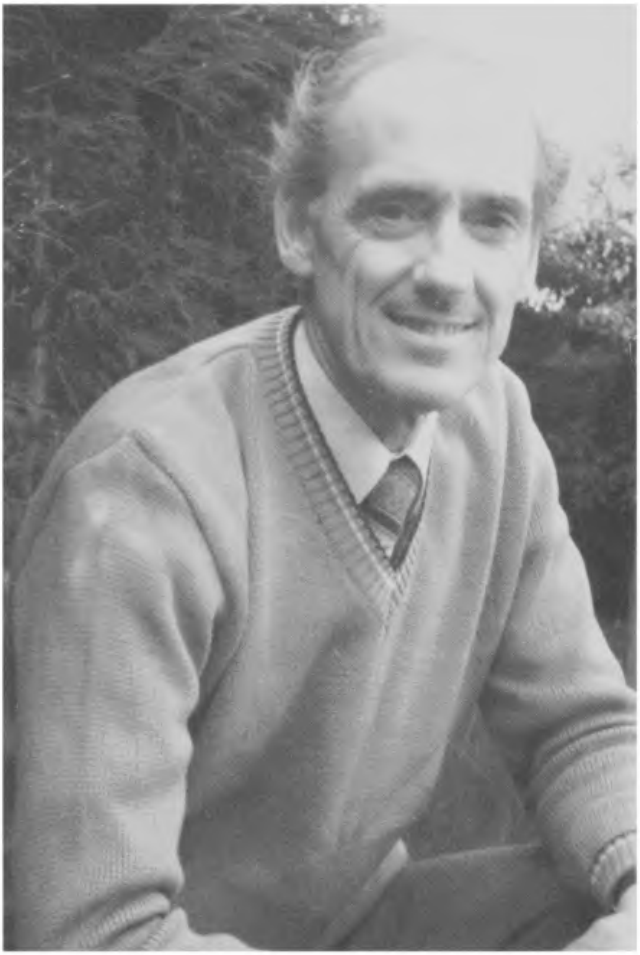
TEACHING HARRY TO FLY

by

DAVID MILLETT



THE AUTHOR

TEACHING HARRY TO FLY

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DEDICATION

Dedicated to

Jimmy Hempseed

and

Neville Allcoat

FOREWORD

I was delighted when asked to write this foreword, as I share David's love and enthusiasm for the magic and thrill of this fascinating sport. The combination of vast experience and knowledge are blended with the skills of the teacher; David's charm and humanity provide us with a story about the personal challenges that Gliding can present.

The wealth of technical books and personal recollections available on the bookshelves seldom address the very human anxieties that affect us all when embarking on, and participating in, a challenging adventure. Who is Harry, you may ask? Harry is you, Harry is me, Harry is Everywoman and Everyman. Harry shares our worries, he asks the questions we would like to ask, he makes the mistakes that we will make, and he achieves that to which we can all aspire.

"Why didn't I do this ten years ago?" Harry is there to take us across the giant step at the door of the Club. He tells us what to expect and how to act. David reveals that special fellowship of Glider Pilots and the all important relationships between instructor and pupil. We share the humour and delights of discovery and achievement and the mutual satisfaction of a receptive student in the company of a master teacher.

We are introduced to the mysteries of flight. David's deep understanding allows Harry to get to grips with the crucial points of theory through straightforward and satisfying explanations while whetting the appetite for a deeper understanding. Harry knows the questions to ask and David knows how to get him thinking. He is carefully tutored in the pitfalls and dangers that await the carefree pilot.

What good fortune to chance upon one such as David! We might not have an Instructor's undivided attention, nor be blessed with fair weather, nor reliable machinery, but no matter! We can savour the anticipation of our next challenge, understand how progress is made and monitor our developing skills. Harry takes us along the pathway of discovery, the successes and failures, the thrills and disappointments, the laughter and tears. Today was brilliant but what about tomorrow?

Harry can fly and we are allowed a glimpse into his exalted new world. We are eager to know of the exciting opportunities that await him. We feel the zest of breathtaking new experiences. We are inspired by the prospect of the new challenges that await him. Good luck to Harry - but now it's my turn!

JOHN McKENZIE

ABOUT THE AUTHOR

Born in Lancaster May 1924, the son of a local dentist, David was the youngest of a family of six. He lived in a happy and affluent household until the premature death of his father left the family in financial difficulty and they moved to more humble surroundings.

Dyslexia led to wasted and frustrating years at school until the father of his closest friend, a gifted teacher unlocked the door of learning. His skill and understanding allowed David to achieve a standard of education which enabled him to pass the Air Crew Selection Board in 1942.

David left gunnery school with the rank of Sergeant and the highest 'air to air' hits the school had recorded. David missed out on three months at an Operation Training Unit when he was asked if he would leave his assigned crew, in order to replace the injured rear gunner in Sgt. Alty's crew.

Sgt. Alty and crew - later Flight Lieutenant Alty DFC - went on to complete a tour of thirty operations with a No. 49 Squadron, Bomber Command. David's crew were killed on their second operation. The teacher's son, David's friend, was shot down on what would have been his last flight for the completion of his tour. After the completion of his tour David, now a flying officer, volunteered to go to Ringway (Manchester Airport) where he completed an instructor's course in parachuting to train the army.

After demobilisation he worked as a representative in the hair dressing trade before 'discovering' gliding, a sport he eventually made his living by for many years, teaching others the joy of soaring flight.

David found time to grab a full Gold Badge with a Diamond Goal. Diamond heights were also gained several times but none were documented due to lack of barograph proof.

At the age of 53 David suffered a pulmonary embolism, with a one in a thousand chance of recovery, and lived to fly again.

David has two daughters. Now retired, David still enjoys flying his rather ancient wooden glider and occasionally occupies the instructor's seat, to give others the benefit of his vast experience.

AUTHOR'S COMMENT

An instructional book, written in this manner, is the result of a suggestion from pupils. Many of whom felt a traditional text book, while informative, was dull. 'Why not,' they said, 'write in the manner of your teaching? Why not,' I thought. This is my effort for what it is worth!

By the same Author:

"WHISPERING WINGS."

AUTHOR'S NOTE

My intention, when writing the book 'Teaching Harry To Fly', was to attempt a conversational type of instructional book. To write down as much as possible my teaching method, rather than the traditional text book.

There are numerous text books about. Many of which are very good. Such books are required to be studied, to be pondered over. The technicality of some, in my view, delve deeper than is necessary for the making of a good basic glider pilot. For those with a technical mind however, they have much to offer.

For safety reasons, the learning of some technicalities are essential for the appreciation of what is going on around the aircraft during flight. For example, when the glider is at, or near, the stall. One should have some understanding of the movement of the air caused, both by the glider's travel through it, and the general air movement itself.

My experience of instructing over many years, has shown me that in general, a pupil learns quicker if one keeps things simple. By so doing, the pupil develops his 'feel' into flying naturally. Providing his instructor gives him the right 'lead'. Of course, the aim is not necessarily to see how quickly the pupil learns, but rather how 'well' he learns.

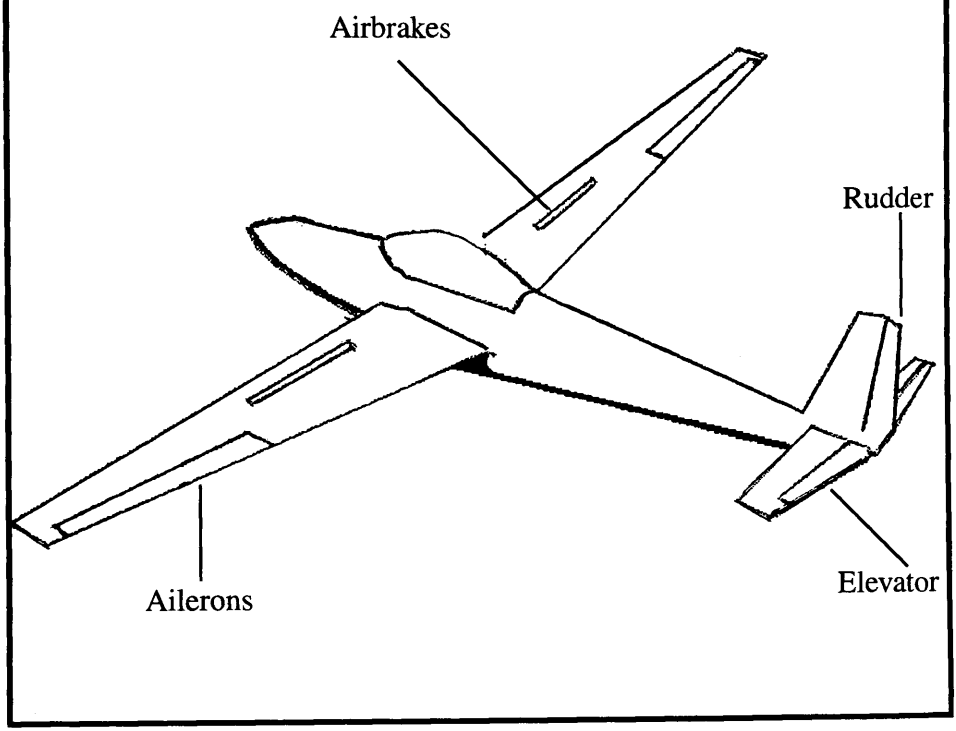
With a clear mind, uncluttered with technicalities the pupil is not forever watching for the technical reason why his glider is not flying accurately. Instead, he will 'feel' his way there, with the help of a few timely demonstrations by his instructor.

There are, of course, a number of pupils who lean towards the academic even while flying. Their minds are forever concentrating on the technical whys and wherefores at the expense of developing a natural 'feel'. There input to the controls, for a change of aircraft attitude, is a movement in response to a technical reason, rather than 'feeling' the requirement of the aircraft. Such pupils may well develop into adequately competent pilots, but they rarely develop 'flair' where soaring is concerned.

One could argue that such people as test pilots, helping the development of new aircraft, must have done a great deal of delving into technicalities but still have plenty of flair. Well I fancy much 'delving' must be done **after** the flair has shown itself.

So, if you wish to delve deeply into aeronautics, metrology or navigation; then this book is not for you. If though you want to get a good grounding, for the safe and practical handling of a glider, I think you may find it useful.

GLIDER CONTROL SURFACES



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CHAPTER ONE

"Do not push there, that is the trailing edge of the wing, it is not to be handled. You are new to this game, I think," said the instructor. "But it is nice of you to help get the glider out of the hangar."

"Yes, I am new here. I am Harry Proctor. I have not been near any kind of aeroplane before, but I think I would like to fly," said the young man.

"Welcome Harry. If you join this club I know they will be delighted to train you to become a glider pilot. So I'll tell you a few do's an don'ts concerning the handling of a glider when it is on the ground. I am sure you will know which is the wing, see how the front edge is quite thick but then it tapers off before reaching the back, which is very thin. However, we do not refer to the front or back, rather we say the 'leading and trailing' edge, O.K.?"

"Yes. Leading and trailing edge," replied Harry.

"When moving a glider," continues the instructor, "you may push as hard as you wish on the leading edge, as it is very tough, but the trailing edge may not be handled. You can also push on the nose, which is quite strong. You may have guessed that we have a name for the body of the glider. We call it a 'fuselage'. Then we come to the tailplane, which also has a leading and trailing edge, but in the case of the tailplane we do not push anywhere. At the back there is also this thing, standing near the perpendicular, which is known as the 'fin' and onto it, is hinged the rudder. Also hinged to the tailplane, are the 'elevators'. Now look outboard of the wings at the trailing edge Harry, and see that each wing has a hinged surface, but these are set into the wing, so as not to trail back. These fixtures are the 'ailerons'".

"Yes, as you say they are hinged, so they must be able to be moved. So how do you use them?" asked Harry.

"Never mind about that just now, all will be made plain to you later. Let's just concentrate on ground handling for now. Right then, we have got the glider out of the hangar and we will park it on the grass. By the way, the most vulnerable time for a glider is when it is being taken from or put into the hangar. It is essential before lifting a wing tip from the ground, to work out what will happen to the other wing coming down. It may well be interlaced with other long wings in a packed hangar."

"Yes, it was a bit of an eye opener when I first looked in through the doors."

"We can move a glider backwards by pushing on the wing, but if we do that, the tail must be lifted by it's lifting bar, otherwise the tail skid will catch into the ground. Or, we can move the glider forward, pulling on the seat straps, but on a windy day, this is not a good idea, as it is best to keep the canopy closed. Since there is only one main wheel, we steer from the wing tip, pivoting on the wheel."

"Right," said Harry. "I'll take the wing tip. Let's go."

"Now just hold on," cut in the instructor. "Since we are going to be pulling, we will ask someone to walk at the nose, to prevent the machine running downhill."

"Well yes, but the ground is flat here," observed Harry.

"That's as may be," said the instructor, "but in flying we like to create habits right from the start. A habit, once it has got hold, is a hard thing to break, so we make sure, we start off with good habits."

At that, the instructor asked a passing member to give a hand. Harry said: "O.K. then, I'll take this wing."

"Wrong. Take the other wing, please. Harry looked bemused.

"I'm not being difficult old lad, there is a good reason for holding that one. You see, if there is no wind blowing it really does not matter a jot which wing you hold. Or even if there is a wind, it doesn't matter, providing we move the glider directly with, or, against the wind. However, more often than not, the wind will be blowing across the glider to some degree. This being so, we must hold the wing tip which is most into the wind. By doing this, it is easier to prevent the wind lifting the wing, than it would be if you were holding the down wind wing. Also Harry, when we are moving the glider over some distance, we may be required to change directions a time or two. If this should be so, you will realise that the wing which has been into the wind, will now swing away from it, while the other one goes into it. Now you can see that it becomes necessary to change the tip being held. A second man must be ready to take the other tip before the first man lets go. To be sure that there will be no misunderstanding, we have a short formula, which is: 'Your wing. My wing'. This means, the holder will call 'Your wing' and he will not let go, until he hears the reply 'My wing'. Here then is another good habit, which you will develop from day one. The test of time has shown it to be the most sure way. I'll tell you a little story, Harry. A true story. The day was windy with the glider changing direction, so that a wing tip change was necessary.

The first holder rightly called: 'Change wings. Your wing'. He heard the reply: 'O.K. I've got her'. So he let go. He was surprised to see a wing blow up high, while the other crashed down into the ground. What had happened? Well, I'll tell you what happened, Harry. He had not obeyed the word formula 'Your wing. My wing'. The man heard 'O.K. I've got her'. So he let go. But he was not hearing a reply. What he heard just at that moment, was the cry of a young blood, who had thrown his arms around a pretty thing, lifting her feet of the ground. Glider pilots are individuals by definition, but within their individuality, must have built in good safety habits. Here we are then, so now it has to be parked. A glider is not just left any old how, Harry. There is a correct way of parking as well."

"I might have guessed," commented Harry.

"We could picket it down, using stays, but the usual way is to use old car tyres. There are plenty of those at most clubs."

"I wondered about the tyres," said Harry.

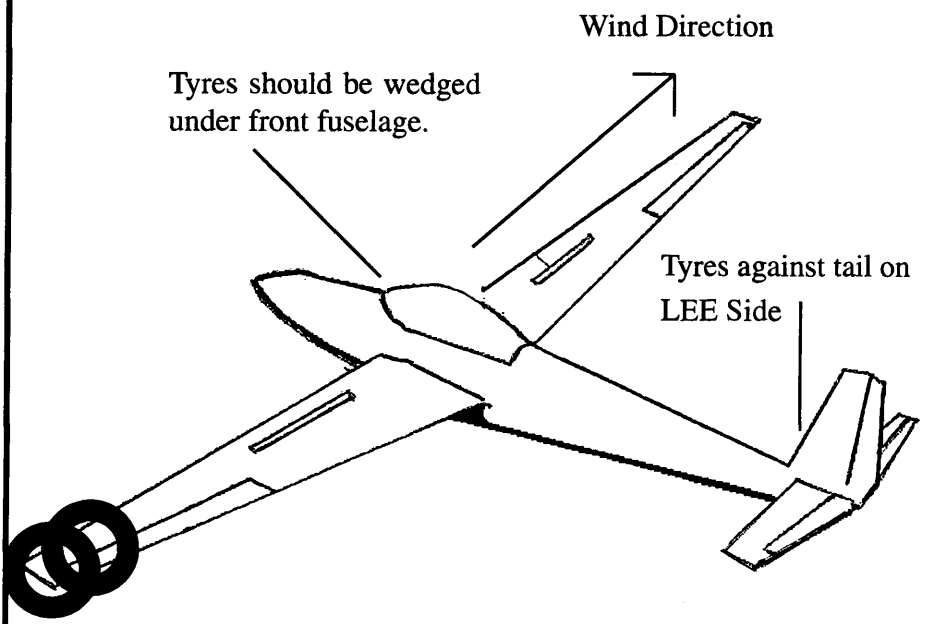
"Walk in the direction of the nose with your wing tip while I lift the tail off the ground. That's right, but go a little further. Stop there. Now rest it on the grass and place three tyres on top. Are you wondering why I am being so fussy as to exactly how far you pivot the wing forward?" asked the instructor.

"Yes I was, to tell you the truth. Why?"

"If you check, you will notice the wind is blowing along the wing from tip to tip. Or rather almost, but not quite. Actually, the wind is at a very slight angle to the trailing edge. This way, less lift is created on the wing, helping it to remain on the ground. You will learn a lot about lift in due course, my friend. Even so, the glider is not yet properly parked. We still need to place a heavy tyre against the tail skid at the far side of the fuselage from the grounded tip. Regarding the wind, that is the 'lee' side. You see Harry, the centre of gravity is placed somewhere on the wing at the centre of its span. From that point you can see there is a much greater length of fuselage, reaching to the tail, than there is to the nose. Also at the tail we have got this tall fin and rudder. All the fuselage reaching back, plus the fin and rudder, is offered to the wind and since the main wheel is placed near the centre of gravity, the glider can take on a weather cocking action, swinging the wing into the wind, where the air flow creates lift. If the wind is strong, it could blow the glider over. A heavy tire on the lee side of the tail, will make weather cocking unlikely. To make it safer still, we finish off by pushing a tyre under the nose, which in

turn presses the tail hard onto the ground. So there we are Harry, the glider is properly parked. It would take a strong wind to upset it now."

PARKING A GLIDER USING TYRES



Wind should be slightly behind lower wing.

CHAPTER TWO

The fellow in the front seat of the K13 glider was preparing for his first instructional flight. The instructor in the rear said "Your first flight, I believe?"

"Yes it is!" replied the young fellow.

"Well it's fortunate that the winch driver is not quite ready to launch us into the air, because before we fly, I must have a talk with you. You see, I want you to start forming a habit, a very important one, which will be done in the form of a drill, and remember, if over the coming years you fly 5000 times, then see to it, you carry out 5000 cockpit drills. It is necessary for your own safety. So here we go. Your cockpit drill. You will need to remember the letters C.B.SIFT.C.B. These letters stand for the following: C: Controls, B: Ballast, S: Straps, I: Instruments, F: Flaps, T: Trim, C: Canopy, B: Brakes, C.B.SIFT.C.B.

"Number one, then, C for controls. What we are after here, is to check each control moves in the correct sense. By this I mean, that if we ease the control stick back, i.e. towards us, we want to know that the elevators on the tailplane lift up. You cannot see the elevators from the cockpit, so ask someone who can, to confirm. Push the stick forward and they should go down. Then, with your foot, push full left rudder, then check if the rudder at the tail has moved fully left. Likewise with the right rudder. Now for the ailerons on the wings. Move the stick to the left and you want to see the left aileron move up, while at the same time, the right one moves down. Then you see a vice versa action when moving the stick to the right. Look. Right aileron up, left down. It is easy to remember when you know the stick always leans toward the upward moving flying surface; stick leans left, left aileron up. Stick leaning back elevators up. Should any of the surfaces move differently, or not at all, then we do not fly! Gliders Harry, are often rigged and de-rigged, so we want to know everything has been connected the right way round. Well, there we are C for controls. Let's see what B for ballast is all about. The pilot weight, including a parachute, if carried, must reach a certain minimum but not exceed a maximum. If you do not reach the minimum, you must carry ballast with you. If your weight is more than the maximum, you may not fly that glider, but to be overweight is rare. Fixed in every glider, is a placard, displaying the limitations. Why are we concerned with the limitations? Well, it has to do with how the centre of gravity is effected, Harry. If the pilot is too heavy, the Centre of Gravity (C. of G.) moves forward, which will cause the elevators to

be less affected on their upward movement, i.e. to bring the nose up. Not so good if you are in steep dive! On the other hand, if the load is too low, the C. of G. will move back, thus shortening the moment arm from the C. of G. to the rudder. This may result in preventing spin recovery, as the rudder is the main control for this purpose. The shortened arm being unable to exert enough leverage. O.K. Now for S. This tells you to check your straps, seat belts. Fit them correctly and have them tight. Now on to I. for instruments. Check that they are correctly set and have no broken glass. In this glider, all that needs to be set, is the altimeter, done by turning the small knob on the instrument, which turns like the hands of a watch. The big hand indicates hundreds of feet; the small hand, thousands. By turning the knob, we place one hand over the other, pointing straight up at zero, the position for 12 o'clock on an watch. The numbers on a watch are 1 to 12, but on the altimeter, they are 1 to 9. 9 is followed by zero. Have you put the pointers on zero?" "Yes, I have adjusted them," confirmed Harry.

"Good. Next we have F. for flaps. On this machine there are no flaps. It will be quite some time, before you fly on one, which has. Nevertheless, flaps will be mentioned with each cockpit drill, so when the time does come that you are flying a flapped glider, you will not forget them. Good habits, Harry. Good habits. Right, let us move on to T. for trim. Look for the small green lever on the right side. You can move it back and forth. Go on, try it."

"Yes, it moves alright. What is it for?"

