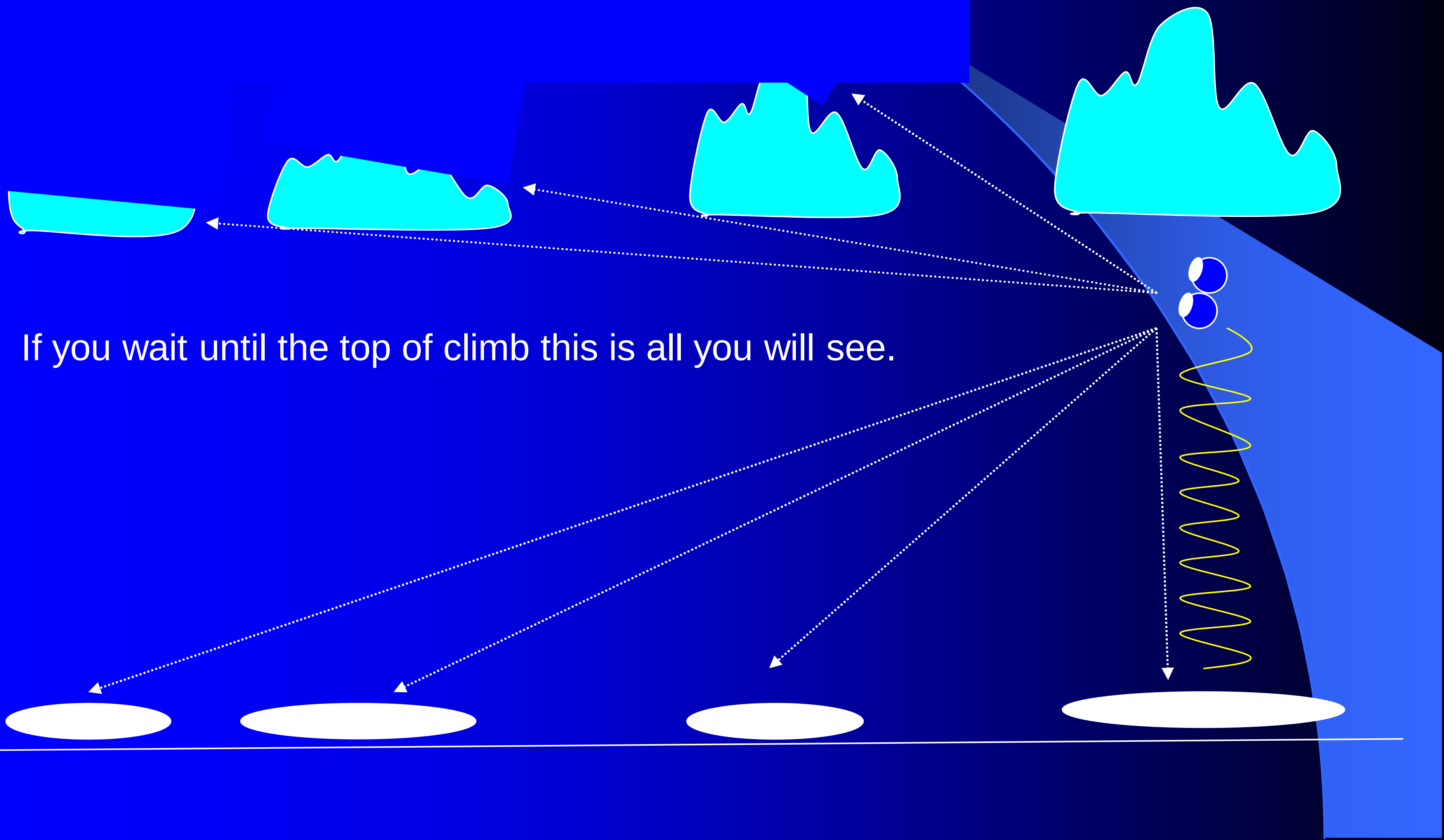


# Why look so soon?



You can see the tops of down track clouds and related shadows

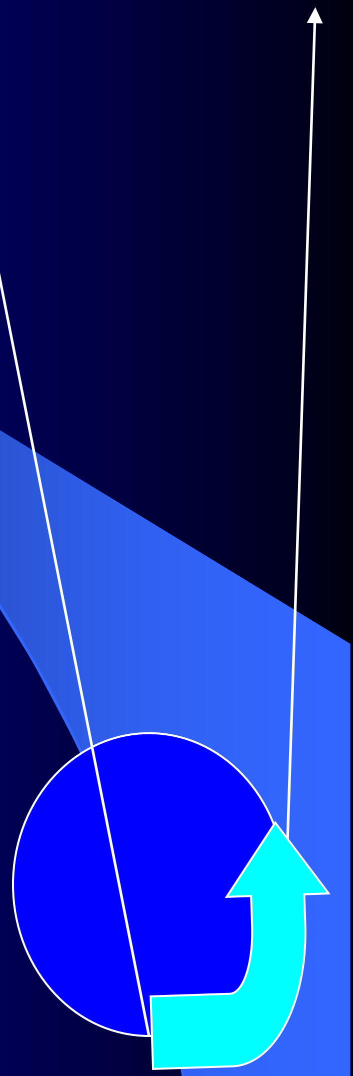
# Why look so soon?



If you wait until the top of climb this is all you will see.

# On track features

- Cloud, height of tops, shape, and change along with possible streeting.
- Cloud shadow and how they relate to the good clouds, track and an estimate of distance.
- Sunny and hot spots on the ground.
- Other gliders.



# Behind you

- Look back and view the clouds / line you have just flown, especially if one of your subsequent tracks will go in that general direction.
- Other gliders joining.

# Top of climb

- Consideration for the thermal exit starts as you enter at the bottom with a confirmation of the visual features which you can use to ensure that if you reject the thermal then you know immediately where to point after the waffling 'S' around.
- At the top of climb you need to set off on the correct heading and at the correct speed. Use the height of cloud tops to help here.
- 5 turns to go pick 2 visual ground features for track. One near and one far.
- 4 turns to go pick the 2 or 3 energy lines which could be taken, relative to your ground track features.
- 3 turns to go identify the best route.
- 2 turns to go confirm with cloud shadows and airspace restrictions.
- 1 turn to go look for gliders on your chosen route.
- Now go! And check no high cirrus or spread out shadows.
- If it takes about 20 seconds to do a turn and you are climbing at 6 knots then this process starts 1000 feet before the thermal exit!
- Now think through in your mind the thought processes for a blue day!