"I do not want to load your mind with too much at one go. On the first flight, you will not be using it anyway, it comes with a later lesson. However, you need to know from the start to move the lever a little forward of centre during the cockpit drill. The reason for this will also be made plain later. Remember, the lever is always coloured green to help identification. We finish with the other C.B. This other C. is for canopy. Simply be sure the canopy is properly secured and finally B. for brakes. The brake lever is on the left side and is always coloured blue. Of course, brake in this case means air brake. The movement of the lever, operates them. Put your left hand on the blue lever, Harry. Now, look out along the wing and you will see a kind of paddle standing up from the top surface and another one from the under surface. The brakes are now in the open position. To close them, push the lever forward. That's it, now they have gone into the wing and are flush with the surface. Of course, both wings have brakes working together. Lever back brakes open. Lever forward brakes closed. Lever in the middle brakes half open. And so on. Now

close them with the lever forward. No one can see them now, because the are fully closed. But....., push the lever harder forward. That's it! Did you hear the click?"

"Yes I did."

"Only now are the brakes both closed and locked. Only the pilot knows this, because from the outside no one can see the difference between the brakes being just closed or closed and locked. As with the trim, you will not be using the brakes on your first flights. It is enough to know, that during flight there is low pressure over the upper wing surface, so if the brakes were not locked, they could be sucked open. Not healthy! Well there you are then. C.B.SIFT.C.B. It seems to take a long time, but that is only because it was the first time and I was explaining things to you. Very soon, you will be doing the full drill quite quickly and efficiently. One final word concerning the drill. Before we ask if 'all is clear above and behind for take off', the tow cable, or tow rope, has to be attached. This is done externally by a helper and we say to him: 'MY BRAKES ARE LOCKED! Cable on please'. At the same time, you check push the brake lever. If you fail to confirm to the helper, then he should ask you if the brakes are locked."

The rope that trailed back from the tug aircraft, was attached to the nose of the glider. The instructor in the rear seat, after checking with the wing tip holder that there were no aircraft above or coming in from behind, called for the slack to be taken out of the rope (* See page 102). Someone responded by swinging a bat through a half circle on a vertical plain, down from one shoulder and up to the other. The tug responded to the signal by moving slowly forward. The rope came alive, then taut. "All out", called the instructor. Now the signaller swung the bat up from one shoulder down to the other, this time the half circle passing over his head. Reading this, the tug pilot accelerated the combination down the runway, while the wing tip holder ran a few yards, before allowing the wing to slide from his hand. The glider became airborne a little before the tug. Then both were climbing gently into the sky. They climbed to 2000 feet, before the instructor released the tow by pulling a yellow knob in the cockpit. He watched the rope fall free before making a climbing turn to the left, while at the same moment, the tug fell away in a diving turn to the right.

"Since this is your first flight, I want you to enjoy it," said the instructor. "To help you become acclimatised, I want you to look at the far distance and relax. Look at where the earth meets the sky. The horizon. Still watching the

horizon, look out at one side, then the other. Do that for a minute or two, then look a little closer in. Good, now look at about 45° at the farm over on the right. Super, isn't it?"

"Great!" came the reply.

"O.K. then, now look straight down. That's my boy. There is nothing to it, eh! No giddy feeling from height, even though we are around 2000 feet."

"No, none at all, I am enjoying every minute of it."

"I knew you would, Harry. What's more, we are in luck because we have contacted a thermal. By the look of the cloud above, I reckon we can climb to around 4000 feet, which is a jolly good thing as it will give you time for a good lesson."

At 4300 feet the instructor levelled the glider from its turning flight and flew from under the cloud. He asked his pupil if he still felt good after the climb. He received his assurance. "You are going to start your first lesson. But Harry, let me remind you of what you were told on your pre - flight briefing about the glider being controlled by its flying surfaces. Do you recall, that if we ease the stick back, the nose goes up? This is because the movement of the stick, causes the elevators at the tail to slant upwards from their hinges, which effects the airflow in such a way, as to suck the tail down, and so lift the nose. If you ease the stick forward, the opposite happens, pitching the nose down. So you see, the effect of elevators is to cause a change in pitch. Now I am going to demonstrate 'The effect of elevators', so listen carefully and relax. Look straight ahead and note where the horizon cuts across your canopy. We are in steady straight and level flight now, so it is important to remember that horizon position, because whenever it is there, the glide angle and airspeed will always be the same in a glider without flaps. Providing of course, you do not alter your own position by changing the thickness of the seating under your bottom. Now look at the A.S.I. and tell me what it indicates."

"45 Kts."

"Correct. Now listen carefully to the sound of the air flowing over the cockpit. Note the volume level. It stays constant, and that also represents 45 Kts. So Harry, a change in pitch, not only alters the glide angle, but also the speed and the volume of the airflow. Here we go then for the effect of elevators. I'm easing the stick forward. Note the horizon climbing the canopy as the nose lowers. Listen to the volume of the airflow or slipstream rise with the increasing speed. Now take a quick glance at the A.S.I. to see the pointer

hand moving to higher figures. I shall now ease the stick back towards me. Look at the nose coming up to meet the horizon again, note how the horizon is now slipping down the canopy. Also the sound is decreasing. Look, it is back were it started, and, tell me Harry, what does the A.S.I. read now?"

"45 Kts."

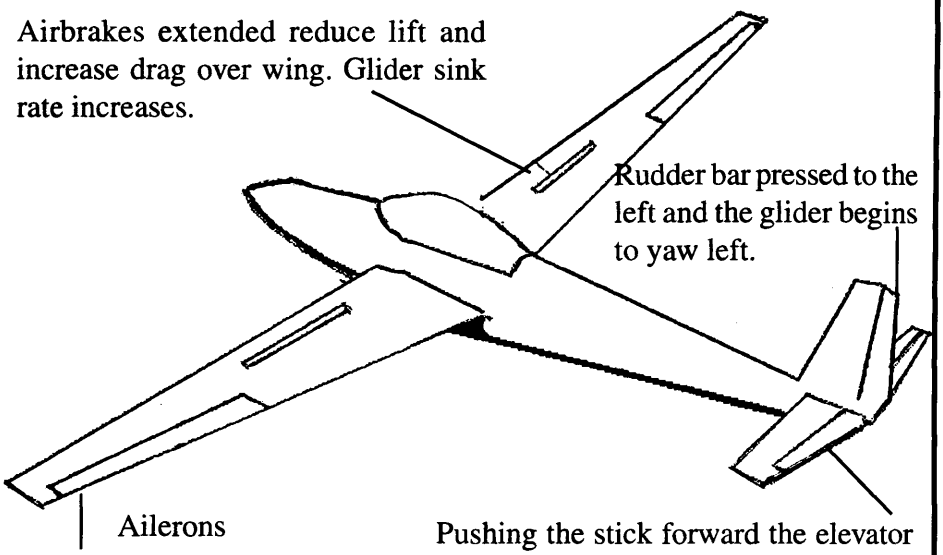
"It does indeed. That my friend, is the effects of elevators. Now it is your turn. I want you to do just what I have done, but please believe me, I will not be touching the stick, unless I say I am doing so by informing you 'I have control'. So, any movement will only come from your own input. Ease the stick forward then. See the horizon climbing up your canopy? Don't be shy, push the stick some more. That's better, now there is more green scenery and less sky straight ahead. Listen to the increasing airspeed noise. A glance at the A.S.I. will show the speed is increasing. Now pull out of the dive by easing back on the stick and try to replace the horizon to where it was. Oops.., the nose is climbing too high. I have control, I will settle it for you. There we are, back at 45 Kts."

"Now let's have a go at the effects of ailerons. Remember, it is the sideway movement of the stick which operates them, and their movement causes the glider to roll laterally, leading it into a bank. The wing which is lifting, has the aileron down, while the down going wing, has the aileron up. Because banking causes the glider to turn away from straight and level flight, it becomes necessary to look out in the direction of the intended turn, so as to be sure of that part of the sky being clear of other aircraft. I'm going to demonstrate the effect of ailerons now Harry. While the glider is flying straight and level, I take a good look in the direction of the intended turn, which is to the left. Now look at the horizon straight ahead, and as I move the stick to the left, watch the horizon tilt across your canopy. The wing is now reaching 30° of bank so, to stop it rolling further and also to keep a 30° bank, I return the stick to its starting position in the centre. But to level the wings, I move the stick from the centre to the right. As the wings become level and the horizon is straight across the canopy, I replace the stick in the centre. If I did not do so, the glider would roll to the right. Now you try. Hold the stick gently with thumb and fingers. I want you to bank to the left by the use of ailerons. First take a good look out. Is it clear? I can't hear you. Is it clear?"

"Yes it is!"

"O.K. then. Now progressively move the stick to the left so as to roll into a

GLIDER CONTROL SURFACES
Effects of Controls



bank. Do not allow a forward or a backward movement on the stick. Good. Now we have rolled to about 30° of bank, so hold the bank by returning the stick to the centre. Note the horizon slanting across the canopy. Roll out of the bank by moving the stick across to the right, then centralise it as the wings become level with the horizon. Oops..!! The nose is going up, so check that by removing the slight back pressure from the stick. Oh dear, you have over corrected, now we are diving. I have control. Well Harry, that was not bad for a first try. I will retain control while we have a short talk, so relax. You saw the nose coming up as you were rolling out of the bank?"

"Yes, but only when it was pointed out to me."

"Well, the nose came up because of the back pressure you unintentionally applied to the stick, while rolling out of the bank. But it should prove to you that the elevators still take effect, even when using ailerons. Of course, if you are in level flight at the time you bring the stick back, the nose will climb towards the vertical above the horizon. But, the elevators take effect at any

time the stick is moved back or forth, regardless of the attitude of the glider. It is best to think therefore, of the nose coming up or going down, in front of your face. Ready to take control again?"

"Yes."

"Try a bank to the right. What is the first thing you must do?"

"Look out. See if it is clear. And it is," came the reply.

"That's my boy," said the instructor. "Ease the stick to the right to roll into a bank. Now centralise the stick to stay in the bank for a moment. Now roll out and level the wings by moving the stick across to the left. Then, as the wings become level with the horizon, centralise the stick. Not bad at all, Harry! There you are then, the effects of ailerons. Ailerons cause roll, leading into bank. We still have some height to spare, so we will finish the lesson with the effect of rudder. I will demonstrate first. Keeping the wings level with the horizon, I am pressing my right foot on the rudder pedal. See how the nose moves to the right? Feel the cold air drafting in through the left clear vision panel? We call the movement 'yaw'. The nose has yawed to the right. Now I am pressing the left rudder, and the nose is yawing from right to left, with the draft now coming in through the right panel. I will now centralise the rudders, putting both feet in line. All yaw has been removed, there is no draft from either panel, because the glider is flying cleanly through the air, which is now flowing straight along the fuselage from the nose to tail."

"Take control Harry! Try yawing the nose to the left. Go on, push your left foot harder. Release the nervous pressure from the other foot, to let the pedals move. Ah, now you have it. Be conscious of the draft during yaw. Now press the right rudder to yaw right. Good. Centralize the rudders for clean balanced flight. There you are Harry, you know the effect of controls. I have control, so sit back and relax. Have you enjoyed it so far?"

"I certainly have. I was a little anxious before we took off, but not any more. It was wonderful."

"It is a great sport. You have wonderful days ahead. But I want to tell you something, which you must remember. You see, up to now, you have just had the effects of controls to show you what the control surfaces do in flight. From now on though, whenever you move the stick sideways, you must also move the rudder to the same side. Coordinate stick with rudder. You will learn why, during the next flight, so don't worry about it now. Anyway, we are in the circuit and will be landing in a few minutes."

CHAPTER THREE

For the second time, Harry saw the tug fall away like a stone. Then he heard the instructor ask: "Do you notice the airflow becoming quieter as we slow down."

"Yes I do. With the glider making a climbing turn, the speed and sound fall off quickly."

"You are putting a few points together now, Harry", commented the instructor. "You already know something about effect and controls, so on this flight we will move onto turning the glider through the air. First though, try a few minutes straight and level flying. I am trimming the glider to fly at 45 Kts. The use of trimmer is something you will learn about later. For now, it is enough for you to know that the glider wants to fly at the speed to which it is trimmed. In this case 45 Kts. On your first lesson, you worked the stick with its aileron control surface on its own, as you did with the rudder bar for the rudder control. From now on Harry, during normal flight, the stick and rudder will be used together. We will coordinate the two. We are flying level now, so note the horizon position. Now take the controls. Remember, do not hold the stick tightly. O.K. you have control. Let the glider fly itself, if it requires a correction, make it with a small movement. Now look Harry, do you notice anything happening to the horizon?"

"Yes, it is tilting."

"Right, but which way?"

"It is tilted to the right."

"It is. Now look to the horizon to your left. What does it tell you?"

"Oh, it is high. The left wing is down."

"OK, the left wing is down as if in a bank. So bring it up by moving the stick to the right and at the same time, press the right rudder pedal. Good. Now centralize both."

"I have control."

"To help you get a feeling for coordination," said the instructor, "I want you to follow me through on the controls. I'm going to move the stick and rudder together, first to the right, then to the left. I shall do it several times without a pause. The wings will roll to 30° of bank. First to one side, then to the other. Here we go: Right stick and rudder. Left stick and rudder. Right stick and

rudder. Left stick and rudder. See how the nose remains on the same spot as the wings roll. This is because the stick and rudder are properly coordinating. Now you try it. But don't worry about the nose swinging off the point straight ahead, you cannot be expected to keep it steady yet, but you are developing the feeling of working the controls together."

Harry tried for several minutes to coordinate, rocking the wings laterally before the instructor took over the controls.

"Now we are going to do something about introducing you to turning the glider in flight. As usual Harry, we will start the exercise by my demonstrating to you. Sit back a moment. I shall turn to the right. So, of course I check that it is clear and safe to change the glider's direction of flight. I pay special attention to the right. Satisfied there is not another aircraft near, I look straight ahead at the horizon to check the glider's attitude. I roll into the turn by applying right stick and rudder. The nose pivots on the horizon, as it rolls. At 30° of bank, I centralize the stick and at the same time remove most of the rudder. The nose is now sweeping constantly around the horizon with no draft coming through the clear vision panels. But I look ahead at the horizon, to see that it is slanting correctly across the canopy, and there is no pitching taking place. I do, nevertheless, take at least one look out for each 90° of turn. Watch Harry. Although it is a good steady turn, I am going to ease the stick back a little, to show the elevators remain effective in all attitudes. See the nose rising, and again the airflow noise is decreasing with the fall of speed, giving me the message to make a correction. Having kept the glider in the turn, I will now roll out of the bank to return to straight and level flight. I do this by moving the stick from the centre to the left, while at the same time applying left rudder. The wings roll out of the bank, again with the nose pivoting on a point. Just as the wings are becoming level, I centralize the stick and rudder. Again Harry, that must seem an awful lot to remember, but soon it will not seem so. To start with, your turns will be rather basic, so you must not worry if the nose of the glider does not remain on a point, while rolling in and out of the bank. So, let's see you have a go at turning to the left. You have control."

"I have control."

"Start by checking that the horizon is laying across the canopy at the right place."

"It looks O.K. to me," said Harry.

"Good. Now you tell me what you must do next."

"Check that it is clear. Especially in the direction of the turn."

"Right. If it is clear, then look straight ahead. Apply left stick and rudder to enter the bank. Fine. To maintain the bank, return the stick to the middle and take off most of the rudder. Try to maintain that slant of the horizon across the canopy, making only small corrections. Look, the nose is climbing, check with elevators by making only a small forward movement of the stick. That's better. It's time to look out in the direction of the turn. Is it clear?"

"Yes."

"O.K. Eyes back to the horizon across the canopy. What do you make of it?"

"It is not tilting as much."

"That is because the left wing is lifting, lessening the bank. So, bring the stick just a little left, into the bank, use the left rudder as well. A small movement now! That's it. Now the nose is sweeping about the horizon at the correct angle. Take another look out. Then when you are ready, stop the turn by rolling out of the bank, back into level flight. Take the stick well over to the right as you use right rudder. Centralize the controls as the wings become level.

"I have control," said the instructor. "You will get lots of practice at turning, Harry. For a really successful soaring pilot, the need for accurate turning, cannot be stressed enough. You will learn why when you come to thermal soaring. For the moment let me enlarge a little on controlling a good turn. Once in the turn, having centralising the stick and taken off most of the rudder, you will sometimes find the bank either continues to roll steeper, though at a reduced rate, or the wing may roll out of the bank. When this occurs, you do not say to yourself: 'Oh dear me, the stick cannot be quite in the middle' and so take a look at where it is placed. No Harry. Once you have made the initial centering to stay in the bank, you almost stop thinking about the position of the stick, but instead think of the position of the glider. So, with that in mind, if the wing is rolling out a little, then move the stick towards the lower wing to push it back down. Or if the wing is rolling steeper onto the bank, then lift it out by moving the stick away. You can imagine a bar, reaching from the top of the stick to the tip of the lower wing, with which you can push it down or pull it up. So you see Harry, if the turn is constant, with the wing neither adding-on nor taking-off bank, then the stick is in the correct position, even if it is not dead centre. A reason for this may be, rising air under the wing

pushing it up. You prevent it from lifting by putting on a touch more aileron and rudder. You take the opposite action, if the high wing has air shoving it up, therefore lowering the lower wing. A final thought about the position of the controls, Harry. If you were driving a car, negotiating a bend, and while rounding it, the bend became sharper, sweeping the car to the other side of the road, what would you do? You would simply turn the wheel until the car is taking the right line. You do not wonder how many degrees you must turn the steering wheel. Nor should you think 'How far do I move the stick?.' Rather you should 'see' how far to move the attitude of the glider. It's a matter of feel.

"Come on Harry, let's go to the club house and get some coffee. There are one of two points I would like to talk about, before your next flight."

"You do take sugar, I think?"

"Yes please, but no milk."

"Before I start Harry, are there any questions you would like to ask, concerning your flying so far?"

"Yes, there is something, which has been puzzling me. After entering a bank and to stay in it, you say centralise the stick and take off **most** of the rudder. I know from the flying yesterday, that the stick may not always remain exactly at the centre in order to maintain a constant degree of bank, but at least it starts there. What I want to know is: If I have to centralise the ailerons to start with, then why don't I centralise the rudder, by removing all of it?"

"I am delighted with that question, because it is one of the points I'm bringing up in this little lecture. First though, I would like to say just a little bit about lift. In any case, it will tie in with answering your question.

"Something has to get an aeroplane off the ground. We call it lift. But there is something else, which would like to get the aeroplane back on the ground. It's called drag. Where there is lift, there is also drag. If it was not so, a glider need never return to earth, unless of course, it was flying in descending air. There are three main causes for the creation of lift. The shape of surface which the airflow passes over, the speed of the airflow and the angle at which it arrives at the surface. Most of the total surface is made up by the wings, so the shape of the wings is important. In past days, the upper surface of the

wing, was rounded from the leading to the trailing edge, in a convex manner, while the under surface was flat, or slightly concaved. With most modern wings however, both surfaces are curved outwards, that is convex. By the way Harry, if you were to take a straight line from the leading edge, through the wing to the trailing edge, that would be called 'the cord line'. When the airflow is about to strike on the leading edge of the wing, the airflow parts. Some air goes over the upper, some along the under surface. The stream of air passing over the upper surface, accelerates and in doing so, creates low pressure over that surface. You may, very loosely, think of it as a semi vacuum that must be filled. Hence the lift over the upper surface of the wing. Many laymen imagine the wing is being pushed up to make it fly. Actually, more lift is generated from the upper surface, probably two thirds."

"You have mentioned the older wing, in what way is the modern wing different?" asked Harry.

"Most modern wings are rounded in the convex manner on the lower surface as well as the upper. Actually though, the stream of moving air over the top surface still travels faster than the lower air. This is because the wing presents itself tilted slightly upwards to the airflow, enabling a low pressure to develop. The angle at which the airflow reaches the wing, is known as the 'angle of attack'. Remember 'the cord line' I mentioned Harry? Well, you measure the angle of the airflow to that. That is until the angle reaches around 15°, which in most cases, is the point at which the wing stalls. The tilting angle of the 'cord line' to the fuselage is known as the 'angle of incident'. We have seen how the shape of the wing, and the angle of attack, effects lift. To that we add the speed of the airflow. The faster the airflow, the greater the lift. Generally speaking, the deeper the camber of a wing, the greater the lift. So when you move the stick to the left, which, remember, puts the right aileron down, you are increasing the camber at that point. Which in turn increases the lift and so starts the wing rolling. Remember Harry, more lift more drag. Now the outboard of the upward rolling right wing is producing more drag. You can think of it as an invisible hand pulling the wing back. This pull on the wing swings the nose up to the right, away from the intended turn. We call this swing 'adverse' yaw. You know now Harry, that the 'effect of aileron' is to cause roll. But now we have discovered a 'further effect' which is to cause drag, which in turn causes 'adverse yaw'. The whole of this effect is as follows: After the adverse yaw has taken place - and bear in mind Harry, the nose yaws above the horizon because of the bank, as well as away from the intended

turn - the glider is no longer in balanced flight. It is in fact moving slightly sideways through the air, with a draft entering the left clear vision panel. Because of the glider now being banked, with the nose above the horizon, it starts to slip in towards the lower wing. Very soon a weather-cocking action takes place, causing the nose to fall away from its high position and back into a clean airflow, flowing directly from nose to tail. The glider is now in a clean diving turn to the left."

"I think I have most of that" said Harry, "but I am not sure why the glider should weathercock."

"Think back on the procedure of parking a glider. Why do we place a tyre against the lee side of the rudder, especially in a strong wind?"

"To prevent the glider from weather-cocking, due to there being more surface behind the centre of gravity than in front," said Harry.

"So Harry, to enter a bank to the left without rudder, we get adverse yaw swinging the nose to the right. Remember your first flight where you were shown the effects of controls? Can you recall what happened when you used rudder alone?"

"Yes, the nose of the glider yawed to one side."

"Which side? Any old side?" prompted the instructor.

"No, of course not. If I applied right rudder the nose yaws to the right."

"That's right. And of course applying left rudder causes left yaw. So, moving the stick across to the left in coordination with the left rudder, cancels the drag from the right aileron going down. If you coordinate stick and rudder, the yaw from the rudder and the adverse yaw from the aileron cancel each other. Neither being dominant, the nose pivots on the horizon as the wings start to roll into the bank.

"There is also 'further effect' from rudder. It causes the glider to roll. You see Harry, when you use rudder only, the effect is to yaw the glider, as you know. This means, if you rudder to the left, the left wing will swing back with the airstream as the right wing swings forward into the airstream. The left wing decelerates, while the forward going right wing accelerates. Remember! More airspeed, more lift. The forward going wing, is producing more lift. Hence it will roll."

"Now at last Harry we are getting to the point of answering your question as to why we take off most of the rudder during a turn. When the glider is in a

bank, especially a steep one, each wing is describing an arc. The arc from the upper wing-tip is greater than that of the lower wing-tip. Therefore the upper tip is travelling further and must have a greater air speed. So it is producing more lift. Remember, more lift, more drag. So we balance the drag by leaving a little rudder on. Got it?"

"I do believe I have. Though maybe I had better do a little thinking about it later. But I have been thinking. If the glider is banked, it should turn, shouldn't it?"

"Yes," agreed the instructor.

"Well, could it not be easier to just use the rudder for turning then?"

"Maybe easier, but the degree of bank and therefore the turn, would be limited. But more important, it could also be dangerous, leading to a spin in some circumstances. Anyway I will go into that point later in your training. For the moment let's stay with 'further effects'. So what about further effects of elevator! You will be happy to learn there are none! I will be honest concerning the business of leaving a little rudder on during a turn. It is being rather a perfectionist and it will take some time before you get it just right in the turn. But it is something to aim for. For the moment it is enough to work on developing your coordination. Flying well, like many things, is a matter of feeling. I mean, getting back to the turn, think of the central position of the stick as that point where the wings are neither adding-on nor taking-off bank. Sometimes it will be a little to the left, or a touch to the right of centre, due to the air movement or aileron design. If the bank remains constant, then the stick is in the correct position, wherever it is.

Once again, Harry is airborne.....

"You are improving Harry. So now you can put further effects into practice. Start by trying the ailerons with their adverse yaw. I will talk you through, so don't be timid with the movements for this exercise. Please slide the clear vision panel open on the left hand side of the canopy. Right. Now you retain control and listen to me. You will bank to the left for this one, so if you are sitting comfortably, we will begin. What must we first do?"

"Look out to see if it is clear," answered Harry.

"You are learning. O.K. keep the rudders centralised, resisting any pressure which may come on them, and take the stick well over to the left. Can you see the nose being pulled above the horizon and out to the right as we roll left?"

"I can," replied the pupil.

"Keep the bank on Harry. Are you now feeling the strong draft coming through the left panel?"

"I am."

"That's because we are side-slipping in that direction, due to the bank not being balanced. Now note the nose weather-cocking in the direction of the lower wing, as we are about to enter a diving turn to the left. Hear the airflow noise rising? O.K. I have control now.

"Now we are straight and level again. You have control."

"I have control," repeated Harry.

"O.K. Now you go into a turn, using full coordination and note the difference. That was a good entry. In fact the whole roll in, holding in and rolling out, were good. Now show me the further effects of rudder. I shall talk you through but I will not be on the controls, so please make your look out Harry."

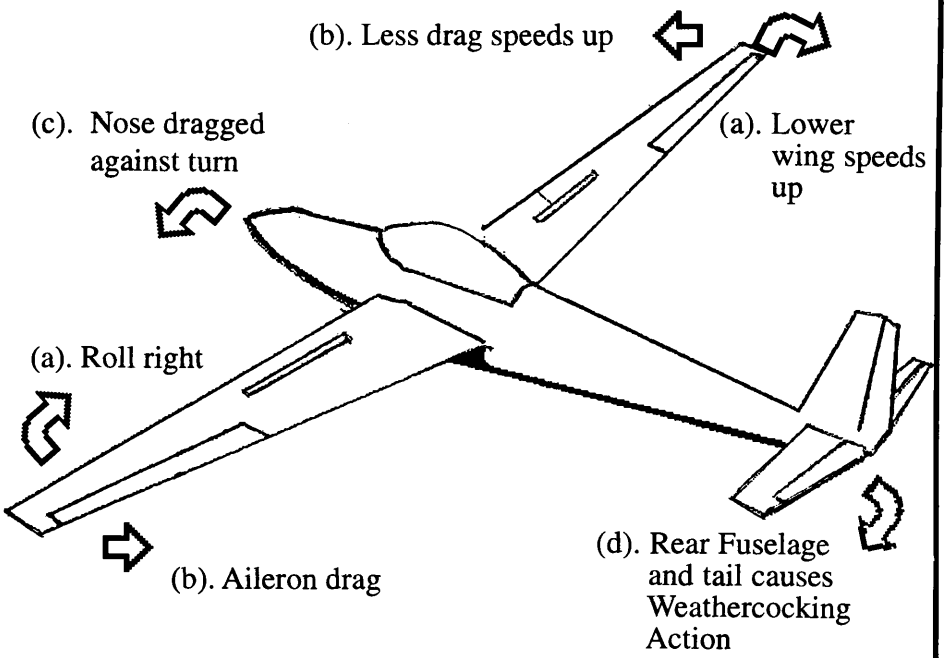
"It is clear."

"Right, hold the stick firmly in the centre and apply full right rudder. Good, feel the draft as the nose yaws to the right? See the faster moving left wing rising, bringing the glider into a bank. Now centralise the rudder and note the removal of the draft from the left side. O.K. Get straight and level again now. Well, there you have it Harry, the further effects of controls. You know something about them now I think and also what to do to keep a balanced flight. With plenty of practice you will have no problem. I think I have informed you there is no further effect of elevators. The elevators will always cause the nose to move up or down relative to the pilot, regardless of the attitude of the glider.

"O.K Harry, take me home, that will do for today. As a point of interest, the adverse yaw is much more pronounced on a glider than on a powered aircraft. This is because of the larger wingspan, relative to the fuselage of the glider, which gives the drag from the outboard wing more leverage. Also many powered aircraft have specially designed ailerons. The up-going ailerons on the down going wing are made to deliberately produce more drag, to balance the induced drag, coming from the down going aileron on the up going wing. With it's engine, the power plane can afford such a luxury. Not so the glider, as we want as little drag as possible, so we must fly with a greater degree of coordination.

FURTHER EFFECTS OF CONTROLS

Ailerons



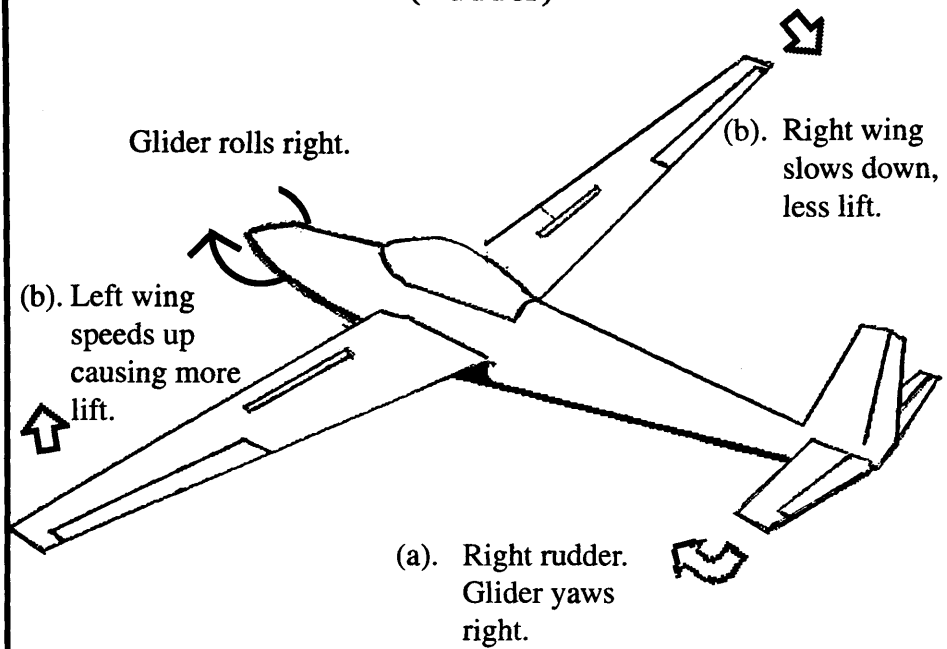
With the stick to the right the glider starts rolling right. The down aileron on the left up going wing creates more drag than the up aileron on the down going right wing. This extra drag from the down aileron on the up going wing causes the glider to yaw left, against the turn. This is "adverse yaw".

The glider is now in unbalanced flight and slips towards the lower wing, creating a side draft. Since there is more fuselage behind the C. of G. than forward of it, plus the surface of the fin and rudder, a weather-cocking action takes place, bringing the glider into a diving turn to the right.

ie. Further effects of the Aileron:

1. Adverse yaw. 2. Weather-cocking. 3. Diving turn.

FURTHER EFFECTS OF CONTROLS
(Rudder)



Right rudder yaws the Glider to the right with left speeding up and gaining more lift as right wing slows down and loses lift. Glider rolls right.

CHAPTER FOUR

"On your next flight Harry, you will as usual practice straight and level and turning flight. But then we are going to add to your flying the use of trim. Until now I have been setting up the trim, perhaps without your knowledge, but after this coming flight, you will be doing it yourself. First, before we fly I want you to walk to the tail. Now look at the small surface built into the trailing edge of the elevator. Got it ?"

"Yes, it seems to have two fine control cables running to it."

"That's the one Harry. Now watch. I'm keeping the elevator in the neutral position with the stick in the cockpit, but when I move the green trim lever forward, notice the trim tag slopes upwards. Now, by bringing the lever back, the tag slopes down. Maybe you have already appreciated the trim lever does not work in the same sense as the control stick. By this I mean I'm keeping the elevator in the neutral position with the stick in the cockpit, but when I move the green trim lever forward, notice the trim tag slopes upwards. But if I push the stick forward the elevator slopes down. However, don't worry about that Harry, because when you are in the cockpit, the effects on the direction of the pitch of the glider is the same when either stick or trim lever is moved forward or backward. I might add now Harry, that as from your next cockpit drill, you will include the correct movement of the trim tag."

"O.K. Will do."

"As you can imagine, since the trim tag is built into the elevator, it must in some way have an effect on the elevator in flight, so let us go up and find out what it is."

On releasing from the tow, the instructor was able to gain height before handing over control to the pupil for him to carry out his usual warming up practice.

"Right Harry, that's fine. Settle down at 45 kts in level flight. Now take your hands off the stick for a moment. See, the glider is maintaining the same altitude in pitch. The nose is neither lifting or lowering. This is because I have trimmed the glider to fly at 45 kts. Now take hold of the stick again and lower the nose to an attitude for 70 kts. Go on, keep trying until its around 70, which of course means you have to retain a constant forward pressure on the stick to maintain the new speed. That's about right Harry, so maintain the pressure on the stick and at the same time, push the green trim lever forward,

until it has taken off all the pressure from the stick. Right have you done that? Has the pressure gone from the stick?"

"Yes. I don't have to push it for it to stay now."

"Well, let's see. Take your hand away from the stick. If you have got it right, the new attitude will not change. Ah yes, that is fine. Now, without touching the trim, bring back the stick, until the glider is again flying at 45 kts."

"I am about there," said Harry, "but I am having to hold the stick back all the time."

"O.K. then, let go of the stick and notice how the nose will lower below the horizon, with the glider increasing speed. There we go. This is because the glider wants to fly at 70 kts, as it is still trimmed for that speed. Right then, take hold again to bring the attitude back to 45 kts. Now bring the trim lever back, until the backward pressure is removed from the stick. So my boy, this is what you should have discovered. You find a new speed i.e. pitch/attitude with the stick. Then you maintain the new attitude by removing the forward or backward pressure with the trim. Now the movement of the trim lever is in the same sense as the stick, which is to say, if you need to hold the stick forward, then move the trim lever forward, until no pressure is required on the stick. And of course, if there is a back pressure, you remove that by bringing the trim back. Remember Harry, if you want a new speed always attain it by the use of the stick, then trim 'to' it. Do not change your speed with the trim. Practice trimming to several different speeds. Each time you feel you have got it correct, lift your hands so that I can see them. If you have got it right, the glider will stay put."

Presently the glider landed. But before leaving Harry, the instructor reminded him that with a new speed, resulting in the glider's change at attitude, the stick remains in its new position. Therefore one trims to it, whereas to maintain a bank, the stick returns approximately to the middle, or its starting position.

Another day and another flight. Once again the tug aircraft fell away to the right, as it parted company from the glider.

"I want you to practice some more straight and level flying Harry," said the instructor. "In common with other pilots at your stage, you are not yet holding an absolutely straight course. It seems this is a little more difficult than one may at first expect. Now the best way, at your stage, is to pick out an object a

long way ahead, such as a building or a different coloured field, or maybe a patch of water. Anything you can use as a distant marker. Then, if the glider's nose stays pointing directly at it, you will be flying straight and level. But if the nose swings to either side, even only slightly, then you are not.

"Look, there is a small wood, a little to the left at about 11 o'clock. Line up on that. That's it, now try to stay just there. Oh dear, the nose has swung away a little. Look, now it is going past the other side. See Harry, you are not quite holding the wood, but are alternating from side to side. The cause for the swinging is very small further effects of ailerons, resulting from not perfectly coordinating with the rudder. Because the corrections required, are so slight, it is hard to get the balance of aileron and rudder just right. So here is a tip for you. When a very small swing takes place, you can correct it with rudder alone. Now Harry, I must emphasize, that to use rudder alone is only for very small alterations of swing. Never try to use rudder only to make a real change of direction, as this can be very dangerous indeed. Later I will explain why, but now just take it as read. However, it is perfectly safe, to use rudder for small corrections of swing. Look, here comes a swing to the left again, so touch the right rudder and as the nose returns back towards the wood, 'kill' the new swing with a touch of left rudder, then immediately centralize both. Good, keep practising and you will soon notice your own improvement.

"O.K. Harry, you have been at it for ten minutes and are coming along fine. Getting better at straight and level all the time, so let me climb in this thermal and I will explain to you, why the rudder alone for small corrections, keeps the glider straight and level.

"Right, we have got ourselves another 3000 feet, giving us more time in the air. I'll explain then, what was happening when you were using rudder only. The lift produced by the wing is perpendicular to the airflow which is passing over the wing, so, in effect, the lift is almost perpendicular to the wing. If the wing is level with the horizon, then the lift is perpendicular to the wing and vertical to the horizon, so in this state the glider must be flying straight and level. If, though, a wing is banked say 45° to the horizon, then the lift must also be 45° to the horizon, but still perpendicular to the wing. The effect being, to pull the glider inwards towards the turn. The inward pull would be at its strongest if the wing was at 90° to the horizon. But, as a wing decreases its angle of bank, the inward pull becomes less and less, until the wing is

level again to the horizon where there is no inward pull. All the lift now being both vertical and perpendicular. You can see Harry, that if the wing is banked only a few degrees there will still be an inward pull towards the lower wing, causing the nose to swing away from the aiming point. If, in such circumstances, you use only the rudder, there will be no further effects of aileron because you are not using them. They remain neutral. But, using only rudder, will yaw the glider back to the aiming point and, the further effect of rudder will lift the lower wing due to it speeding up, even if it is only slightly. Remember, it was due to the wing being down in the first place, that the nose swung from the aiming point. Then, as the nose swings back to the aiming point Harry, you kill the swing with the opposite rudder before centralizing both. Anyway Harry, that should give you something to think about before you go to sleep".

"I am sure it will. Thanks a lot," said Harry.

"You are ready now to make a start on launching the glider yourself with the use of aero-tow. The wind is blowing straight down the runway and is fairly light, so the conditions are good for learning. Also the air is generally stable, which means you will get a smooth ride, any deviation of the glider will result from its own controls rather than from turbulence. So, if the tug appears to move from side to side, or up and down, it will be the glider moving out of position, not the tug. However, with your progress so far, it will not be long before you are following the tug nicely. Soon you will appreciate why we trim forward in our cockpit drill. While on the tow, we want to avoid having to hold forward pressure on the stick. This would be necessary if the trim was in the neutral position. You see Harry, as the combination gathers speed, the lift is all the time increasing from the wings. Remember, more speed more lift! Which means of course, with a neutral trim, you would be applying more and more forward pressure to stop the glider from lifting high above the tug. Any release of forward pressure could cause acceleration through an upward arch on the end of the rope, resulting in a sling shot effect with the glider getting high above the tug. This may well overcome the power of the tug's elevators and cause it to enter a steep dive from which the pilot would not immediately be able to recover. A very dangerous situation, if at all, near the ground. It is much better to have a little back pressure, as it is far less of a problem should the glider get low. Anyway, when the glider is moving downwards there is no sling shot effect.

"Now concerning the take off Harry. As you start to roll down the runway behind the tug, the slow flowing air over the surfaces will have little effect on the controls. What effect you can get will only be achieved from large coarse movements of the controls. As the speed increases the controls will become more firm, resulting in less coarse movements being required from the pilot. As we roll behind the tug Harry, you must steer with the rudder only. The ailerons are used only to keep the wings level. The use of the rudder is to make the glider pivot around its main wheel. Or rather 'not' to pivot, so keeping directly behind the tug. This means, that until the glider is off the ground, you must not coordinate the controls. It will be new to you, because until now you have been coordinating all the time. However, on this tow, you will not have control until we are at 500 feet.

"Here we are then, at 500'. If you look carefully at the tug Harry, you will notice that I have placed the wheels of the tug on the horizon, which is a good place to have them throughout the entire launch. If I ease back a fraction on the stick, the wheels, followed by the complete tug, slip below the horizon. Of course, it is the glider which is changing position, but it appears to be the tug. Right, I've got the wheels back on the horizon again, so now we look along the tow rope, see how it is in line with the rudder and the rudder is in line with the fuselage. This means, the glider is in station directly behind the tug. If it were not, the rope would leave the tug at an angle. You have control. Remember, only make small corrections."

"Struth! This is more difficult than it looks."

"Most people think so at first, but you will be surprised how quickly you will catch on, now that you can fly a little. O.K. you have control again."

"Hell, now I am way out to one side."

"Hey, not so much control movement. I have control. Now try following me through. See if you can detect the rather slow and fine movements. Look, I've only a slight bank on and the glider is sliding gently across into position, and just before it is quite behind the tug, I level the wings and centralize the controls. If we did not level off slightly early, the glider would continue its sideways slide on the end of the rope a little past the centre line, so we anticipate for that. Look, I'll show you something Harry. We will deliberately put the glider out of position to one side. Now, if we just level the wings and leave them level, the pulling angle of the rope will slowly bring the glider behind

the tug again. All you have to do, is sit there, keeping the wings level and remain at the right height and the pull will do the rest. But of course you should speed up the slide by applying just a little bank. O.K. I still have control, but follow me through again Harry. We will place the glider below the tug so that we can regain station from below. The tug is well above the horizon to our view. See if you can sense with me the gentle movement on the controls as we climb slowly up into position. Now check the controls just before the tugs wheels touch the horizon again. Right, lets move down again together. Now you take it back gently into position. You have control."

"I have control," said Harry.

"Not bad. Not bad. But gently go down a touch as you have gone a little high. Can you see the tug's wing is a bit below the horizon. Bring the wheels up to it, then for the rest of the tow try to stay in position."

Later that day Harry and his instructor were to be found in the club house, chatting over a coffee.

"The weather today was lovely and clear, but of course it is not always like that, unfortunately. Many are the times when the horizon is far from distinct, making it not possible to place the tug's wheels on it. Should it be hazy you will not see where the earth finishes and the sky begins. So, how can we tell we are in the correct position behind the tug?"

"I can't imagine how, without the horizon, from what I have seen today," said Harry.

"I've news for you. When you can keep your position behind the glider competently with an horizon, you will soon do so without one. I'll tell you how. The next time you take an aero tow, you will again be using the horizon. With the tugs wheels placed on the horizon, I shall point out to you the position of the tailplane, and you will find that it cuts across the wing struts at a particular place. For argument's sake, let us say when the wheels are on the horizon, the tailplane cuts across the wing struts a quarter of the way up. Now, if I take the glider too low, the tug will appear to lift above the horizon causing the tailplane to slide up the wing struts. Of course Harry, if we move the glider above the tug, we get the opposite situation, where the tug apparently drops below the horizon, and, this is the point, the tailplane slides down the struts. From this Harry, you can see if we know where the tailplane should

bisect the struts, we do not need an horizon, nor very good visibility. While using this method, we still want to see the rope in line with the rudder and the line of sight with the rudder, straight along the fuselage. Here is another way of keeping station. One can use the tug's rudder as a reference. Again, whilst being towed in clear air with a good horizon, we will note where the top of the rudder is placed. On some tugs, it will be on the canopy, about at the pilot's head. So, if you can see the tip of the rudder is beyond the pilot's head, then the glider is too low, but if it is well down the fuselage behind the pilot's head, you are too high. Of course, if the rudder should be to one side, then so is the glider. Rudder to the right side, means the glider must be to the left, and of course, vice-versa."

"Remember your first aero-tow and your concern with your efforts to follow the tug? Well your towing is coming along very nicely now Harry."

"Yes, at first it did seem as though I was chasing a tug which was trying to get away from me all the time. Now I can sense much better, that it is the glider which moves. Anyhow, I hardly ever get out of position now, don't I?"

"I agree, when you are in position you don't lose it any more. On this next flight Harry, I will introduce a couple of more points for you to master, then you will have buttoned up basic aero-tow training. But of course, as with most things, competence will increase with practice. Alright. Off you go, the cable is attached."

"All clear above and behind?" called Harry to the wing tip holder.

"All clear," came the reply.

"Take up slack."

The tug's propeller seemed to turn into a disk as the revolutions increased. Soon the glider's tip had parted from the man's hand, and Harry was using coarse controls during the early stage of the take off run. The glider moved a little to one side of the tug, and while bringing it back into line with the rudder, the instructor saw Harry had the stick hard over, giving the aileron full deflection as the prop-wash lifted the wing. A moment later they were in line, with the wings level. The instructor smiled.

The combination was a short way past the boundary of the airfield at 200' when the instructor said: "Point out the field you would land in, if we were to part company with the tug now."

It took Harry a few moments to identify the field, which had previously been recommended. The added pressure of search for the field while on tow at a low height, almost proved too much. His station behind the tug became unsteady, but did not get out of hand before the tug was again under full control and the field identified.