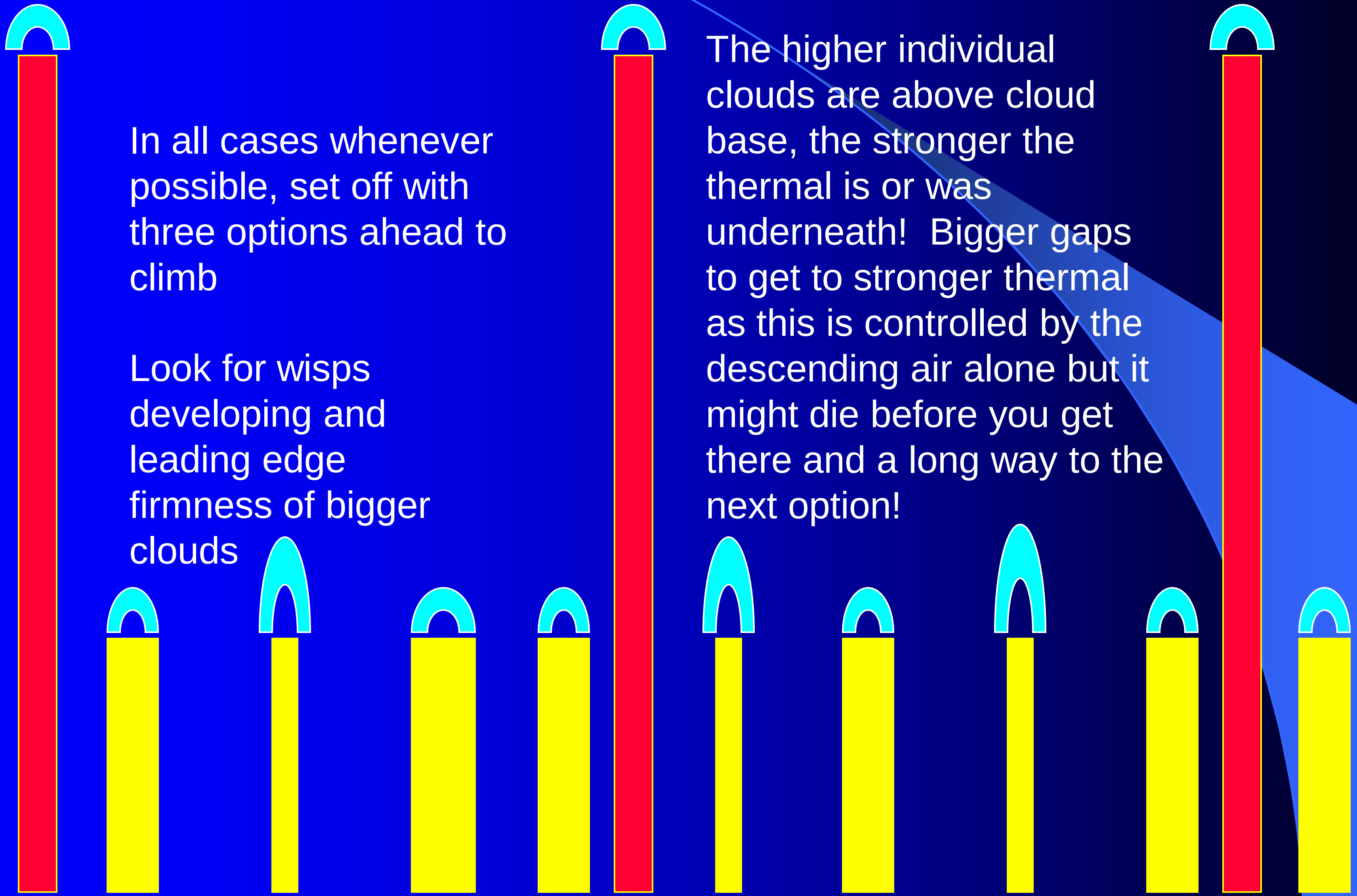
# Top of Climb Blue day

- The problem on a blue day is that it is all relative to ground features and the inversion/wind.
- An inversion is like a cloud base except that approaching the top of the thermal the strength will reduce and this can be anticipated.  Thermals can be quite strong low down but diminish with height and can become wide.
- 5 turns to go (before the inversion top) pick 2 visual ground features for track.  One near and far.  Ideally these will be the same as you pick for item 4 turns to go.
- 4 turns to go pick the 2 or 3 strong looking ground features for thermal production.
- 3 turns to go pick the 2  energy lines  which could be taken, to get you to your next thermal source and really look at the wind and possible street lines to get you to your next anticipated thermal sources or route via any strong looking ground sources.
- 2 turns to go identify the best route.
- 1 turn to go look for gliders on your chosen route.
- Now go!
- Occasionally you can get cloud wisps.  If you do it is often worth climbing higher and accepting the lower rate of climb because the visibility at the top improves and you can see the next wisp and strongest thermals ahead.  Once you sink back down into the inversion though they won’t be visible any more so fly accurate headings.

# Get High Stay High

- This is a common held view but not always true and can be bad on an into wind leg.
- The thermals might weaken at height so that would be pretty safe but pretty slow really.
- No doubt you will have heard also of the ‘set 4 knots on the MacCready above 4000’ and then reduce it to 3 above 3000’ etc.
- To me this also makes no sense especially as at 5000’ you get a 9% advantage on true airspeed so 80 knots is actually 87 knots true speed.
- Down at 2000’ 80 knots is 83 knots true speed.
- Pick a speed for the next realistic thermal strength and go.
- Remember that every time you move the stick or rudder you are using energy, either loss of height or loss of speed and what is often forgotten - loss of smooth laminar flow (wing efficiency).
- Whilst the LX does give an indication of the wind speed and direction, It does not relate this information to the height required for the task except on final glide. It is therefore only accurate on task if there is no wind. Other programs like ‘see you’ adjust the whole task for wind.
- Therefore only gives you the speed to fly as set by the McCready value in nil wind (plus any ballast, bug inputs and safety height). So canter into wind (add either speed or McCready) and float (fly a bit slower) down wind.
- More of this later.

- Weak days and low cloud base, often poor visibility. Thermals are close together. Fly light and very smoothly often close to best glide. Decision making not critical but you must press on.
- Strong days and high cloud base, big gaps, decisions actually more critical.



In all cases whenever possible, set off with three options ahead to climb

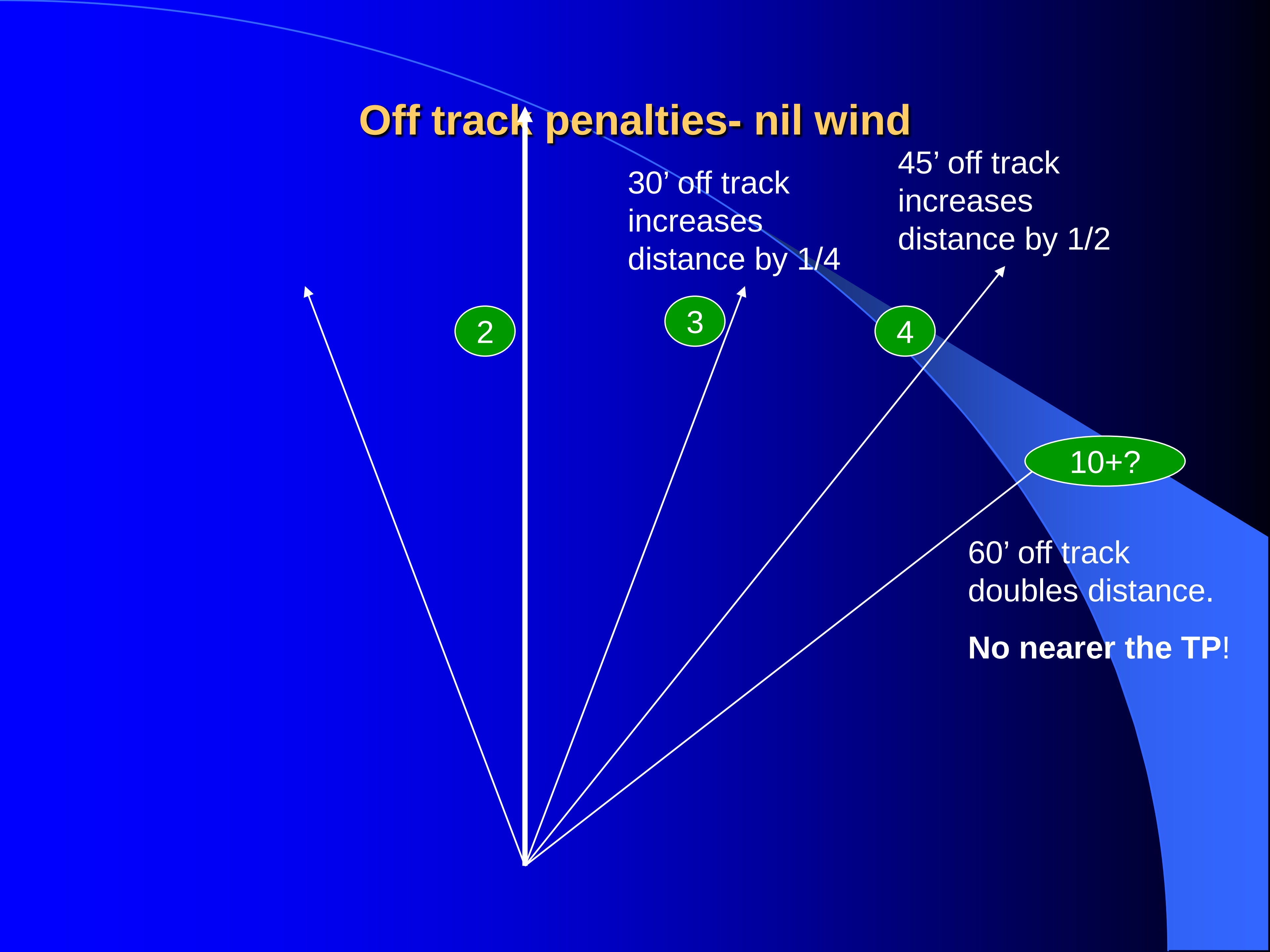
Look for wisps developing and leading edge firmness of bigger clouds

The higher individual clouds are above cloud base, the stronger the thermal is or was underneath! Bigger gaps to get to stronger thermal as this is controlled by the descending air alone but it might die before you get there and a long way to the next option!