At 800' the instructor said: "I have control. Follow me through on the controls. We are going to place the glider at each of the four corners of a square, with the tug at the centre of the square. We will stay in position at each corner for half a minute or so. We will start with the bottom left, then climb to the upper left. We will cross over to upper right, before dropping down to lower right. And finally, diagonally up left to the starting position behind the tug. O.K. here we go to lower left. You know from your aero-tow training so far, if we fly in this new position with the controls balanced and with the wings level, the pull on the angle of the rope, will slowly return us behind the tug. To prevent this, we put on a very small amount of left bank. Right, we are ready to move up to high left. We move up slowly Harry, because we do not want the glider to accelerate during the changing of position. We must be especially careful when high, note also, there is still slight left bank on. We'll now slide from high left to high right. I am replacing the left bank with even less right bank, because we will have angle pull from the rope towards the tug for a short time. But, when passing over the tug, we will increase the right bank, because the angle of pull from the rope starts to work against us. O.K. Now we will move down from high right to low right. Even though we are moving downwards behind and to one side of the tug, we still must not do so too quickly. It is true, there is no sling shot effect when moving down as there can be when climbing and describing an arch which maintains, or even increases tension on the rope. However, if one moves down too quickly, the tension will be removed from the rope due to the glider accelerating, becoming faster than the tug. Then when the glider has stopped descending, its drag slows it to a speed less than the tug. This results in the tug rapidly taking the slack out of the rope, which then causes a jerk as the rope becomes taut. Just one more point Harry. I said the tug is the centre of the square. Well that is not really the case, because we make the two bottom corners further down from the tug than the upper corners are high. This keeps the high part of the square within safety limits."

Harry's effort at 'squaring the tug', left a lot to be desired, but he did learn something about large movements while on tow, which was after all the object

of the exercise.

"Now Harry, before you release, I want you to fly into, what is called, the low tow position. It is not often used for an ordinary 2000' tow. But it is useful, if one was to do a tow over a long distance, as the low tow is rather more stable than the high tow and therefore less tiring over a long period. I'm going to talk you into the low position, so gently take the glider down. Carry on, I will tell you when to stop. In a moment there will be buffeting as the glider passes through the tug's slipstream. Ha, there it is now, keep moving down. That's it, we have passed through and are in smooth air again. Now gently take the glider up, until you feel the canopy is just out of it now, that's right. That is the way to check that the glider is exactly in the low tow position, Harry."

CHAPTER FIVE

"That was a nice flight and we had a few good climbs, but now we are down to 1.000'. We may have to join the circuit soon. From now on you will fly the circuit with, I hope, only verbal advice. As the lift faded Harry, I deliberately guided you to this position by telling you where to fly. There is no reason why we can't use another thermal, if we can find one before losing more than a couple of hundred feet. But should we fail, then we will move over to the high key position, which is the start of our circuit at the beginning of the down wind leg. The high key position is to one side of the runway at a height of 6/700 feet. We can carry out a left or a right hand circuit, depending on wind conditions, or what has been previously agreed before take off. The first leg of the circuit is achieved by flying parallel to the runway and down wind. That is flying with the wind; a tailwind. So move over to the high key position on the right hand side of the runway. As you fly down wind on the first leg, the runway will be on your left, so you will be flying a left hand circuit.

"On reaching the high key Harry, your aim will be to see the runway at an angle of 30° to one side, this will indicate how far out you should be. It is not difficult Harry if you do it this way. First note a forty five degrees angle, which is easy to read if you remember that the horizon is not just in front of the glider, but is all around it. So with wings level, and flying parallel to the runway, you look at the horizon on your left side, if flying a left hand circuit. You then bring an imaginary line from that horizon to the cockpit and drop a perpendicular line of 90° to the ground, making a right angle. It is then easy to imagine bisecting the right angle at 45°. If you find the 45° line strikes the ground at, or beyond the runway, then you are too close in, because this means the line of 30° down from the horizon will be striking the ground well beyond the runway. But, by opening the circuit out, you will bring the 30° line to the runway. Eventually you will know you are about right at a glance.

"So here we are at 650', a little up wind and at 30°. The high key position. Perfect! At this point we do our pre landing checks, which is remembered by the mnemonic U.S.T.A.L. U is for under carriage, which must be lowered. If we are flying a glider with a fixed wheel, like this one, we still say under carriage, though we can't do anything about it Harry. This way we will not forget to lower the wheel when we are flying a retractable wheel glider. S is

for speed. During the down wind leg we will increase the speed by 10 kts. A high performance glider may well reduce speed when joining the circuit after a high cruising speed. Then we have T for trim. So we trim to our new speed. This is followed by A for airbrakes. At this point, we find the blue airbrake lever with our hand, though at this stage we do not usually open it. Finally we have L for lookout. During lookout we look for any other traffic which may be on the circuit. We note if the landing area is clear, and if not, we will adapt for a landing further down the runway, or, if practical, to one side of the normal landing area. Finally with lookout, we make sure we can see any tugs which may be approaching the base leg from either side. All that may seem a lot Harry, but eventually you will find yourself doing the full checks in less than a minute.

"Anyway, here we are, near the end of the down wind leg, or the low key position. We have of course lost some height, we are down to 400'. You will note the landing area is still as 30°, even when we allow for the loss of height, this is because we move in slightly towards the runway as we lose height to keep the angle correct. If we had kept the same distance out from the runway all the way along the down wind leg, then at this height our angle to the landing area would be flat, at say 20° rather than the desired 30°.. We are now going to turn left through 90° onto the base leg from a height of around 400'. We aim to start the turn away from the base leg slightly before we are directly opposite the runway, so that we are opposite it on the completion of the turn, by which time the glider should be about 300' high. As we make our approach for the landing, we are flying into wind with an approach speed of 50 kts. Now open the brakes about half way. Good, leave them like that. Look along the runway, not at the far horizon. The speed is falling off, lower the nose slightly and bring your eyes a bit closer in. Ha, that's better, keep it like that. Now, from this height, which is about the height of a house, no don't look at the altimeter, keep your eyes moving along the runway about a hundred yards ahead until the touch down. We are almost down, ease the stick slowly back, slowly, bring the nose level, not up. Now more back as the speed dies, that's it, we are down. Keep her rolling straight with rudder. Lift the left wing but do not coordinate. O.K. we are stopping now. You can relax now Harry, you did pretty well. We will go to the club house, have a drink, then I'll give you a more in depth talk on circuit planning.

"All the circuits which you have been personally involved with, have been with a slight wind blowing straight down the runway. Often the wind is strong,

or is blowing across the runway from, say, a few degrees through to a full cross wind at 90° to the runway. With such conditions we have new considerations to add to the planning of the circuit. Have you any idea how a glider will be moving through the air if it were pointing to the north but a strong wind was blowing from the west?".

"Moving through the air! Well I suppose we would go sideways through the air, but we would move forward as well because we would have an airspeed," considered Harry.

"Are you saying there would be a draft blowing in from the left, because if we were pointing north a west wind would come from the left?"

"Yes I think that is what I am saying," said the pupil.

"No, that's not right Harry. You see, when we are not attached to the ground, we are part of the air mass so we move with the air movement, then we add a movement through the air provided by any other power source, such as an engine or gravity. Let me explain."

"I think maybe you should," said Harry, frowning.

"If you were in the basket of a balloon, the balloon being tethered to the ground, so that it could not be blown away by the wind, you would find yourself stationary over the ground."

"Yes, agreed."

"So, your ground speed would be zero. Right?"

"Right."

"Now, if the wind was blowing at 20 kts. What would be your airspeed?"

"You said I'm tethered to the ground so there will be no airspeed."

"Ha, Harry, I think you have the impression that your machine must move over the ground in order to move through the air to obtain an airspeed. Certainly, a machine moving through the air does achieve an airspeed. But an object, stationary over the ground, such as a tethered balloon, can also have an airspeed. You see, wind blowing air past an object which has no ground speed, has an airspeed equal to that of the wind speed. So, air speed is achieved by the air flowing over the machine. It does not matter if the air is flowing past a machine that is stationary over the ground, or, if the machine is moving over the ground and moving through stationary air. Just as one can have an air speed with a zero ground speed, one can also have a ground speed with a zero airspeed."

"I don't get," said Harry.

"You will. Lets put you back into the balloon's basket. It's a nice windy day. Lets say 20 kts. We untether the balloon and off you go. After a while you fancy a smoke, so you take out a cigarette and strike a match. At once you shelter the flame with your hand but you are surprised to discover the flame burns steadily, despite the 20 kts wind you are in. And that is the point Harry, you are 'in' the wind and are moving with it. You are part of the air mass. The air is not passing you in any direction. In fact you have a zero airspeed. But since the balloon and the air are as one, moving over the ground together, you do have a ground speed of 20 kts. The same as the wind.

"So you see, an airspeed and a ground speed are two different measurements and are not necessary from the same direction. By that I mean, providing you add some power, you fly through the air mass with the air flowing directly along the fuselage from nose to tail, but the aircraft also moves 'with' the air mass in the direction it is moving at 20 kts. Therefore the aircraft's movement through the air is in the same direction as its movement over the ground, or its track, as we say. Not in the direction the nose is pointing. Unless, that is, the aircraft is flying directly into wind, directly with the wind or flying in no wind at all.

"In all those circumstances the aircraft will be flying in the direction it is pointing, both through the air and over the ground. If this is not fully clear Harry, this will help. Imagine you are flying in a 90° crosswind, blowing from the left. The nose of the aircraft is pointing directly at a small village. Then you notice the village seems to be moving to your left, as you move with the wind to the right while you fly forward. You will soon see from the line the aircraft is taking over the ground your track is not where the nose is pointing. So, if you want to make a track to the village, you will need to point the nose to the left, which will be partly into wind. How much into wind, will depend on the strength of the wind. The stronger the wind, the more you will turn into it, before the track over the ground is making for the village.

"Remember Harry, when you have found the correct track, you will fly with the aircraft's wings level and with all controls central, so that the airflow flows straight from the nose to the tail. Just because you are tracking to the right does not mean you have to keep left rudder on to keep the nose partly into wind. Remember, you are part of the air mass and you are moving with it as well as through it"

"Ha, now I think I understand," smiled the pupil.

"Good. You will understand what goes on with cross wind circuit planning now. Its all a matter of adjusting the gliders heading to get the track we want.

"Today we have a crosswind Harry, about 60° across the runway. Of course, if we were able to choose another runway which was into wind, we would do so. But since this is not possible, we have to handle the situation we are in. If we would be able to choose a left or a right hand circuit, we would take the circuit which has the wind blowing out from the runway as we fly the down wind leg. I should explain here, the first leg of the circuit is always known as the down wind, even if the wind is not blowing down the runway. It's a positional term as much as anything. I know we have only reached 1,000' but I want you to release from the tug now, please. Good. We are only interested in the circuit for this flight. So more height is not required. Move over to the high key position, so that we are blown outwards if we were to fly parallel to the runway, Harry. That will mean a left hand circuit in this case."

"O.K. here we are at the high key," said Harry.

"Are you satisfied with your 30° angle, because I'm not!" said the instructor.

"Er, maybe the angle is a little steep," confessed the pupil.

"We are much too close in. Move out."

"How's that?"

"Much better. I am surprised at you . Don't start letting me down. I have been singing your praises. So tell me what you have to do to track parallel to the runway in this crosswind."

"I'll have to turn the nose to the left, partly into wind."

"That's my boy."

"Yes, but I am not sure how much, Boss."

A smile crossed the instructors lips, as he said: "Until you see you are tracking parallel with the runway. If the glider continues to track outwards, even though you are now flying at a lesser angle, then you have not turned enough. On the other hand, should the glider start to track towards the runway, you have overdone it, by turning too far. So observe your track Harry, and sort it out."

"Right. I reckon I've got it now."

"That's O.K. Get on with USTAL, the pre-landing checks."

"Checks completed, but I am at the low key now, ready to turn onto base leg.

I like my angle to the landing area. Do you?"

"I've no complaints, said the instructor.

Harry progressed along the base leg, but because of the strongish head wind component, his ground speed was slower than the other circuits he had done, but he did not notice this to be so, he was about to use air brake until the instructor told him to leave them closed. Harry turned off base leg onto the approach at the point he had learned to use when the wind was straight down the runway, but because of the head wind component, against which he was now flying, his turn was completed too early, which resulted in his approach being at the near side of the runway. The instructor knew precisely what was happening, but allowed the error to take place, enabling the pupil to 'see' the result of his error, which adds much more weight, than simply being told what the result would be, if he did not make allowance for the head wind component.

"Look, we are at one side of the runway. You did not allow for the wind, the turn was made too soon. Bank over to the right while there is still time. Then start the approach again when you get opposite the runway. Right. Turn onto the approach now. That's better, but stop the drift to the left, turn the nose right, more into wind. That's better, now the glider is crabbing, or tracking, along the extended runway centre line. Note how the landing area does not appear in the centre of the canopy, but is over to the left side, where it must stay until just before we land, at which time we will yaw the nose left with the rudder, to place the glider straight on the runway. If we line the glider to the runway too soon, the drift will take hold again, making the glider arrive on the runway with a sideways movement added to the forward movement, which is not at all kind to the under carriage. Anyway, I have control now."

"Come, let's sit in my car and we will talk a bit more about the effects of wind on the circuit. There is something I would like to have explained," said Harry. "Why did you say, with a cross wind circuit it is better to fly the circuit which has the wind blowing out from the runway, as the glider is on the down wind leg? That meant flying a left hand circuit for the one we have just done. Why could we not have flown a right hand?"

"We could have flown a right hand, but it is better to have the wind coming out from the runway on the down wind leg, because this means you will have a nose wind component while flying base leg. You remember Harry, during the circuit, when you turned from the base leg for the approach, you discovered you had done so too soon?"

"Yes, I was a bit surprised to find I was to the left of the landing area."

"You realise why, don't you?"

"Yes, I do. Having thought about it. Because of having some headwind, my passage over the ground was slow, I think."

"You are getting warm, it is true you had a slower ground speed at that point of the circuit than you had previously experienced, but a point to bear in mind is, the glider, as it turns onto the approach is coming more into wind, until it actually passes through a full head wind. At the commencement of the turn from the base leg, the head wind component came from the left of the nose, then, after passing through the direct head wind, the component came from the right of the nose. Right?"

"Yes, I can see that," said Harry.

"During a turn then, the glider's track is describing a arc over the ground, isn't it?"

"Yes it is."

"Well, with a given angle of bank, the glider's track over the ground, in a no wind condition, makes a larger arc than it does when flying through a head wind component. Conversely, if, with the wind as it is today, we had flown a right hand circuit, so that the wind blew in towards the runway from the down wind leg, then, while turning onto the approach from the base leg the glider would pass through a full tail wind. The arc over the ground from this turn, would be larger than that of a still air turn. And much larger than from a turn with a headwind component. So, when there is a strong wind we will choose, if we are able, the circuit which will enable you to turn onto the approach from the base leg by passing through a head wind component. To bite into the wind that way, is more decisive. You can see Harry, if you turn onto the approach through a strong tail wind component, it will result in a large sweeping turn over the ground, for which you must make an allowance by turning in early. If you misjudged your circuit, so that the final turn is low, you could well be in a fraught situation. What's the matter? You are looking puzzled." commented the instructor.

"No, it's not that. I was just thinking what a fascinating sport this gliding is."

"I will second that. Anyway, let's continue with circuit planning."

"You mean there is more?" questioned Harry.

"Yes, there are a few points to ponder over, my boy. You see Harry, when you have been flying solo, as you certainly will, you may one day feel frustrated, because for the umpteenth time you have failed to make contact with a thermal. And there you are, already at the high key position of your circuit. True, it is rather a windy day, but nevertheless, some others are soaring well, but it does not help you to remove your disappointment. Anyway, you are in the circuit having by now completed your pre-landing checks. You will soon be turning onto base leg. Your angle to the landing area is good. When, hello, what's this? Turbulence has shaken the glider a little. On making a quick glance at the vario. You see the pointer moving 'up'. 'There is lift' you say, and at once bank the glider into a turn. Oh, how you concentrate on the instrument. You must have completed a full circle, and not once did the pointer indicate sink. True, it did not show much lift either, but at least you are holding your own.

"Having lost no height, for you are still at 400', you continue to turn. Encouraged, as the instrument indicates a bit of lift again, you feel at last you may 'get away'. But then, after a few more turns in zero lift, the needle drops into the 'sink'. Ah, well it was worth a try, you think and you are still at 400'. Nothing ventured, nothing gained. Better get onto base leg now. You look out. Bloody hell! Where's the landing area? God, I'm way down wind. But I am sure I was close to the low key, ready for base leg. Oh mother, look at this flat angle to the landing area and the ground speed is so slow against this damn wind. I will never get back. You are in trouble, my boy!"

"But I would never do a thing like that, Boss. Honest."

"Maybe not, but many have, because they had not thought enough about the wind. Or, worse still, they had not been told. Well I'm telling you now Harry, so that you will not make that mythical flight real. You see, in the mythical flight the effect of the strong wind on the turning circle, had not been considered. You recall what happened to your turn onto the approach through the headwind component?"

"Yes. I did not reach opposite the runway because the headwind slowed down my ground speed," said Harry.

"That's right. Now we know, that if you turn through a tailwind, the moving airmass is added to your speed over the ground. The total will give the glider a high groundspeed. Now, if you fly a full circle, as when thermalling, we

will have half the circle with a decreasing groundspeed because of the headwind, while the remaining half of the circle has an increasing groundspeed because of the tailwind component. This results in the glider's track over the ground, being anything but round. In fact it is oval. Something like a race track for horses. If the glider was making smoke during its turn, we would see a true air circle. But we would also see that it was well downwind from the point over the ground at which the circle started. This being due to the whole air moving. The mythical flight could only have remained at the low key position whilst trying to thermal, had it been in still air. Anyhow Harry, apart from anything else, the mythical pilot had displayed terrible airmanship in that he had not kept a good look out. Had he done so, he would have quickly realised what was happening. Would he not?"

"He would, Boss."

"What a beautiful day for gliding," commented Harry, who was returning after some pleasant soaring.

"Yes, it certainly is," replied his instructor. "But fly off, downwind of the airfield, please. You are not yet really competent with the use of air brakes, so I hope to put things right on the remainder of this flight. Your approaches for the landing are not too bad, but the accuracy for the touch down position leaves a little to be desired. As it is a lovely day, with a gentle 12 kts wind blowing directly down the runway, we will do a long approach on this flight without the usual base leg. So fly down wind Harry, so that we can turn onto the approach from about 7 miles back and from 1600'."

"Wow, that seems along way down wind," commented Harry

"Good boy, you are starting to think like an airman. However, you will find our angle to the field will be more than 30°, which will easily allow for the slight headwind. The long approach will allow time for you to learn about the brakes. Move over a little to the right, it will take the glider closer to the imaginary extended runway line. Of course, we must be aware all the time of our position relative to the airfield, which is now becoming lost from view. We do not want to finally turn and find the airfield further away than we had expected. We will therefore make an occasional turn, just sufficient to be able to glance over your shoulder, to check the airfield. Remember, even though the wind is not strong, we are travelling with it, so our ground speed is increased. O.K. We will be fine here, Harry. Turn through 180°. Can you

identify the airfield? It should be almost dead ahead."

"Yes, I've got it. I can just make out the runway."

"Fine. Now carry out the pre-landing checks, and as always, when you reach B for brakes, put your hand on the blue lever and leave it there. That's right Now keep a 50 kts airspeed steady, so that the glider's attitude remains constant. Take particular notice now, which part of the canopy you are looking through to see the airfield. That is your aiming point. Without changing the glider's attitude, tell me if you can detect any positional change of the aiming point on the canopy."

"Oh yes, I can see it moving down the canopy," said Harry.

"You are right. It is moving down the canopy, and if we continue at this speed/attitude, the aiming point will continue to move down until it disappears through the bottom. Do you agree that this is, what would happen?"

"Yes I do. I can see the point you are making."

" So, if we continue as we are, which of the following three do you think will happen?

a. Will the glider land on the runway?

b. Will it over fly the runway?

c. Will it land before reaching the runway?

Think about it Harry."

" Er. Well. Oh yes, I see. We will over shoot the airfield."

"Right. Now that the penny has dropped, it is easy to see, isn't it?"

"Yes it is," agreed Harry.

"O.K. then, watch this. Without changing the airspeed, I want you to open the brakes fully. That's it. Now tell me what is happening to the aiming point?"

"It is sliding up the canopy instead of down."

"So will we over fly the field now?"

"No, if we continue like this, we won't even reach it."

"Excellent my boy, you have got it," smiled the instructor.

"Thanks Boss."

The instructor said: "I have control. But follow me through."

After a movement of the brakes and a slight pause he said: "Look at the aiming point now, tell me what is happening."

"It is not moving at all. It is stationary on the canopy, but we are still flying at 50 kts," observed Harry.

"So, if nothing changes, we should land on the runway?"

"Yes we should."

"You are right, we would if nothing changes. But what if the glider flew into sinking air. What then Harry?"

"We would also sink."

"Indeed we would, which means our glide path would become steeper. Not the glider's attitude Harry, just the flight path, and we would see the aiming point climb up the canopy. That would tell us we were in an under shoot situation. If we were to fly into rising air, the opposite would be the case, giving an over shoot situation. But now you can see the aiming point is stationary. The reason, is that I have positioned the brakes to give a glide path, that will take us to the runway. The brakes are neither fully open nor fully closed. I shall now open them fully and cause the aiming point to climb up the canopy. You take control now, I want you to stop the aiming point from rising, make it stationary on the canopy by easing the lever forward. Remember not to change the glider's attitude. Watch it, the aiming point is moving down, you have overdone it, so reopen the brakes a little. That's better. Continue like that Harry. When you find the A.P. moves, make smallish checks with the brakes. Take regular glances at the A.S.I. to retain 50 kts. If the brake setting is not moved, and the speed/attitude remains constant, then the A.P. will also remain stationary on the canopy. Providing that is, the air is stable. You will then have a constant glide path. However, should the glider fly through vertical moving air, then the A.P. will move either up or down the canopy. It then beholds the pilot to check those movements with the brakes, so as to keep a constant glide path to the landing area.