# Efficient Climbs?

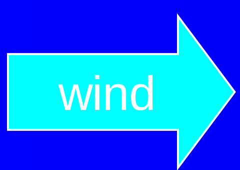
- The simple solution is to climb after long glides. The reason is because of the time lost finding and centring on each climb.
- If you take one turn (30 seconds a turn) to centre on a 4 knot (400'/min) thermal and then do 3 turns climbing (2 minutes total time) (600' in 2 minutes) your average climb becomes 3 knots.
- If you take one turn to centre on a 4 knot thermal and then do 12 turns, (6 x 400' = 2400' in 6 ½ minutes) your average climb becomes 3.7 knots. Overall them about a 20% improvement in average climb.

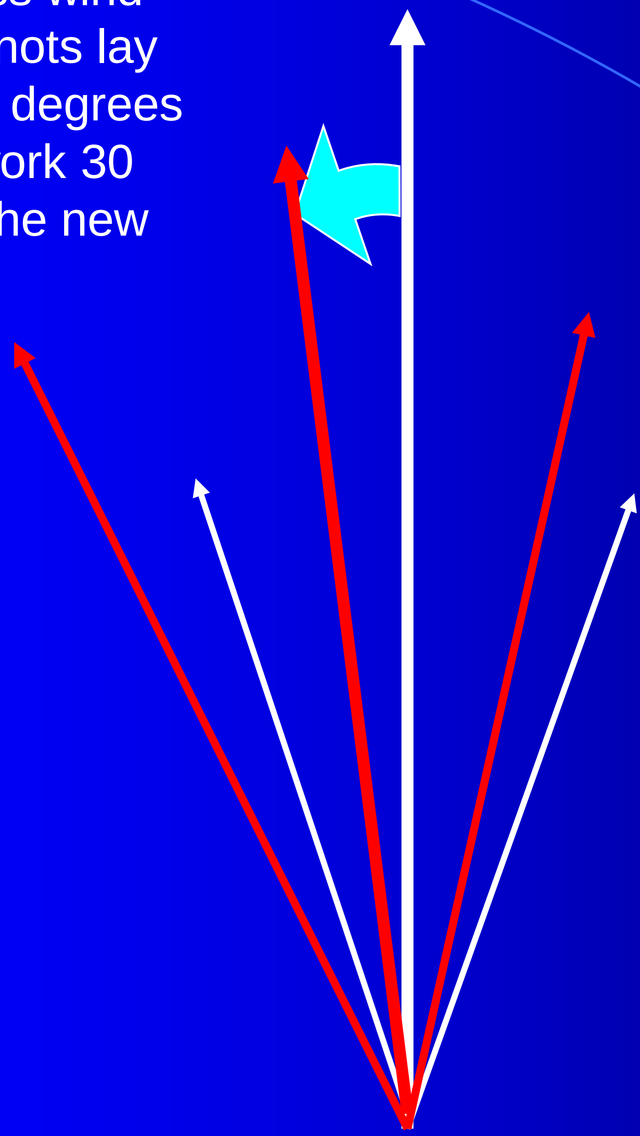
# Off track penalties- nil wind



# Off track penalties- cross wind

15 knots of cross wind cruising at 90 knots lay off minimum 10 degrees into wind and work 30 degrees +/- of the new heading