"You are doing fine Harry, but I can tell you are having to 'think' which way to move the brake lever when the A.P. moves. It will help you, when you are under shooting, to think of pushing the glider 'forward' by pushing the brake lever forward. When over shooting, you 'hold' the glider back by pulling the lever back. We now find ourselves at 500' with the A.P. and airspeed steady. The long glide has done wonders to your air brake control. I think the problem is solved, Harry. From 100' do not move the brakes again before touch down. It is best that they should be positioned about half way open, approximately will do. Don't spend time trying to be exact with the brakes when at 200', but

with brakes 'fixed' you are able to devote all your attention to completing a good landing. Remember, when you are at the height of a house, look a 100 yards ahead and keep doing so until touch down. Good, hold off now, a touch more back pressure on the stick, that's fine, keep it like that with the nose slightly up. We are down, keep straight with rudder, don't coordinate the stick, wings level. What are you sweating for?"

"Phew, I'm glad that's over, but I feel fine Boss."

"And so you should. You did well. Come and help me park the glider then."

The instructor and his pupil sat sunning themselves on the grass, but the learning process continued.

"Harry, if our mythical pilot carried out a 'spot landing', then came to me saying: 'How about that then. I made a spot landing without the use of air brakes. Not bad eh?' Do you think I would offer my congratulations?"

"Well, I would think so Boss. It can't be easy, spot landing without using the air brakes at any time during the approach."

"What do you think I would have said, if he had made a spot landing with brakes fully open, all the way down the approach?"

"That has got to be very accurate, hasn't it? I expect you would congratulate him for that as well."

"Wrong on both counts, Harry. The pilot may have shown skill, but he had also demonstrated poor airmanship. You see, with the no brake approach, it is true, he had made a spot landing. But supposing he had been a little out with his judgement and had gone a bit further back on his base leg, or had flown through sinking air during part of his approach. There is no way he would have reached the runway, as the pilot had nothing in reserve. To have opened the brakes would only have made matters worse by steepening his glide path. He had made an infinite decision."

"You are so right," said Harry, "I can see that now".

"O.K. Let's have a look at the fully open brakes all the way down the approach. That wasn't very clever either. Suppose he had over shot, what could he have done about it? He already had full brakes. Had he been landing in a farmers small field instead of a long runway, a small over shoot would have caused him to fly into the upwind hedge. Unlike the no brake approach, he may have had the option of side slipping, if he was capable of it. Side

slipping is something you don't know about yet".

"Yes, I see that as well," said Harry. "I mean, if he already has full brakes out, there was no way he could steepen his glide path, should he be over shooting. Not unless he were to dive, that is. If he were to dive his speed would increase, making the impact with any object all the harder," added the instructor. So, Harry, when do you think I would congratulate a pilot for making a spot landing?"

"Go on, tell me."

"I will. I would congratulate the man who came to me saying: 'Did you see my spot landing? I had half brakes all the way down the approach, I did not move them once.' That's the man for me, Harry. Not only had he shown perfect judgement, he had left all the options open. He could have taken care of an over shoot, an under shoot, or any vertical movement of air he may have flown through and still have made a spot landing. Small field or no."

"So the half brake approach is the thing to try for then?"

"It is. Nevertheless, during a majority of approaches, it will be necessary to readjust the brake settings once or twice, and if you commence with half brake, there is nothing wrong with that. But remember, from a 100' or so of height, keep the brakes still except in an emergency. Preferably at about half setting. By doing so, the only pitch change will come from the stick".

"Still on about brakes, Boss, there is a small point I would like to clear up. When carrying out the U.S.T.A.L. drill, and reaching A, I find the air brake lever with my hand. Then you stress that I leave my hand on the lever, even though I am only about half way along the down wind leg at the time. I mean, I'm not going to be using it yet, so what is the point?"

"Again Harry, you are developing a good habit which, like all good habits, increases the safety factor. Let us suppose you reach for the brake only when you require it, often only when on the approach. Say you do this all the way through your training in the two seater, and of course, you continue to do so on becoming a solo pilot. The two seater flights are made mostly, if not solely, on the same type of aircraft, so you become very familiar with it. This will probably apply to the single seater as well. Then one fine day, you move into a new aircraft type. New to you anyway. Maybe a friend has invited you to fly his machine. Or you have joined a syndicate. You come for the landing, feeling a little tense. It is a different type after all. Late into the approach you require air brake, and, because you did not develop the good habit you do what you

have always done, which is reach for the lever. Of course, you can do it with your eyes shut, after reaching there several hundred times previously. You know the position of the lever to a millimetre. This time it is not there!!! Not quite in the same place. Now I suggest, that as you are coming in over the fence, it is not a good time to be putting your head into the cockpit to make a search. On the downwind leg though, there would be no problem. You have all the height and time in the world. So you see Harry, with your hand on the lever, its already been found! Good habits equal good airmanship."

"Fine. That answers another question for me Boss. And it does make good sense."

"Good. I'm glad you agree," smiled the instructor. "Now I want to say a few more words concerning flying on the circuit. Remember the mythical pilot, who tried to pick up a thermal from 400' in a strong wind? Well we all know what happened to him. But that is not to say that one may never thermal, once a circuit has commenced. If, say, on leaving the high key you find yourself half along the downwind leg with no height loss, you may then decide to adjust the height with air brakes. It is perfectly O.K. to do so, providing you bear in mind the air you have flow through has been rising somewhat, therefore the air you have yet to fly through, may well be sinking. With this in mind you are advised, when adjusting the height, to remain a little on the high side. Brakes can remove height, but they cannot return it to you! Another time you may find yourself halfway along the downwind leg at a normal 500' when you feel lift. Providing the wind is not strong, it is O.K. to fly a full 360° investigative turn. Should you be fortunate with the lift, then use it. What will dictate if, or not, you should continue turning is the height gain, as compared to the drift over the ground. With a slight wind the drift will be minimal, or even none at all. But if the wind is stiff, then make sure the 30° angle to the landing area becomes steeper as you drift down wind with the thermal. If it does not, then forget the thermal and get on with the circuit."

CHAPTER SIX

"The little talk we had before take off, concerning the stall, is now going to be put into practice Harry. We have plenty of air between ourselves and the ground, so there will be no problem on that count. We shall do the first one or two together, so please follow me through on the controls. You will only get the feeling of the exercise when you have full control, but you will be a little more involved by following me through, than just sitting watching. During the stall the glider will be descending into the air below. This is space we cannot see at the moment, so we must check that it is clear to descend into. We can see that it is clear ahead and on each side. But I will bank quite steeply, so that we look down at a sharp angle. So here is left stick and rudder and away we go. Although we can't see straight down, we can, after completing half a circle, see the space below from the point where we started. Also during the turn, we can check the air which was behind us. All is clear, so we will level off. It is now safe to stall, Harry. We are in level flight at 45 kts. For a few moments we will stay with this speed and attitude so that we will become conscious of the sound level from 45 kts. Now I am easing all the way back on the stick. Note the nose lifting above the horizon. Listen to the airstream noise drop. Feel with me the sloppiness of the stick as I make course movements. I'm getting little effect from the controls. See the A.S.I. pointer falling back. Feel the shudder run through the glider. Look! The nose is falling below the horizon. We are stalled."

"Wowee," was emitted from the pupil.

"To unstall the glider, I remove the back pressure from the stick. Listen, at once the airflow is increasing and the controls firm up, so I ease back on the stick to come out of the dive.

"There were six points to indicate we were approaching the stall. Each point can act as a warning. When we stall deliberately, as we did, we are not interested in the warnings, we intended to stall. But of course, we only do it when our height and all around us is safe. However, what you are going to do now Harry, is a series of stalls to enable you to get the feel of them. But, more important, I want you to try to call out to me each of the six warnings as they arise. It will not be easy during the first few stalls, because the warnings will follow each other fairly rapidly. You will catch on though, with practice.

Let me refresh your memory on the six points.

1. The nose lifts above the horizon.
2. The airflow noise diminishes.
3. Sloppiness of the controls, giving poor effect.
4. The A.S.I. pointer shows falling airspeed.
5. Shuddering through the glider.
6. The nose drops below the horizon.

Nos. 2, 3, 4, 5, are important warnings, to be acted on without delay, to stop the stall from developing. But for the moment we intend that the stall should develop, so that you will become aware of each of the warning points."

Eventually the instructor was satisfied with his pupil's progress, and he asked him to return to the club, saying, "Return to the club now. I hope it will not be necessary to talk to you before the glider stops rolling down the runway. Imagine you are on your own, making all the decisions."

Over coffee, the subject of the stall continued. "All the warning points are useful indicators. But perhaps you recall me saying Nos. 2, 3, 4, 5, are the most important. So what about Nos. 1 and 6? Well, there are times when they are not easily noticed, since both 1 and 6 concern the horizon. No. 1 rising above, and No. 6 dropping below the horizon. The point I am making is, when flying in poor visibility with no clear horizon, it is not always readily obvious that the nose has moved. However, No. 2, airflow noise, No. 3, sloppiness of controls, No. 4, A.S.I. indication, No. 5, shuddering, none of these should be missed, anyone of which, give an almost immediate warning. But there is a small qualification for No. 5, shuddering. Some gliders, when over ruddered, will shudder. So Harry, get yourself really familiar with the warnings, then you will not be caught out. On your next flight you are going to act on the warnings, so as to prevent the stall developing. You will simply ease the stick forward, lowering the glider's nose, thus returning to normal flight almost at once. Here we have a case, where following through on the controls is really useful. This is what we will do. I will handle the glider in such a manner which will lead towards a stall. When you become aware of a warning point or two, you will say 'I have control' whereupon you will put matters right, without delay, by easing the stick forward. Do not go into a screaming dive, as it will only be necessary to change the attitude just a little. If you take over from me too soon, or too late, we will keep at it, until you get it right. But you will master it quickly. I promise you. When the aircraft is

stalled, it simply means the airflow is striking the cord line at an angle of more than 15°. Remember the cord line? That imaginary line running from the wings leading edge to the trailing edge. Anyway, this large angle of attack causes the airflow over the top surface of the wing to brake away, bringing about a reduction in lift. The usual reason for the angle of attack increasing, is because the glider is flying too slowly. The machine then sinks, or mushes, which of course increases the angle of the airflow from below. Hence, pushing the stick forward to lower the nose, angles the cord downwards towards the airflow. Thus reducing the angle of attack. Are you following me, Harry?"

"I am indeed, you explain it so well, Boss," said Harry, grinning.

"We can do without the sarcasm."

"Sorry Boss."

"During our stall exercise today, we entered steep stalls from a high nose up attitude, giving quite a pronounced reduction of positive G. as the nose fell away. Then we carried out a series of shallow stalls, which 'crept' up on us, but those had less effect on G. It is very important to develop an awareness of a change in the G force. And to understand the cause. To recover from the stall, we have learnt to ease the stick forward, so that we gain flying speed from the ensuing dive. Normal G. is quickly returned when the nose is below the horizon after a straight stall."

"I do feel I learnt a lot from that flight. After all, I did do many stalls and dithered around the pre-stall speed," said Harry.

"Yes, I think you have. But I want you to consider carefully what I am about to tell you. You have not as yet received winch launching training Harry. But you will have noticed the highup nose attitude of the glider when it is in full climb. Sometimes the winch cable will break, and if the pilot delays his action, the glider will stall because of the power having been removed. To prevent this from happening, the pilot must lower the nose of the glider while there is still flying speed. In other words he continues to 'fly' the glider from its steep attitude by pushing the nose over the top. Now, try to understand this Harry. If the pilot is over enthusiastic when pushing the stick as he reacts to the cable break, the reduced G. he will create, will be quite strong. So, although the glider is flying, the pilot may think it is stalled, so he goes on pushing the stick, making the glider enter a very steep dive. If the break had occurred at a lowish height, the man is in serious trouble. On our flight my friend, we will

be doing a little flying over the top, to get you used to the feel of reduced G. from flying, as opposed to stalling.

"Again we will put into practice the lecture we had before take off. Before we enter the spin, we will make a clearing turn to see that we are clear of other aircraft, as we did before the stall. Check your seat straps and be sure there are no loose objects in the cockpit."

"All clear," Harry confirmed.

"First we will take the glider to a high nose up attitude, from were we will deliberately enter the spin. At the moment our speed is 45 kts in level flight, which is sufficient speed to bring the nose up on pulling back the stick, but not so much as to take us over the top. Here we go then. We ease firmly back on the stick, but not very quickly. With the stick all the way back, the speed rapidly diminishes. We apply full left rudder just before the stall. The nose yaws to the left and the full rudder remains on, and with the left wing now stalled the nose pitches down, though the stick remains fully back. The glider rolls to the left because of the remaining lift from the unstalled outer section of the right wing. We are now in a full spin."

"You are telling me!" exclaimed Harry.

"To recover, we apply full opposite rudder. Pause. Ease the stick progressively forward until the spins stops. Then, at once centralize the controls and ease out of the dive. There you are, do you think you can do that?"

"I'll have a go, but you won't go away will you?"

"Now remember. The stick all the way back and leave it there until recovery action. O.K. Off you go then, but settle at 45 kts first."

"What would we do without our cups of coffee, Boss?"

"They do go down well, don't they! Anyway, about this spinning, it is a combination of pitching action, yawing action and rolling. It is known as autorotation. Auto suggesting the glider will continue to spin while the stick is fully back and full left rudder remains on, and the distribution of weight is appropriate. Fortunately, aircraft will always recover from the spin with the right corrective action. Usually at once, where gliders are concerned. It is largely because of the spin recovery control, that we have in our cockpit drill the 'B' for ballast. As you know, the glider's weight placard informs the pilot

of the limitations, to which he must conform. Let us look at the consequence of having underweight cockpit load. An underweight cockpit load will result in the C of G moving back towards the tail. If the glider was spinning in such a circumstance, the C of G would become more effected by the centrifugal force, as the tail rotated around the spin axis line. The effect of this would be to flatten the spin. During a flat spin, the air is striking the tail unit at a larger angle to the fuselage, which prevents the rudder from biting the air for recovery. Also, since the C of G is too close to the tail, the moment arm is shortened, resulting in less leverage from the rudder. In other words, the centrifugal force behind the C of G is stronger than the effect of the rudder. We do not neglect our cockpit drill, do we?"

"We certainly do not," replied Harry.

"Regardless of the spin, if the C of G is too far back, then the pitch control becomes over sensitive. This could lead to a problem during the hold off when landing. Now let us talk about those spins we did from a slow over ruddered turn: the ones I have named the 'accidental' spin. There have been occasions in the past, where pilots have spun into the ground from the turn for the approach. This is why I showed you all the wrong things, so that we would enter an 'accidental' spin. In our case the ground was not in the way. In showing you the wrong things, you now know they exist and what they can do. Hopefully you will not now be caught by one, or, should you become careless, you will realise what is developing, wake up and do something about it in time.

"To know of the existence of the 'accidental' spin is so important, we will go through it again. Even though only verbally this time. Let us see if we can get into the mind of a pilot who was caught! - 'Hell, my base leg is too low. My angle is flat to the landing area. Lord, that's a bloody tall tree, but I must turn now. I haven't the height to fly over it then to return and line up with the runway again. A bank may put my wing into the tree. God, this is dicey. I know! I'll make a flattish turn on rudder, but I'll need to remain slow, because I can't afford the height to speed up, especially with that tree there. Good, the nose is coming round nicely. Damn, the bank is increasing, I can do without that. I'll have to pick up the wing with the aileron. Oh God, it is dropping faster. I'm starting to spin.' - What happened Harry? Can you tell me why it happened?"

"Well, apart from being too low, he was also too slow. Pretty near the stall in fact. Then, when he gave left rudder for his flattish turn, he really cocked it

up. Because by so doing, the resultant yaw, speeded up the right wing, pushing it through the air faster, which increased the lift from it. But at the same time the left wing slowed, reducing its lift even more. So, with more lift on the right wing and less on the left, a roll began. Maybe his biggest mistake of all, was trying to lift up the wing with aileron. Because, by deflecting the left aileron down, the angle of attack increased on that part of the wing, taking the airflow well past the angle of the full stall, removing all lift. Errr....."

"Yes, go on, you are doing fine. The full result was?"

"Death!"

"Charming. But you are probably right. Now carry on, Buster"

"Er..., roll, pitching down and yaw. A spin," said Harry.

"Jolly good, you have got it. Our time in the air was not wasted. Now tell me, having got into such a situation, what should the pilot have done as soon as he realised the wing was dropping?"

"He should have lowered the nose, at least a little with his restricted height, while keeping the rudder and ailerons neutral. Then lift the wing by coordinating stick and rudder. To try to lift the wing by rudder only, would mean danger of entering a spin in the opposite direction."

"Have another cup of coffee son. Can you stand a little more before going home?" asked the instructor.

"Yes Boss."

"We will stay on the subject of poor airmanship. This time our pilot or rather another pilot, because the last one is dead, has misjudged his distance from the field, which resulted in a very low turn onto the approach. He is making a steep bank into a strong wind, but he feels quite happy, because he is close in to the field. In fact just behind the hedge. His speed is almost normal, just a little slow. You see, he had been flying towards the airfield slowly, because he had not been too sure if he was going to make it. In fact he had been trying to stretch his glide. Anyway, things seemed O.K. even if the lower wing was near the ground during the turn onto the approach. He may even finish up with a spot landing. Suddenly his heartbeat increases, as the response to the roll out of the turn is desperately sluggish. Eventually the wings do level, but now there is a nasty taste in the pilot's mouth. After landing he checks the ailerons. He is wasting his time. Can you tell me why Harry?"

"No I can't. I cannot understand why the roll out should be so slow," admitted Harry.

"I will need to explain a problem or two, associated with a condition known as 'wind gradient'. In order to have a wind gradient, there must be a wind blowing, of course. The stronger the wind, the stronger the gradient. Of course Harry, I am a flying instructor, not a meteorologist. Like most pilots, my knowledge of the subject is limited, but is sufficient to meet the practical needs of most pilots. It is a subject in its own right and much studying is required to gain a deep understanding. My explanation therefore is from a practical airman's point of view, to keep us out of trouble when flying.

"As I was saying, the stronger the wind, the greater the gradient. But what is a wind gradient? It is a changing windspeed with height, and is caused by the lower layers of air, slowing down as they pass over the ground. The friction from the ground reduces the windspeed. If the surface is rough, the greater is the effect of the friction, especially so, when the roughness is up wind, in the shape of building or trees. The change in the wind speed is at its most near the ground and up to a 100' or so, after which the effect becomes less. By about 1000', there is hardly any.

"The effect of wind gradient during the final part of the approach can be considerable. If the glider maintains the same attitude all the way down, as on a calm day, its airspeed will remain constant. However, if the glider passes through a wind gradient, its airspeed will be reduced, particularly through the last 100' or so. Remember Harry, this while maintaining a constant attitude. It's rate of sink near the ground will be increased rapidly, causing a heavy landing or stall, even though the nose was not above the horizon. It is important in such conditions to use only a small amount of brake during the final part of the approach.

"To guard against the danger of the wind gradient, the approach should become steeper as the glider nears the ground, to overcome what would have become a reduced airspeed. If an inexperienced pilot feels happier with a constant angled approach, he may do this by adding an extra 15 kts to his normal approach speed. Then, if he maintains that angle until round out, he will avoid an early stall. The pilot should be aware, that a wind gradient can change the wind from 30 kts above 1000 ' to a 10 kts wind at ground level. The gradient is not necessarily smooth. It may be turbulent and gusty, especially downwind of houses or trees, etc.

"Now we have the hint, that our friend was following the wrong trail when checking the ailerons of his glider. As you know Harry, the wingspan of a glider is considerable. So if the glider is making a steep bank when near the

ground, its wings are reaching through much of the wind gradient, so that the lower wing is passing through a slower wind than the upper wing. The difference being most at the wing tips near the ailerons! The upper wing being in faster moving air, must generate more lift than the lower wing, which has diminishing lift in the slower moving air. Result? Less effective aileron control when rolling out of a bank. Though, if you think about it, you get faster roll, when rolling into the bank. Always assuming of course, that you are turning into wind which, if it is prior to landing, you will be. A point of interest. Should the glider bank to turn downwind, the pilot will discover the situation has reversed. The lower wing is now moving 'with' a slower wind, as the upper wing is now moving 'with' a faster wind. The airspeed of the lower wing therefore, is now more than that of the upper wing. This being so, the lower wing now has more lift than the upper wing, enabling the roll out to be faster and positive."

EFFECT OF WIND ON GROUND SPEED

a. Into wind

Landing into wind reduces ground speed and control surfaces effective during complete landing phase due to 25 knot airflow.

 Wind speed = 25 knots

b. Downwind (with the wind)

Glider downwind 50 knots airspeed plus 25 knots wind speed ... ground speed now 75 knots.

Loss of control in landing as airflow zero at 25 knot ground speed.

 Wind speed = 25 knots

The instructor is again airborne with his pupil. He is admiring the countryside, which is looking at its best in the clear visibility. Before take off the instructor had noted a pleasant and gentle breeze, blowing straight down the runway. The climb of the combination had been smooth and steady. He thought of the time he had first met his pupil, trying to 'break' the gliders in the hangar. It seem as if it were yesterday. Now he felt like a passenger in the glider, while Harry was holding a steady course after rolling out of a nicely executed turn.

"You look sleepy, Boss," commented Harry, glancing over his shoulder.

"Maybe a little, but I am awake now. In fact it is back to work. So, please find yourself a nice aiming point and aim the nose at it."

The glider swung to the right, then the nose settled on a distant tall chimney with a plume of heavy smoke reaching to the sky.

"Follow me through," said the instructor. I am going to rock the wings 45° from side to side. Left, right, left, right. But I shall pivot the nose on the chimney, allowing no swing."

After half a dozen 45° banks to each side, the instructor levelled the wings while the nose of the glider was still lined up on the chimney.

"I have been demonstrating coordination to you Harry. If all the aileron drag had not been balanced by the rudder, the nose of the glider would not have remained stationary on the aiming point. It is a matter of marrying the stick and rudder exactly together. Have a go Harry, but do not take the first two rolls beyond 30°, all the following rolls should be 45° though. It is easier to start that way. Right. Off you go."

Harry was surprised to discover, he was not able to prevent the nose of the glider from swinging away from the chimney during the second roll, but it became progressively worse with those that followed.

"O.K. Level up and get back onto the aiming point," said the instructor.

"Gosh, I cocked that up," muttered Harry.

"Don't worry about it, I expected you to, as would many solo pilots. It is not as easy as it looks. You probably don't know it, but the banks which you did were in no way even. The rolls to the right did well if they reached as much as 15°. The ones to the left certainly were not 45°. But don't worry about it Harry. This time we will try it together again. You just feel your way through with me. I will set it up and maintain at least six banks to each side before removing my hands from the controls for you to keep the movement going.