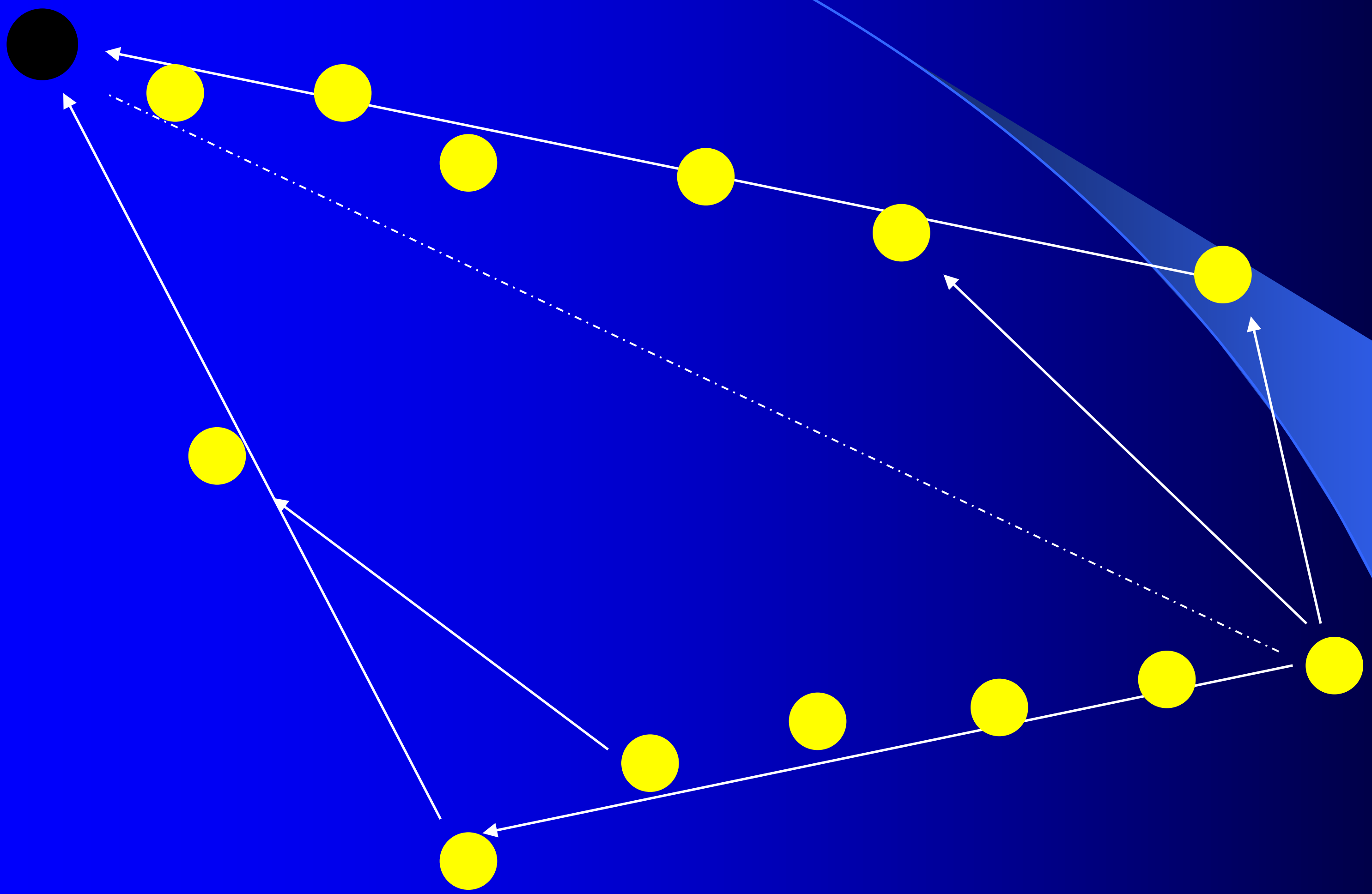


15 knots of cross wind cruising at 60 knots lay off minimum 15 degrees into wind and work 30 degrees +/- of the new heading, preferred into x-wind than downwind