You will do better this time I promise you!"

Harry did do better. He left something to be desired, but improve he definitely did.

"Here is a little tip for you Harry, when you are flying solo in a glider with which you are not familiar. You may find the coordination is not quite the same as the one you have known. The new glider could have weaker ailerons, or perhaps more aileron drag. Or, its rudder may be weak, requiring a fuller movement for the entry into a moderate bank. It could take you a little time for the penny to drop, so that in the meantime, your thermalling technique would suffer. But, if at a safe height, you pivot on a point to 45°, you will quickly sort out the coordination needed for that glider. Of course, you first have to be capable of doing it properly. So practice until you can. You may find a few gliders, when rolling quickly to 45°, do not have a strong enough rudder to overcome all the aileron drag, so that you still end up with some adverse yaw. Then you will know, when you wish to centre a thermal, you must not roll the glider at a faster rate than the rudder can handle. Or, you may wish you can turn a little earlier with a 30° bank, rather than later with a 45°. This though Harry, is about working a thermal, about which you know little at the moment. The time will come though, when it will be useful to know your glider's coordinating qualities. Pivoting on a point will tell them quickly to you. Now, What is the action for spin recovery, Harry?"

"Full opposite rudder, pause, then progressively push the stick forward until the spin stops. Then centralize the controls and ease out of the dive".

"Of course it is," confirmed the instructor. "Harry, I want you to operate the rudder pedals, while I use the stick. So take your hands off. What you must do now, is prevent the glider from entering a spin, while I will try to make it spin."

The glider was made to fly slow before banking over steeply, the instructor trying quickly to bring on aileron drag. Then the glider was made to stall from a high up nose attitude with a dropping wing. It was stalled from a slight banking turn. But never did the glider spin. On each occasion the glider may have spun, Harry prevented it from doing so with the rudder.

Finally the instructor, being satisfied, said: "You have control. Please take me home."

Harry made an accurate landing and on rolling to a stop, the instructor signalled for a tug. The rope was laid out and Harry commenced his cockpit

drill. With the controls checked, he reached 'ballast', saying 'the same as before' when the instructor stepped out, saying:

"You are on your own now, so check the ballast weight for flying solo."

His cheeks were slightly flushed, when Harry asked: "I'm going solo?"

"That's right. Just get on with your drill, while I make the rear seat straps secure." After a slight hesitation and a deep intake of breath, Harry continued. At the completion of the drill the instructor had no advice to offer, other than: "Just continue to do what you have been doing for sometime now." Then added: "My only comment is think about a tow rope break and the emergency landing field. Then, if it should happen you will not be taken by surprise. The tug will drop you off upwind at 1,500 feet."

With that the instructor walked away. At once the rope was attached and before Harry had time to build up any apprehension, he was rolling down the runway. The instructor, watching with a critical eye, saw the wings remain level as the glider followed directly behind the tug. The wheel left the ground, a moment later touched once, before steadying three feet above the runway. The tug became airborne and the combination climbed smoothly into the sky. Harry's approach was a little on the high side, causing a touch down a couple of hundred yards along the runway. Otherwise it was a perfect half brake landing with a straight roll to the stop. Harry's instructor was very pleased. All smiles now, Harry was about to climb from the cockpit, when the instructor restrained his pupil, saying:

"Stay where you are, and congratulations my boy, that was very nice. I am proud of you. Now do your cockpit drill and do another flight for me, just like that."

Again, the rope was attached, the instructor repeated: "Think about a rope break. Off you go."

The second flight was followed by a third solo, after which Harry parked the glider before reflecting on his new found glory.

CHAPTER SEVEN

"Back in the two seater, Harry. No, not for a check flight, but for more training. You are now going to be introduced to winch launching. You would really feel fed up if you visited another club, only to discover, there was no aero towing. So, before we take off, I will give you a briefing, just as I did for most exercises.

"The acceleration during the take off run is very much quicker than that of the aero tow, so, of course, we are airborne much sooner. Because of the quick acceleration, you are less likely to have a wing drop, or to wander to one side during the take off. Even when trimmed forward, the glider on leaving the ground, may well quickly reach a nose up attitude during a winch launch. That attitude will develop even more, when taking off into a strong wind. The pilot must see to it that a steep nose up attitude does not occur before the glider reaches a speed of 50 kts or so, some say, not before 300 feet. The most important factor of the two however, is the 50 kts or more.

"Why should a glider have to reach 50 kts before being allowed to enter a full climb of, say, 45°? Let us imagine a full climbing attitude with an airspeed of only 40 kts. The glider will go up fine, everything in the garden will seem lovely. Then the cable breaks, and there we are, only a little above the stall. We would be lucky if we got the nose below the horizon before the stall, with the ground close by at that. Definitely not a healthy situation, Harry! If we had another 10 kts or more, we would have no difficulty in flying the glider round the top to get the nose below the horizon, not giving the stall a chance. You see, no matter when the cable breaks, we must be sure we have enough flying speed to set up the required slightly nose down attitude. The emergency may be due to a weak winch, without the help of good headwind to help it attain sufficient airspeed. Or, we may be taking the first launch of the day before the winch driver has got the speed right. Or, the winch could lose power during the launch. Whatever the reason Harry, the climb must not become steep before we have enough airspeed for the pilot to be able to fly the glider over the top, should a failure occur.

"Lets start again: On leaving the ground, the attitude of the glider should be such, that the nose is only slightly above the horizon. And that is where it should stay, until reaching an airspeed of 50 kts or more. Be cautious yes, but not over cautious to the point of holding the nose level with, or below the

horizon. Should this become necessary, because of the lack of speed developing, then you must release the cable. Not to do so will induce the glider to over run the cable, creating what may become a dangerous situation by over flying the winch cable's parachute. Let me take you back to when you were learning to hold a constant bank. Remember me saying. 'Wherever the stick may be, if the bank was steady, then the stick must be in the right place, even if it were not dead centre?"

"Yes I do. I don't even think about its position now. Only the angle of the bank."

"Right. Well this also applies for winch launching, but more so. It may well be during a full climb, that there is a forward pressure on the stick, or more likely, no pressure at all. It will depend on the glider you are flying. Certainly a back pressure will be necessary on some, all the way up. Almost certainly if you have a strong winch plus a strong wind, the attitude of the glider will be nose up immediately on take off, even with the stick in the neutral position, so it will be necessary to have the stick forward to some degree. Get the combination of a particular glider with a light pilot, then, what I have been saying can be most pronounced. You are not a heavy man Harry, so expect to be susceptible. What I am saying is attitude, attitude, attitude. When launching, fly by attitude. Get that right and the position of the stick will be right. At the beginning it could be difficult for you, not to ignore the possible need for forward stick, when you are wanting to climb. But when you think of attitude, all will be well. When you are happy to enter and maintain the full climb, at first you may not be sure when this is reached. However, you can discover it by looking along the under surface of the wing, so that you see how it's cord is angled to the horizon. You simply adjust it to 45°. Also, Harry, you may not be sure if the glider is climbing true, without wandering off to one or the other side. Sometimes you will see a nice cloud in direct line with the launch, which enables you to point the glider's nose at, using the cloud as a marker. So, it is as well to check the sky before take off. Normally though, it will be necessary to take a quick glance at each wing tip during the climb. By looking at each one in turn, you will quickly notice if one is lower than the other. If so, the glider will naturally move out in the direction of the lower wing, certainly if climbing into a direct headwind, or if the conditions are dead calm. Since, when nearing the top of the launch the winch is hidden from view, you may not know when to release the cable. Many winch drivers solve the problem for you, by closing down the power completely, which is easy to

read inside the glider. If the power is not shut off, then you will see the nose of the glider being pulled down nearer the horizon, regardless of the stick being held back. That is the time to release, of course. At some sites, on a particular run, there is a convenient marker on the ground, such as a club house maybe, that can been seen at a certain angle when the glider reaches release height. Such a method should be regarded rather loosely though, because release heights can vary. For example on a low wind day as against a high wind day."

Because of his flying experience to date, it did not take Harry long to gain the technique for the basic winch launch. Though he did have a small problem in the timing for removing the tension from the cable, before releasing at the top of the launch. He had to learn to be kind to the release mechanism. Also Harry was inclined to be rather heavy footed, when yawing the glider during the climb, as he signalled the winch driver, to slow down. His instructor was a little surprised at this, because, in all fairness, he could not claim his pupil was inclined that way, in fact he had rather a sensitive touch of the controls. However, when giving the 'too slow' signal, in request for more speed, Harry's movement in lowering the glider's nose was smooth and decisive. A winch could not miss the clear change of attitude, giving him a clear message.

"Someone was saying, the other day, Boss, that the 'too slow' signal, used to be relayed to the winch driver by rocking the wings. Surely, that could not be missed. Why don't we still give that signal?"

"It comes down to safety, me old son. For years, that slow signal was in use, mostly without any problems. However, for it to be quite safe, it was first necessary, to lower the nose from the climb to just below the horizon. Then, as the speed increased a little, it became safe to give the signal by rocking the wings. The trouble was Harry, some pilots would rock their wings, while the glider still had a steep nose up attitude and was slow. Should the winch cable break at that moment, when the glider was full of aileron drag, slow and nose high, the chances of the glider entering a spin were considerable. From time to time, pilots did come to grief that way. Hence, the change to the present method. Sensible, don't you think?"

"Yes it is, when you put it like that," conceded Harry. "Do you think I'm O.K. now Boss to solo off the winch?" asked Harry.

"Yes, you would be perfectly alright off the winch, providing there was not an emergency during the launch. So first, you are going to experience cables

breaks at differing heights, Harry. But, if you feel the need for a flight on your own first, then be my guest. Take an aero tow."

Harry returned from his flight full of smiles. "Gee, did I enjoy that! For the first time while flying solo, I actually gained height in a thermal. I climbed up from 1800 to 3220 feet. It felt really good Boss. And did you see me do those two incipient spins? They felt good as well!" exclaimed Harry.

"It has all been worthwhile, hasn't it son?"

"Oh yes it has. Imagine, had I not popped in to have a look around the hangar on that first day, I would have missed all this!"

A smiling instructor said, "Come on then, climb into the two seater and we will get on with your cable break training. The first couple of 'breaks' will occur very shortly after take off. I shall release the cable, but I hope it will not be necessary to physically help you. Though I will give verbal advice to start with. Of course, you will be landing straight ahead off the break. So do your checks and let's get on with it."

Although Harry did know the cable would be released early in the launch, he did not know an arrangement had been with the winch driver for a slow launch. So, after take off the speed gradually bled away.

"Look at the speed Harry, don't even think of entering the full climb. Lower the nose to give 45 to 50 kts. Good. Now we are safe but the cable is loose, it is not speeding up. In fact we are beginning to over run it, so I'm releasing. Keep the speed good, while you go straight ahead for a landing with no more than half air brakes. That was a nice touch down, now give a little left rudder. Fine, now keep the glider running straight, as it runs slightly across the runway to the left."

On rolling to a stop. the instructor informed his pupil of the arrangement he had made with the winch driver.

"The driver gave us the effect of a failing, or missing engine. You must be wide awake to such things, because, unlike a cable break, which occurs suddenly and completely, a failing engine sort of creeps up on you, causing a dangerous falling off of airspeed if you fail to react. I wonder if you would have been onto it, if you had been solo? We shall see next time when that situation happens, because I shall not forewarn you, or speak at the time. So, if I need to take control, you will have failed! But I promise, it will not be your next flight. Unless it's for real! Can you think why I told you to move across to the left on landing, Harry?"

"No, I was going to ask you about that."

"It was to get the glider clear of the cable which was running ahead of us on the runway. We had overrun the cable. Remember? So, if the winch had picked up, it would have rushed the cable along the runway, maybe fouling the glider. Also, it is quite possible for the cable's parachute to fill with air, as it is being dragged along. If that should foul the glider and the winch engine was not immediately cut, a lot of damage could be done. Of course, I could have told you to rudder to the right, but I didn't. Why? Well, as you know, the wind is a little across, coming slightly from the left. Had we moved over to the right, the wind from the left might have weather cocked the glider back onto the cable, as the rudder lost its effect and as the glider slowed. If there is going to be any weather cocking, we want it to work in our favour. But remember, when rolling along the ground and ruddering towards a crosswind, the rudder is initially more effective ... so slight rudder.

"The next simulated cable break will take place at a height, which is considered by some as being difficult and dangerous. It is not, if you have previously thought about it, together with the wind condition of the day. The 'Break' will take place at 300 feet. As you can see, the wind is light, but slightly across the runway from the left. If we were taking off into a strong wind, and a break occurred at 300 feet, we would then land straight ahead. In those circumstances the reasons for a straight ahead are several. First, with a strong, or reasonably stiff headwind, the glider will reach a height of 300 feet before it has moved far down the runway, due to it having a slow groundspeed. This of course leaves a lot of runway ahead of you. Also your approach groundspeed will be slow, though, of course, your airspeed will be sufficiently high to counter a wind gradient. Secondly, it would be unwise to carry out a low circuit, because of having to turn downwind which would sweep you far back over the ground, relatively speaking, because of the high groundspeed during the downwind part of the turn. The circuit required from only 300 feet, would not be much more than a large elongated circle. But a strongish wind may elongate it too much, resulting in the turn becoming too low before levelling up for a short approach. And through a gradient at that! The trick is, Harry, to decide before take off, what height you must reach before making a smart circuit, rather than a straight ahead approach. This way there will be no panicking and time wasting decision making at the time of the break. Always, during the first 4/500 feet of any winch launch, the pilot should be thinking what action he will take if the cable breaks now. He will then be able to lower

the nose, pull the yellow knob twice, check his speed and at once proceed with his previously made decision.

"As I have said Harry, we will simulate a break at 300 feet on this flight. This is the lowest height for a short circuit. Because we have decided that 300 feet is the lowest limit, one may be tempted to think that it is a difficult break height, if difficult is the right word, which it is not. If it were, it would be pointless not to raise the minimum height limit for a smart circuit. This will simply be a demonstration flight of a calm, panic free circuit from 300 feet. So, sit back, watch and listen. We are leaving the ground now. I am thinking, 'straight ahead' if the cable should break. In the full climb. Straight ahead. 300 feet. A smart circuit. The cable has broken. Nose down. Pull twice on the release knob. Check speed and attitude. Good. 50 kts. Bank immediately to the right. Not too steep, about 30°. I look over my right shoulder at the runway. Height is good. Do you feel a problem, or any undue urgency Harry?"

"No, not at all."

"There isn't any. We can afford a short down wind leg, so I'll level the wings a moment, while re-checking the speed. Hand on brake lever, ready for use. I'm moving out a touch, the angle is a bit steep. Now for a fairly gentle turn to the right through 180° to get onto the approach. Speed check, half brakes, and we have a nice little approach."

"Nice one," said Harry, on touch down.

"That was because we knew exactly what we had to do. It was routine. Now you do it this time. I will verbally guide you. Then you will do another two or three, whilst I hope I will remain silent."

Three simulated brakes at 300 feet, removed any apprehension Harry may have felt for a future break at such a height.

"While operating from a site such as this, with its large runway, there should never be any problem from a cable break as regards landing on the runway, either straight ahead, or from a circuit. However, you may one day fly from a gliding site which is considerably shorter than the full runway of an aerodrome. A hill site for example, from which the gliders operate from the top. A short, low launch, being enough for the glider to fly over a escarpment into hill lift. A cable break at such a site, may be at a height which is not sufficient to safely make a 360° turn, but a straight ahead may not bring the glider down into the field. The way to handle the problem efficiently is to effectively 'lengthen' the landing area, once the nose is down after the break. Let me tell

you how."

"I wish you would. Because it sounds like magic to me," commented Harry.

"No, there is no magic about it. Just airmanship, me old son! What we do, is turn the glider through 45° to one side. Then, while you still have the height, turn through 90° to the other side. Then land straight ahead. You will be landing into a 45° crosswind from the left, if your take off had been into wind. If the take off was into a headwind, it does not matter if your 45° turn was to the left or the right, providing one side from the take off run does not have a landing advantage over the other. However, if you were taking off into a crosswind, after the break you will first turn 45° so as to give yourself a tailwind component. Then, on turning the other way, through 90° you will have a headwind, or near headwind to land into, with its slower ground speed."

"Clever stuff," said Harry

"Airmanship," said the instructor. But Harry, there is a circumstance when you can run out of space, even on a big runway, though the pilot has to be rather stupid to do so. Nevertheless, it has happened more than once in the past. This is how: Shortly after take off, the winch engine goes on the blink. Or, maybe the engine is a little under powered and you are flying a heavy glider on a still day. Or even, and this can happen, a slight headwind changed to a slight tailwind at the moment of takeoff, increasing the groundspeed, while diminishing the airspeed. Whatever the reason, the glider refuses to climb because of its slow airspeed. But the pilot will not believe that the winch driver will not increase the speed. So does not release the cable to land straight ahead. Only when there is not enough runway ahead for a landing, and of course he is still too low to turn, does the pilot appreciate the situation - very expensive! Never be so keen to fly, without keeping abreast of the situation."

CHAPTER EIGHT

"Come on Harry, let's get into the two seater, so that I can give you instruction on thermal soaring. Your flying is not at all bad these days. You are a safe and steady pilot, but I think you will be the first to admit your soaring technique is not too hot!"

"Well, I have had a few good climbs, but I must agree that I do get rather frustrated when I see chaps climbing in a thermal I've botched. Especially when it results in a landing, and I see them still airborne an hour later, Boss."

"Let's see if we can discover where you are going wrong. But if you cannot read the sky in the first place, you will be at a big disadvantage. Maybe you can use the lift to some degree, when you are in it, but do you know where to find it, I wonder?"

"When I see a cloud I go for it, but all too often I don't really get a result," said Harry.

"O.K. Before we take off, we will have a little chat about thermal production. Just a working knowledge for glider pilots, you understand. Not the deeper intricacies of the met. man. So what do you know about a cumulus cloud?"

"I know that a cumulus cloud produces lift for us to soar," said Harry.

"Wrong. It is more like the thermal produces the cumulus. You see, before we get any decent cumulus clouds, we need the atmosphere to be rather unstable. It is not necessarily unstable, even on a sunny day. If the temperature within the first few 1000 feet does not decrease at approximately 3°C per 1000 feet or more, then the atmosphere is known to be stable. But, to decrease at 3°C (2.9° C to be correct) or more, we have an unstable atmosphere. This, the glider pilot likes!"

"Why should the descending temperature with height matter?"

"I'll try to explain: The sun shines from a clear sky, warming the surrounding earth. But, as you well know, some surfaces absorb more heat than others, as do some colours. A fine example of this can be seen on the white runway numbers and the centre line, after a night's frost. The frost on the white numbers remains, long after the morning sun has melted the frost off the darker runway, which has already warmed. So, the sun, on warming the ground, finds areas on which its rays are more effective. A large ploughed field, for example, will absorb more heat than the surrounding meadows. We call these 'hot' spots in

the gliding world. The air which is in contact with the 'hot' spot, becomes warmer than the surrounding air. Warm air expands, becomes lighter, so will rise like a bubble in water. As the warm air from the 'hot' spot breaks away, the cooler surrounding air rushes in, to replace the now ascending air. After a little time, this 'new' air will heat and rise also. Have you ever picnicked, maybe with your parents, on a hot still sunny day, when suddenly, from nowhere it seemed, a breeze has sprung up. Only to be still again a few minutes later?"

"Yes, I remember once during a family touring holiday, we had stopped for coffee. There was a large picnic area with wooden tables and benches. You know the sort of thing I mean! Well there we were, noshing away on this hot calm day, when dad's newspaper was suddenly blown from his hand. The look of surprise on his face made us all laugh. He muttered something about it being a bloody gremlin."

"Not a gremlin, Harry. A thermal had broken away from a nearby 'hot' spot, the surrounding air was rushing in on its departure. As did your dad's paper, it seems. You will have heard the weatherman sometimes say: 'Light and variable winds'. Now you know why. If you happen to be near a windsock at such a time, you will see it lift from its inert angle, to point in the direction of a parting thermal. For the thermal to develop sufficiently to be of use to the glider pilot, its birth will have to take place beneath unstable air. Air, which has a lapse rate of not less than 3° C. A lapse rate is the degree the environmental air cools for each 1000' of height. After a climb of 1000', the warm air which has left the 'hot' spot on the ground, now finds itself surrounded by air which is 3° cooler (or, whatever the lapse rate may be.) But the thermal at 1000' is warmer, relative to the air surrounding it, than it was at ground level. This being so, the thermal expands. However, the action of expansion gives off heat, so actually, our thermal is becoming cooler. But, this cooling, due to expansion, is less than the cooling of the surrounding environmental air, brought about by its lapse rate. Therefore, the thermal continues to get relatively warmer as it rises. Of course, with expansion of the thermal we must associate a heat loss, so that finally a point is reached where the thermal has lost so much heat, that it can no longer hold the water vapour it was able to, when warmer. The thermal has cooled to it's 'dew point', when the gas condenses into water droplets. That is the birth of the cumulus cloud, Harry."

"That is interesting, Boss."

"The height at which the cloud forms, depends on how dry the thermal was to start with, and on the lapse rate. The appearance of a small cumulus, informs the glider pilot that there is most likely rising air beneath it. It's a sign post in the sky, which says: 'Fly under me to find lift,' Harry."

"So, for a nice high cloud base we want dry air, then?"

"That's right, if the clouds are of the cumulus type," said the instructor. "Go for that cloud at 10 o'clock Harry, it looks young and healthy."

"How do you know it is young?"

"Because it is smaller than the average."

"Yes Boss, but you told me an active cumulus only lasts so long, then it dissipates after it stops being fed by the thermal. So how do you know it's not on its way out, ready to disappear like a puff of smoke?"