30’ off track increases distance by 1/4

# Off track penalties end point

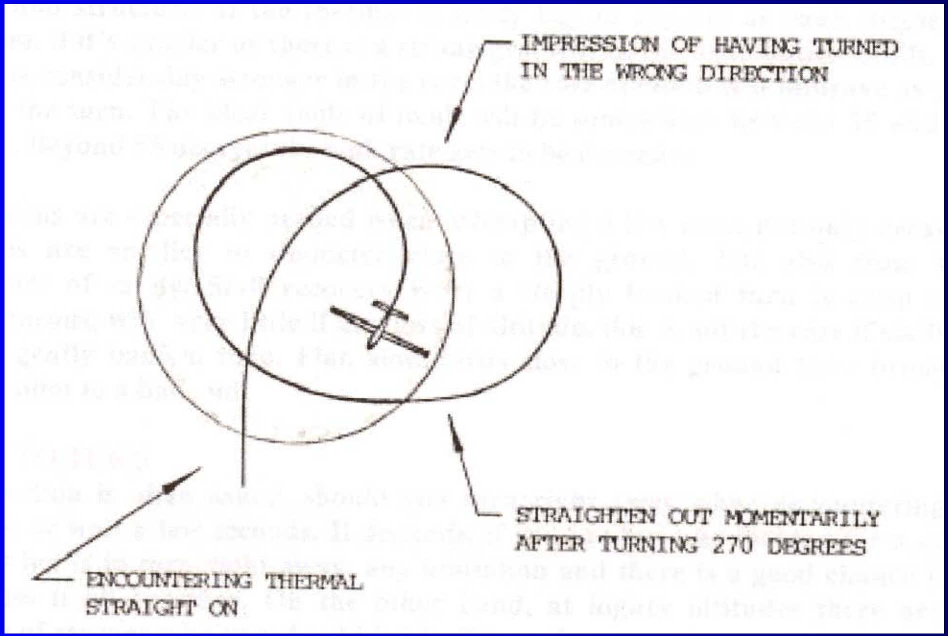


# Optimal thermalling

- Must optimize rate of climb. The average speed nearly proportional to average achieved climb rate
- Concentrate and strive for maximum climb rate
- Continually scan for traffic
- Thermalling time includes time to center thermal, therefore center quickly
- Thermal at angle of bank 35$^{o}$-55$^{o}$ at optimal speed for that wing loading.
- Minimum speed is desirable to fly in the stronger parts of the thermal core.

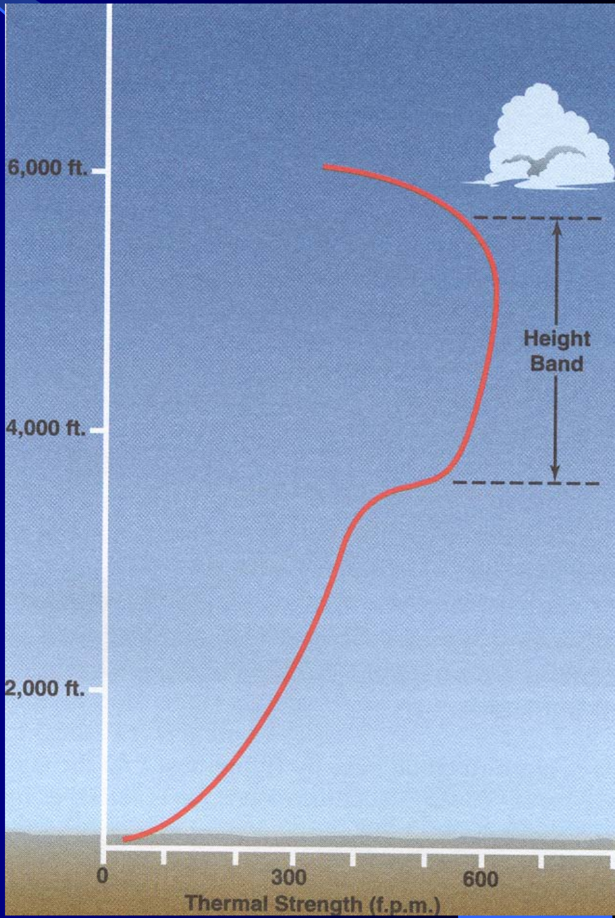
# Optimal thermalling

- At low altitude bank $35^{o}$ immediately lift detected since thermal diameter is small
- At high altitude can delay turn to explore larger diameter thermal profile
- Direction of turn should be towards the rising wing
- Make $270^{o}$ correction if center of thermal missed



# When to thermal?

- Minimize time circling to maximize speed
- Decide on minimum rate of climb for that altitude based on the speed
- Acceptable climb rate depends on the altitude
- For lift below minimum climb rate, use dolphin flight path slowing down in weak lift and vice versa
- Maintain situational awareness, watch for soaring birds, sailplanes.



# Height Bands