"Because it is not scraggy at the edges. It also does not have a dirty look. They often look like that, on their way out. Look, this one is nice and white, it has firm edges, especially at the up wind side. Fly under that and you will find lift, or my name is not Pontius! A good way to approach the cloud, if practical, is from downwind. This way you are less likely to pass to one side of the lift. Don't worry to much if you fly into a patch of sinking air, because if your approach is in line, you may well fly through sink before finding the lift. If there is a lot of air going up Harry, then some must go down to replace it. To the experienced soaring pilot, sink is often the pointer for better things. Do you feel the movement in the air? The smoothness is going out of it, let me have the controls, the vario. is indicating less sink, but we will not change direction yet. Look at the cloud above, it is thin at the near edge, but darker, more solid looking further in. There is more vertical development there. This could be due to latent heat, causing the cloud to build up from within and is probably sucking up air from beneath. Let's fly to it and find out! Already the vario. is showing zero, but this is an electrical instrument which, reacts rather quickly. So I will turn left now with a 45° bank. I will fly a full 360° without altering the bank of my investigative circle. Look, we are getting 2 kts up, but already the pointer is slipping back, there is only 1 knot here. Now we have zero.

"I made a mental note, as to which section of the circle gave the strongest lift. So a little before reaching it during the next circle, I will level the glider for a couple of seconds, then roll back into the 45° bank. This will move the circle along a little into the lift, and is called centering the lift. The idea is to

have a constant value of lift, all the way round the circle, but you will not often achieve this exactly, as there is usually stronger lift in one section than another. There will not be much to complain about Harry, if no sink shows anywhere.

"Once you think you have got the best 'centre' you are likely to get, it is very important to keep the bank absolutely constant, so as to maintain an accurate circle. You should see the nose sweep around the horizon at a constant attitude. Any turbulent air which may try to push a wing, should at once be countered. Failing to do so, will result in the glider being flown away from the strongest lift. There should be no slip or skid, when countering turbulence with the ailerons and adverse yaw must not be allowed to creep in. A perfect circle should change only when the pilot is centering. When working lift, the vario. is important, but the really successful soaring pilot will 'feel' the lift. Sometimes, when flying along a section of the circle, you will hear and feel surge. A moment later the vario. shows an increase in lift. The pilot should take note which part of the circle is giving the surge, Harry. Then, as he approaches it next time around, he will level off for centering. Or, rather than centering on the surge, the pilot may maintain the circle, knowing that when he passes through the surge, his airspeed will increase, as will the angle of attack. Each of these phenomenons, increase the lift. But the pilot can add more lift by easing back on the stick, to convert the extra surge speed into height.

"But to be good at that sort of thing you need experience, for as you temporarily bring the stick back, you also roll off a touch of bank, which is then replaced as the pitch is returned to normal. To convert the extra speed into height, with the elevators only, would create a slight climbing spiral at that point and so de-centre the circle. Pulling up once without a little roll out, would have small effect on the circle. But several times will, as the effects become accumulative, endangering the loss of the thermal.

"Something else, Harry. Be careful, when working a rough thermal, not to fly slow. Nearly always, in a rough thermal you will be turning steeply, which increases the 'G' force a bit and also the stalling speed. Because of the roughness of the thermal, you may be alternating between strong lift and sink. As you fly through the lift, the angle of attack will increase, but it will decrease as you suddenly fly through the sink. The decrease of the angle of attack in a down moving gust, can be considerable and may easily bring about a stall if the glider is being flown slowly. Anyway, let's concentrate on

this thermal, it is a nice one, giving 4 kts most of the time. You have control Harry, see if you can take us up to cloud base."

"I have control," said Harry.

"Although I want you to watch the horizon ahead to keep a steady attitude, you must not neglect the lookout. At least once for each 90° of turn."

"I'm losing it Boss. What did I do wrong?"

"You kept a good attitude on the horizon with pitch, but the bank is considerable less, than when you took control. So what do you reckon happened?"

"I've moved out from the lift."

"Right, most of the turn is now in sink. Try centring by noting the part where there is a little lift."

"Got it, it's here now, so I'll straighten out a while," Harry said, eagerly.

"If you do, you will be too late. Just go round again, keep this turn going. Then, if you fly through some lift, look to the outside of the turn at 90° to identify a house, a wood or a field. Anything, so that when the nose is about to pass through it on the next time round, you can level the wings for a few seconds before going back into the turn. With luck, that may move you into the lift."

"Hey. Magic, it worked Boss," said a delighted Harry.

"Well it did this time. Though there was an element of luck, but you've got the idea"

"Gee, it's getting cold all of a sudden".

"That's because we are near cloud base now, the air we are in, is almost at saturation point. It's about to condense into cloud. Level off and glide down a couple of 1000 feet, then see if you can find some more lift. Do you know where the aerodrome is?"

"Yes, of course, it's on the other side of that lake, over there!"

"O.K. Carry on Mac Duff," said the instructor, smiling.

"I've been thinking," said Harry," when we were thermalling the other day, we were still climbing as we levelled off to fly away from the cloud. If we had continued circling, we would have entered the cloud, would we not?"

"Yes, on that day we would have entered cloud, Harry. But you have enough to get on with, developing your technique for clear air thermalling."

"Yes, but when soaring up to cloud base, could we always enter cloud, if we wanted to?"

"No, sometimes the lift will fizzle out just below the cloud. So quite often you will climb the thermal but not enter cloud."

"Why is that, then?"

"Have you noticed that at times a cumulus cloud has a lot of vertical development, but at other times it is flat with very little depth?" asked the instructor.

"Yes I have. Why do they vary? They were both created by thermals, weren't they?"

"Yes they were, but the one with the vertical development has a saturated lapse rate, which gives off latent heat internally and so it continues to build up."

"But why should that be? Why should the flat cloud remain flat?"

"Do you know what an inversion is, Harry?"

"No, not really Boss"

"Then I'll try to explain. Above the base of the flat cumulus the environment becomes warmer. This effectively puts a lid on the thermal, stopping it in its tracks, because suddenly it has become cooler than it's surroundings. Or, to be correct, it's surroundings have become warmer than the thermal. Often the thermal has reached the inversion level before it has condensed into cloud. On such a day we can have thermals, but there are no clouds to tell us where they are. We call this a 'blue' day. A glider pilot can still soar happily on such a day if he can find the thermal. He just hopes he will fly into one. You see, there is still instability below the inversion."

"Boss, why is the air warmer above the inversion."

"I don't know. You will have to ask a meteorologist. Ask Tom Bradbury."

"Who's Tom Bradbury?"

"You don't know Tom Bradbury? My God!"

"Have you noticed, when we get a long spell of hot clear days, how as the days pass, the visibility becomes less and less?"

"Yes, I have. It happens sometimes when there is high pressure, doesn't it ?"

"That's right. It is also at this time that we get beautiful sunsets. As the days pass by, the height of the inversion steadily lowers, restricting more and more the height to which the thermals can climb. The thermal, on rising, takes up particles of dust, which remain largely suspended during the daytime. When the inversion is high there is plenty of room for the dust to spread itself around, so that it is hardly noticeable. As the inversion lowers however, the dust becomes more dense in the restricted space and so impedes visibility. In the evening, when the sun is low in the sky, it angles through the lower atmosphere, where refraction cuts the spectrum, giving us the lovely sunsets. A number of years ago, before the clean air act, and a bit before your time, old son, we used to get smog in the cities. Each time there was a bad smog, hundreds of people died."

"How awful, why was that?" Harry asked.

"It was caused by an inversion alright, but in winter also during high pressure. Those inversion could be as low as a few hundred feet. There would be a blanket of fog between the ground and the inversion. Added to this was the smoke from thousands of fires. The inversion trapped the smoke, as it did the thermals in summer. Visibility became almost literally nil. Unfortunate people with bad lungs still had to breath, but they couldn't. It killed them."

"And the clean act solved the problem?"

"It did!"

CHAPTER NINE

"When can I push off on a cross country flight?" Harry asked.

"You know very well, you may not do that before you have completed the Bronze Certificate. How much have you completed now?"

"I have had one soaring flight of more than one hour off an aero-tow launch. And I have made my spot landings with you, as your signature in my logbook shows."

"Yes, well that leaves one more duration flight. I would like to see you do that off a winch launch rather than from an aero-tow. I know you will require only half an hour if you are winched up, but because of the lower-release height, it will call for more skill than another full hour from an aero-tow. You will also have to be signed off, as regarding your general flying. So we will take the two-seater for that test one day. Have you done the Bronze paper yet?"

"No, not yet, but I do not think I will have a problem with that, Boss!"

"It has to be done my boy, before pushing off flying across country."

"I know it has. It was just wishful thinking, I suppose."

"It is good that you are keen, Harry. But you know, there are a few things which you can do, to help build up your confidence for cross country flying, and still remain within the regulations concerning the five mile radius of you gliding site. For instance, on a good soaring day, with a nice high cloud base, you should take a single seater, and each time you reach 3000', break off the climb."

"Are you saying I should leave good lift? Lift which may have taken me up to cloud base at 4, 5, or even 6000 feet. Why should I do that?" asked an incredulous Harry.

"If you climbed, to say 5000', it would then be much easier for you to find another thermal, than from 3000'. To break off a climb early, would sharpen you up. Keep you on your toes. Should you fail to find lift, well bad luck. You will just have to land and try again. Being able to get up and away from low thermals around your own base, may well pay big dividends later, when struggling far from home. You can set yourself triangles to fly. Starting and finishing at base. Of course, you will have to remain within the regulated distance for the none-Bronze pilot, so the legs cannot be more than five miles.

However, there is nothing to say that you can't go around your triangle a number of times. It will teach you something about getting round the turn points. Another thing you could do for self improvement, on a reasonably good soaring day, is to refuse to accept every other climb which is available. I am not suggesting that you put yourself deliberately in a position of having to land out. The landing area should always be within reach, in case you mess up the thermal you intended to work.

"Now I will advise you on flying a real cross-country flight, required for the Silver certificate, which obliges you to land away from your place of takeoff, and not within a distance of 50 kilometres, after allowing for the height of the launch. So obviously, before you leave, you should make arrangements for someone to pick you up. Be sure all the fittings are in the trailer before you leave. Take coins for the telephone, not forgetting the club's number, because you will need to inform the club as to exactly where you have landed. Be sure, before you phone, to write down detailed instructions on how you are to be reached. Also remember to give the phone number of the farmer. Make your official declaration and have a pee. Take a map, mark on it a track line to your intended destination.

"However Harry, the flight can be flown in a general direction of your goal, so long as it does not go near prohibited air space. This way you will have the pleasure of being able to concentrate on your thermalling and staying airborne. It will allow you to deviate towards a better looking sky. But be aware of the track line, as a general guide. On your cross-country flight, stay high if you can. You are not trying to make a speed record yet. Take note, from the first one or from two cumulus clouds, where the best lift is. You may find it to be near one edge, rather than under the middle of the cloud. If so, check if this edge is to the North, South, East or West, or anywhere in between. If you can establish the lift area, it may well have a common factor regarding most, if not all the clouds, providing they are in a similar stage of development. Often, well into the afternoon, the lift is to be found towards the sunny-side of the cloud. Although the clouds do not always follow the same pattern, it is well worth your while, to check and note the position of the lift for clouds of similar development. Then you may be able to fly direct to the best part when approaching your next thermal.

"On a good fair weather day, when the cumulus remain quite small before dissipating, rather than overdeveloping into large masses which are slow to

dissipate. On such a day, be on the lookout for any small milky patch against the blue of the sky. Should you see one of these, go for it. Get under it. It will be the top of a thermal commencing to condense, a cumulus, being borne. You will discover the lift to be good and strong.

"Do not plan to fly over a wide mountain range, Harry. You are not ready for such a flight, but to fly over a small range of hills will offer no danger to the thoughtful pilot, but be careful not to choose a landing-field close to the lee side of a mountain or hill, if there is an alternative. If there is an appreciable wind, you can expect a distinct possibility of curl-over on the lee side, which can increase your rate of descent dramatically when making the approach, throwing your normal judgement out of the window. Even with brakes closed, you may find you will not reach your chosen spot. Also on the lee side of a hill the air can be rough and chaotic."

"I shall avoid the lee side," said Harry frowning.

"When you get down to 2000', accept the real possibility of having to land. By this height, you should have previously made sure that you were not flying over a large area of poor terrain for landing. You only go over such terrain, when you know you can easily over-fly it. From 2000' suss out the ground for possible landing fields. Try to find two within two miles of each other, preferably more or less ahead of you, in the direction of the flight. If you are remaining around the 2000' mark, then on reaching the second field, choose a third along your track and disregard the first, which is now well behind you.

"At 2000' or less, do not fly out of range of a probably suitable landing field. Above 2000' you may do so, remembering not to fly over very large areas of inhospitable ground. If between 1500' and 2000' you are not finding lift beneath the clouds, then start thinking about a thermal source: the 'hot' spots. We have talked about a ploughed field, but there are many more sources than that. Places you would never have thought of. A farm, with its concrete yards and slate roofs is a real sun trap. Service areas on the motorways are others. Cut hay, drying in the sun, they can all be excellent sources. Birds of prey and seagulls, that come inland, if seen circling, are thermalling Harry. But watch for wing movement. Should their wings flap now and then, the lift will be poor. But they are great markers of thermals. Even swifts and swallows are good markers. If you notice a bunch of those birds flashing about and well clear of the ground, they will be in lift. Never mind about their wings flapping, its the norm for them. They will, most likely, be having a meal of midges and

other flies swept aloft by the thermal. It is there for you to use, Harry. On a good soaring day, even small garden fires will often kick off a thermal, and because of the smoke, Harry, this is a thermal you can 'see'. Well in it's early stage, anyway!

"Later in your gliding career, when you are more experienced and are attempting long flights, you may well be saved from a landing late in the day, by flying over a forest. The sun, having lost much of its heat, is no longer a thermal producer. The land is cooling rapidly, but the forest retains its heat longer. The forest has not been a thermal producer during the day, because it does not warm up so much, or as quickly as the land. However the heat which it does receive, is jealously retained until the land has cooled. Now the forest comes into its own, as it is now surrounded by a cooler environment. Eventually, the stillness within the forest gently stirs, as the previously entrapped air reaches up to break free. A gentle streaming thermal, reaching to the heavens. A haven for the tired glider pilot, who timed his arrival over the forest correctly. His last climb of the day may be slow, but it will be long, certainly smooth, and in the clear evening air."

"I think you are getting a little poetic, Boss."

"It can be like a beautiful poetic experience, I can tell you. During this same period of the day, the early evening, when the thermal winds have died, the astute glider pilot may achieve his last climb in another manner. Perhaps not quite as dreamy as the last mentioned, but very pleasant nevertheless. Flying over a valley in the now near stable air of the evening, he may find himself in the most smooth lift of the day. The cause for this Harry, is quite different from the hoarded warmth of the forest. This lift is known as catabatic. It is caused by the air at the hill tops becoming cool before the air in the valley. The heavy cool air rolls down the hillside and along the valley floor, pushing the warmer air upwards. Thus, the mass of valley air starts it's gentle rising journey. It is not at all like our thermals Harry, as it is smooth and covers an area as large as the valley itself. It may not reach as high as the day thermals did, but instead, very gently fades until the air is only lifting as much as the normal glider's sink rate, when in still air. The glider then flies in smooth zero sink, sometimes for half an hour or more. But let us return to finding a thermal from its source, while you have a landing field within reach.

"If there is a hill nearby, it is well worth investigating the lee side of the hill, providing that is the side on which the sun is shining. It is of advantage, if the

sun is getting a little low in the sky, so that it strikes the hillside at a near direct angle, the better to heat the surface. Close in to the lee side, the air remains undisturbed, enabling it to heat up more effectively than on the windward side. A thermal which breaks away from the lee side of the hill, is known as a 'wind shadow' thermal.

"Now regarding the final selection of the field for landing, Harry. You have had a couple in mind since you were at 2000'. You have been trying to climb away, but failed. You are now down to 1500'. Up to now either field has seemed to be acceptable, so choose if practical, the field which is up wind. From a height of 1500' and below, you should be able to detect if the field has a slope. If you were not able to detect it from a little above these heights, the field will normally be acceptable. From these lower heights you will see if there are any wire fences, or even a single high-tension cable. Telephone lines will be indicated by their posts, if there are any, see how their lines lay. If it turns out that the field is not suitable, you are now able to go for the second field, and since it is down wind you are able to reach it above circuit height. However, if you are happy with the first field, there is no reason why you should not try to climb away if you run into lift even at this late stage, providing Harry, and only providing, you remain above 1000'. Also you should be up wind of the high key position. Once you are down to 1000' any further attempt to thermal must be resisted, even if you run into lift. You are committed to the circuit and the landing. Understood?"

"Yes, I understand," said Harry.

"Your aiming point for touch down, is one third of the way into the field. During the whole of the flight you should have a good idea of the wind direction. After all, you took off into wind, or nearly so. We know that a heavy squall or a powerful cumulus will temporarily change the direction of the wind, but on your first cross-country flight you will not be flying on such a day. However, if you are in doubt there are ways of ascertaining. Probably the easiest and most reliable way is to read smoke, if there is any nearby. The only snag - it is surprising how rarely there is any about when you want it. If the wind is at least as strong as a stiff breeze, you can read the movement of long grass or crops. But this method is not always easy, therefore you should practice while flying near your own club until you know how a sort of sheen travels over the top of the grass, as it bends in the wind. Another method of finding wind direction: when a little above circuit height, fly a straight course. Then look at an object on the ground. Looking down at a sharp angle you

should be able to notice any drift. If you see none despite the fact you know there is a wind, then turn through 90° and fly straight again. Previously you were flying either into wind or with the wind, showing, of course, no drift. But having now turned 90°, the drift will quickly be noticed. Movement of cloud shadows can be a useful method, but be careful when using this. A cumulus growing strongly may be expanding laterally quite rapidly. Should this be taking place on the windward or upwind side, a false reading may be given by the shadow. Back to the landing, Harry. The reason, when flying at your home club, you have been encouraged not to refer too much to the altimeter after leaving the high key position, is to enable you to become accustomed to the appearance of the landing area as you descend. This, plus reading the angle, makes the altimeter redundant. Thus, the familiarity of 'eye balling' the circuit will eventually safeguard you for the field-out landing. It may well be that the height above sea level of the chosen field, is quite different from that of the club's field. Thus, giving a false reading on the altimeter."

"Well all I want to do now Boss, is to get the Bronze C. completed. Then I can have a crack at putting into practice what you have been saying," said Harry, rather longingly.

CHAPTER TEN

The time came, when the instructor was happy to sign Harry's log book and to congratulate him on gaining the Silver C.

"Before long," he said, "I expect you will be wanting to attempt something more ambitious in the way of cross country flying. So it will be well, if we look further into the problem of navigation. With the busy skies of today, it is not a good idea just to wander off in a willy-nilly fashion. Of course, we have discussed this for your Bronze C. but it will do no harm at all to have a recap. You will take a map to help prevent you wandering off into restricted airspace. The forbidden areas are well defined, so you can plan a flight to keep well clear of said areas. Then learn how best to fold your map. There is nothing worse Harry, than trying to use an incorrectly folded map in the restricted confines of the glider's cockpit.

"Draw a line from the club to your planned destination. Unlike a powered plane, it is unlikely that you will be able to stay on track during the whole of the flight, due to the necessity of having to divert, to reach suitable lift. Mark on your map the major places on the trackline, which you can use to identify your progress and position. A word of warning here, Harry. At times you may not see a town, even a large town, which you know should be nearby. This can confuse, leading to the belief, you are lost. As you know, a good thermal soaring day will mean a sky with plenty of cumulus clouds. The shadow from a heavy cloud is dark. It will also cover a large area of land, within which the town may lay. In such circumstances, the town becomes very difficult to see, as though the town has ceased to exist. Watch out for this kind of trap by referring to the map, to see if any other easily identified object should be near. A major road, or railway running from the town in a known direction, a lake, or a reservoir. Rivers are good navigation aids, as they are not difficult to pick out. Especially if you are flying towards the sun, as it reflects off the water turning the river into dazzling silver. Railway lines are certainly useful for confirming direction and leading to the next town, or, even for identifying the town they are leaving, again, because of the direction. However Harry, railways are difficult to pick up at times. They do not cast a shadow, being so low to the ground. They often run along lines of trees and are hidden from view. Railway lines are likely to disappear into hillsides, and through cuttings. From high up they are very narrow. Usually it is easier to pick up a line which

is running away from you, rather than when they cut across at right angles. Lakes and waters are excellent for identification because of their shape. But at times of drought beware, because their shapes can change dramatically.

"During your flight Harry, try to work out your average speed over the ground. This will help you to know when to expect the next marker to be identified, which you marked on the map. If you become lost, but know the time over the last known position, you will then know, that you cannot be beyond a certain distance away from that position. When crossing a feature line, such as a motorway, check your track to it. This will confirm your drift. The sun is a useful and quick guide, especially when leaving a climb. If you were flying with the sun at 10 o'clock before entering the thermal then, on leaving the thermal, you can immediately replace the sun to that same position and be on your way. Have in mind, the sun's position differs by 15° per hour. But remember to use the aiming point technique, as soon as you have identified anything ahead, which is on your track. And of course, there is always the compass. The compass and the sun are excellent when making a long glide between thermals. Although you have the distance on the map for each major point to be identified, it is also a useful thing to have a pencil with grooves, cut to a scale of 10 nautical miles. Lay the pencil along the map to estimate the distance to the next place of interest."

The instructor, on arriving at the club, went into the clubhouse, where he found his old pupil sitting at the table, filling in his log book.

"Hello Harry, have you been flying?"

"Yes, I've had a couple of hours local soaring," replied Harry.

"Well, you have worked hard to get to where you are, old son. It is a nice feeling eh, to have the Silver C. registered? But I will never know, why you landed in the field you did, when only three fields away there was a beauty, at least twice as big and free of all obstructions. I readily agree, that you made a very good job of a difficult landing, but it is much better airmanship, Harry, to take the safe option every time. You can still give yourself the satisfaction of touching down at an exact aiming point, which would prove to you, that had the field been difficult, you would have coped. You are indeed a pilot in your own right now. But, remember, there is still much to learn and experience to gain. Next week I am going to Scotland with a few friends. We are going to visit the Scottish Gliding Union at Portmoak, in the hope of catching hold of

some wave. It is a pity you are not coming, because, if the weather behaves, it would add to your learning."

Harry, showing a little excitement, said, "Are you saying that if I could make it, your lot would not mind if I joined you?"

"Certainly we would not mind. Not in the least."

"Count me in, Boss. I will get time off somehow. Maybe I can have my holidays brought forward."

"Here we are, in bonny Scotland," said the instructor, as the car turned through the entrance to the Scottish Gliding Union, at Portmoak.

"Cor!!! What a dreadful road," muttered Harry. "Potholes everywhere."

"No, the road is not up to much, but it is a good gliding field with plenty of room. You will find the clubhouse is not so bad. It has nice large windows on two sides, which look out onto the gliding scene, so I will be able to keep an eye on you," said the instructor, grinning.

The rest of the day was spent settling in; finding their rooms and generally looking around the place. But the next day they awoke to a nice 20 kts westerly.

"Right Harry, your first day amongst the hills, I believe?"

"Yes, as far as flying is concerned."

"You will have noticed that in the hills, the cumulus starts earlier in the day than over the flat lands. If they had started this early at our place, we would probably have overdevelopment before lunch time, blocking out the sun for the day. But here you will find, though large parts of the sky will be clouded, there will also be big areas open for most of the day. That is not to say the clouds do not cover the sky completely. Certainly, Scotland gets its fair share and more of dull skies. But not today, I think. The large hill over there is a good one for soaring. What we are looking at now is its West Face. As you reach the North end, the hill turns East, giving it a North facing surface. Its name is The Bishop. On a westwind day it can get very busy there, especially if there is a lack of thermals, so that the gliders become 'hill bound'. This makes the 'look out' very important. You will be putting into use the gliding rules of the air for hill soaring. So, tell them to me Harry."

"Two gliders approaching each other, head on. Each must turn to the right," he replied.

"What if they are below hill top height? Might it not mean that the glider

with the hill on its right, would fly into it?"

"Well, er.... Yes, I suppose it could."

"So the glider with the hill on its left would turn right, while the one with the hill on its right, would remain flying level under normal circumstances."

"Yes Boss, of course."

"You are flying South in the lift above a Westerly facing hill, but you have reached the end of the beat, so you want to turn back to fly North. Do you turn right or left?"

"I will turn right, because that is away from the hill. Likewise, if I were at the North end, I would turn left, so as to turn away from the hill. I would do this even when higher than the hill top, because, should there be a glider following me which I cannot see, that is the way the pilot would expect me to turn. In other words Boss, always turn outwards from the hill. Then, faster flying pilots behind me, knowing this, will therefore overtake me, on the inside."

"You are quite correct Harry, but what if you were away from the hill, and another aircraft was converging at the same height. What then?"

"Ah... yes. The aircraft that is on your right, has the right of way," said Harry.

"Here in Scotland, the gliding field is below the hill, in fact a mile or so away. At some clubs however, the gliding site is on the top of the hill. This means that when you want to land after soaring the hill, you have to turn down wind from the hill. In fact, as you leave the hill, you are in effect in the high key position to your landing field. At first glance, it would seem you are about to break the rule of not turning towards the hill. But Harry, we avoid this by turning away from the hill at the start of a turn, which passes through about 220°, from which you level for the down wind leg of the landing field. By turning outwards from the hill until levelling, to fly down wind, you have been able to see if anyone was coming from behind. It is from a hill top site, that you learn something of curlover.

"Curlover is found downwind of the hill, which is where your landing is to be made. On some hill top sites, the curlover can be bad. It needs watching Harry. The air may be turbulent, just as you are near the ground on the approach. Also, a sudden, rather than a more gradual, wind gradient will often exist. The air may even curl back on itself, giving a tailwind at, or near, touch down. However Harry, we will not have those problems here, because

of the site being below the hill and a distance away from it. Climb into the front seat of that K13 and we will have an hour soaring the hill."

"Right Boss, I'm looking forward to this." At 1200' Harry released the winch cable.

"Turn about to the right and head for The Bishop. We will be flying almost down wind, giving us a good ground speed, so there will be no problem in reaching the hill."

"It looks to me we will be below the top, when we arrive there," commented Harry, with a touch of anxiety.

"Not to worry. You will discover the lift will quickly take us up. Look, we are almost there already. Be ready to turn away from the hill face. Start turning now. A little early, you may think but we must allow for being swept over the ground towards the hill face, during the first part of the turn. It is due to the groundspeed being more than the air speed, of course. At least, during the early part of the turn, then, as the turn reaches into the head wind, the reverse is the case. That's nice Harry. Now we are heading fully into wind and are slowly leaving the hill behind. You see, we have an airspeed of 45 kts while flying into a 25 kts wind. What does that tell you?"

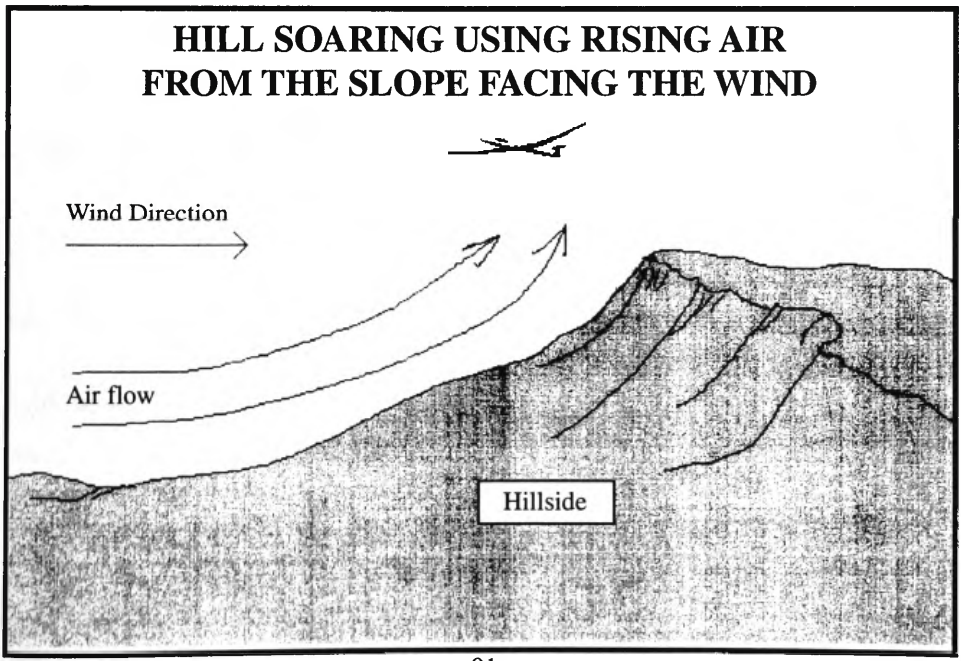
"It tells me we are travelling over the ground at 20 kts."

"Of course it does. So, turn 90° to the right to line up the glider parallel to the hill face. That's it. Note how we are gradually drifting nearer to the hill. Also, the vario is showing increased lift, and you can 'see' the hill face is falling below us. At this point Harry, turn the nose more into wind. Not fully, mind, just to the position where the glider is only flying along the hill, without nosing forward, nor drifting in. You have got it now, old son, the hill is at about 60/70° from the glider's nose, which looks right for this wind strength. If the wind was stronger, then the nose would need to be more into the wind. Say 80°, or even 90° to the hill. If it was necessary to be at 90°, our airspeed would match the wind speed, so the glider would then be stationary over the ground. Let's turn about, to return along the hill. Remember, turn outwards, keeping a sharp look out. Then set up 60/70°. We are at 600' over the top of the hill now. The vario is reading almost zero. Maybe we have reached the optimum, but the height may improve if we fly forward. Or even slide back a bit. Sometimes the lift is better, very slightly back of the hilltop. But note Harry, I said 'slide' or maybe 'drift' is a better word. You must not turn down wind at this stage, as you could be in for a surprise as to how far back you

could go, and how slow your return can be. Not good, if the clutching hand reaches up for you! To find the best position for the lift requires a little experimentation. Of course, one gets familiar with a local hill, but the best position will vary, according as to whether the wind is striking the hill's face fully, or at a slight angle. The face may be rough, or smooth, each surface effecting the wind flowing up the hill face differently. Gullies, cut into the hill face, will often funnel the air strongly upwards. If the hill face has a rather gradual slope, the lift can be best, further forward from the top than from a hill with a steep slope. A bit like a cliff, where the strongest lift is directly above, or slightly behind the clifftop. It is a matter of experimenting Harry, sniffing about, but be careful mind!"

"Yes, I will," said Harry rather seriously.

"When hill soaring, it will pay to keep an eye open for cumulus upwind. For, as they pass overhead, the lift can increase dramatically, giving a boost to the hill lift. Because of this, you can sometimes climb up to cloud base, freeing yourself from the hill for a spell of thermalling. Mind you, a heavily decaying cloud may quite easily dump a load of sinking air, enough to completely kill the hill lift for a time. It's a matter of being on your guard and general airmanship. A heavy cloud may also temporarily change the wind direction, which is not desirable when hill soaring."



"I hear what you are saying Boss, but gee, this is great. It's like being granted free lift, not having to work for it. Look at that glider coming in from the launch. From here he seems so near the ground. Hell! Now look at him, with only one beat along the hill, he is already above the hill top. But wasn't he close in to the face? Looked dicey to me."

"He will have done it many times before. Close in, when you are low, is normally where the strongest lift is to be found. Anyway, go home now Harry. This is your first flight at a new site, so show me a nicely set up circuit."

The weather over the past few days, since Harry had arrived in Scotland, had been kind. The steady Westerly had enabled him to learn much about soaring The Bishop, giving him added knowledge of his now favourite sport. He had been fortunate in as much, that he had been able to use the club's single seater SZD, a Polish glider, known as the Junior. Had it been at the weekend, rather than weekdays, the Junior surely would not have been available. He had particularly enjoyed picking up the thermals, or cloud suck, as they reached the hill.

The increase in lift they had temporarily offered excited him. He thought it great fun, transferring from hill soaring to thermal flying. He thought it a wonderful bonus to be able to run down wind, back to the hill at a low altitude to be rescued, after losing thermal lift up wind. Harry felt like a true airman when he saw Boss wave to him as he came alongside for a bit of loose formation flying, as they stood into wind, forward of the hill. A feeling of camaraderie sped through his being.

"Glad you came?" asked the instructor. "It's the best time I have ever known, Boss. Thanks again for inviting me."

"It is a pleasure, Harry. Anyway old lad, get yourself into the K 13 . We are going to do a bit of wave flying."

"Oh, great. I have wanted to do that since I first heard about it. Do you think it will be there today?"

"It's there alright. It is just a question of whether we will be able to latch onto it. You see the wind has veered to the North, so it won't be any good on The Bishop today. But Benarty, on the South side of the loch, is facing fully into wind. Yes, Benarty will be producing lift alright, so that is where we will start our flight, Harry.

"Nice launch son, now move round to the left for Benarty. Can you see the wind streaking the surface of the loch? I don't know if it indicates anything other than the direction of the wind, but I have experienced good wave climbs with the wind behaving like that, though the transition to wave was difficult. Make a turn now, but not too steep. Allow the glider to be swept during the turn as we are a little above hill height".

"How's that then?" asked Harry.

"Fine. Stay directly over the hill for a while, the lift is good. You will notice Benarty is rather steeper than Bishop, but not as high, so don't expect the lift to reach as far forward. Keep beating the hill. Get as much height as you can, try drifting back slightly or push forward a little. Search for optimum height, Harry. I will tell you a little about wave while you are flying.

"To have good, steady wave, the air should be stable. Undisturbed by thermals or turbulence. Today you can see there are plenty of clouds with a base at about 3,500'. Note the clouds are laying across the wind, and from a thermalling point of view, they seem to be almost overdeveloped, because of the way they are joined together. It is above these cumulus clouds, where the wave is found, above the inversion, through which the cumulus normally will not penetrate, and where the air is stable. Wave appears over mountains and downwind of a mountain range. Waves oscillate, so as to have an amplitude, the trough of which bounces off the inversion . Sometimes, at the wave's crest there is a second inversion, many thousands of feet above the first. This bounces the wave back down. The bouncing from the two inversions gives a strengthening effect to the wave, inducing the air to rise and sink very quickly within it's wave length. In the region of the inversions, the trough and the crest of the waves may rotate, making the air rough. But, on flying up through the lower rotation, the air becomes very smooth."

"It seems rather involved to me, said Harry."

"Well let us see if we are able to put some of this into practice. You will not improve on this height from hill lift alone Harry, so fly straight into wind over the loch. See if we can reach the upwind edge of these clouds. Fly at 60kts. We are more than half way across the loch now, but still no lift. Keep going though."

"We have had reduced sink and even zero for a moment," Harry commented.

"Yes, but if we had tried to work that, we would have been drifted back again because the lift was too weak. Nevertheless, this 3 kts down we are in

now, is bringing us too low, so turn down wind to get back to the hill."

"We still have sink," remarked Harry, "even though the hill is getting close and for the first time today, we are below hill top height."

"I have control, said the instructor. I am going in close. If there is no lift we will make a straight in approach into that field at the other side of the road."

But as the instructor flew close in to the hill, the vario. indicated weak lift at 1 knot. The K13 slowly crawled its way up the hill, until it became level with the top. By careful flying, a little more than hill top height was maintained.

"I reckon the wave has shifted," commented the instructor. "Sometimes the wave length jumps. I think that must have happened. Although the wave is above the inversion Harry, it does have an effect on the thermals below, and can also improve or dampen hill lift, which it seems to have done now. We will have to hang on carefully, hoping it will change again. I think it will."

"I thought wave was all smooth and silky," complained Harry.

"It is mostly. But we are not flying in wave at the moment. You can call it 'wave influence' if you like."

"Seems a bit hairy to me Boss."

"Not to worry son, we have our escape field, but we will not be using it! You'll see. Hello, here we go. We are climbing again. Maybe things will settle down now!"

"We are almost at cloud base at about 3000'. Do you think we will break through this time?" Harry asked.

"No, not from here we won't, the lift is all the way along the hill and we are in zero lift now. Certainly, the hill lift has been helped by the change, but there is not any real thermal or cloud suck, which we will need if we are going to get into the wave. I'm pretty sure we will not achieve that before we reach the north shore of the loch, or beyond. Somehow we must reach that, losing as little height as possible, if we are to thermal our way into the clouds. You have control Harry. Try to cross the loch again."

Harry was soon saying: "We have reached the half way mark with very little height loss, do you think we will get hold of the wave this time?"

"I can't promise anything, but we must try to reach the up wind edge of these clouds. They are reaching from behind Benarty to the North shore. But as you say, we are doing O.K. We are well past the half way mark now and there is little change in our height."

"We've just crossed the North edge, Boss. Wow! That was a bit of rough air."

"Turn now. Now, get on with it Harry."

"Oh hell, we are in a load of sink Boss."

"Give it to me. I have control."

"You have control then."

"Look. See those bits of thin wispy clouds in the blue, a little upwind of the cloud edge? I'm going for those. Maybe they are bits of rota. It's as likely a place as any to break through to the stable air above. Right. I am going to turn now. Damn, I'm only getting turbulence and we are not gaining an inch. I'll try that other wisp, over there. Lord, we are losing out. I'll return to the main cloud edge. It is no good here either, Harry. We will have to run downwind to the hill again. Can't leave it any later. Remember how much height we lost last time!"

"Ya, I certainly do. So it looks as though we will not be getting a wave flight then?"

"Oh... Don't give up as easy as that. We may have to spend a couple of hours, running back and forth, topping up with hill lift before we finally crack it. Anyway you have control."

There were three more return flights to Benarty, before success rewarded the two aviators. The K13 was now finally over the Northside of Loch Leven.

"Let me take control, Harry, if I get away, I will hand it back to you."

"You have control, Boss."

"I'm putting on more bank because this lift is tight. The turn has to be really sharp. It's often the case at transition to the wave above. See, we have been on the right track all along with those bits of clouds on the upwind cloud edge. If you look further upwind of the fleecy bits, there is no cloud at all until nearer the Ochil's, which are almost cross wind. So you see, these bits of fleece are not the last reminiscence of dissipating cloud, because its all blue upwind of them. I'm sure they are not caused by thermal, as they are ghostlike, just coming and going. I feel sure, Harry, they are caused by the bottom of the wave system. Look, this tight turn is having the desired effect, we are climbing. We are probably averaging 2 kts in this turbulence. Sorry about the 'G' from the turn, Harry."

"That's O.K."

"Look back at the main cloud line, we are well above the base of it and we are still climbing."

"Hey, all the roughness has gone, Boss. Gee, it's all smooth. Not a movement."

"We have cracked it son. We are in the wave at 3500'. Look, the vario. is reading 4 kts lift."

"God, it is so smooth. It is marvellous. It's beautiful, nothing seems to be moving, Boss."

"Look out along the wings, there is no movement at all, but the clouds are gradually falling away. There is still 4 kts up. Look at the altimeter quietly winding itself up. It's already showing 4200'. Magic. Isn't it Harry?"

"Oh yes. Sheer magic, Boss."

"You have control Harry. Just keep on this heading, crabbing slightly along the wall of the cloud. It is a bit like flying up the face of a hill, but without the roughness. We are almost at the top of the cloud wall now. The top is about 6000' As we pass through that height, you will see the cloud has a bulged top surface, halfway back to its trailing edge. There you are, can you see it now? These types of cloud are called lenticulars. See how smooth the top surface is, it is like a giant aerofoil. If you were to look along its length, rather than its width, it's shape may remind you of a lens. Hence its name."

"It's fascinating," Harry remarked.

"It is, Harry. The complexities of the wave systems, how they come to be set up, is way beyond me. I have become satisfied with at least having some idea, on how to use them for my pleasure. And on how to read the sky a little, so as not to miss out when they are there. But, I know a deeper knowledge could only give a more all round advantage. Maybe you would like to make a hobby of Met. Then you would be known as 'Harry, the Metman'!," said the instructor.

"I may do just that. You know, since the day I walked into the club back home, a whole new world has opened up for me. I mean just look at this. 11,000' and still climbing. There seems to be nothing to it. The altimeter is busy winding itself up, while I look out onto the most incredible cloudscape, spread out below, reaching away into the distance. It's fascinating, peering down through the gaps at the earth beneath, some of it sunlit while elsewhere one is looking at dark shade. It's so dazzlingly bright up here, that it exaggerates the shade below. You know Boss, I don't think I have ever seen the sky so vividly blue. And this air is so crystal clear. Look, you can see the loch down

there, between the clouds. Can you see that glider, silhouetted against the water? It does not look real. It is more like a small model."

"Before you get completely carried away, we had better start thinking about oxygen, Harry. We are not carrying any, so we are not going any higher. Turn downwind, you are about to learn something else now."

With the glider flying downwind, Harry was able to see his movement over the clouds below. For so long there had seemed to be only slow flight above the forward edge of the cloud, as the glider stood almost into wind. But already the glider was near the back or trailing edge, of the big lenticular.

"Turn back into wind," ordered the instructor. "Have you noticed the vario. Harry?"

"Hell, it is reading a load of sink," Harry said.

"It will be reading a lot more when you put your speed up to 80 kts me old son, because that is what you will have to do if you want to reach forward of this cloud again. What's more, you will be lucky if you make it without entering the cloud first."

"No, surely not Boss, not at 80 kts."

"Oh, it is quite possible. Not only are we flying into a strong wind, you also will be flying in the sink of this cloud for some time. You will see!"

Later, Harry was saying with a touch of anxiety, "We are level with the top of the bulge on the surface of the wave. By the time we reach it Boss, we will be in it."

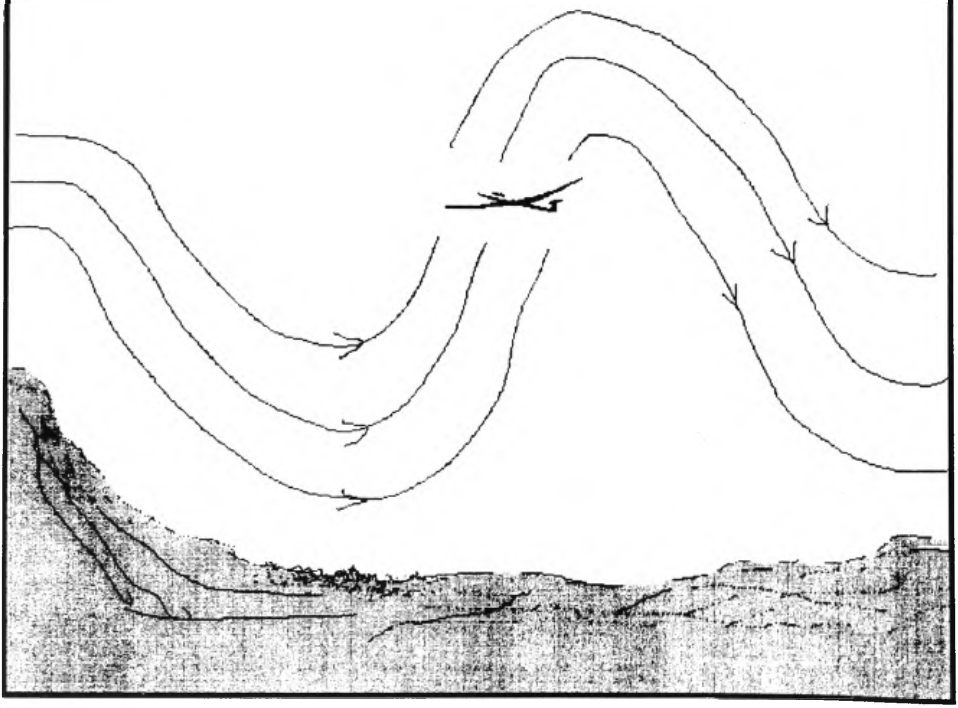
"Right! Remember how quickly you can sink, once you are downwind of the lift from lenticulars. And how long it takes to get back up wind. You are correct, we will not clear the bulge, so we will switch on our turn and slip instruments. Try to keep the glider flying straight and level when we are in cloud. I'll keep an eye on things, don't worry. I have got a T&S also. The trick Harry, is to continually monitor the A.S.I., the turn needle and then the ball. Of course the A.S.I. will control the gliders pitch. The needle is associated with the ailerons and should stay in the middle for the wings to be level and the ball in the centre, for balanced flight. If you find one or more of these instruments giving an undesirable reading, concentrate on correcting one, then move on to the other. The monitoring of each in turn, continues."

The glider broke cloud well down the upwind side. Then Harry enjoyed a long glide back to earth, weaving his way down, keeping in clear air.

"That was the best holiday I have ever had, Boss. I certainly shall be returning to Portmoak next year. I am joining a syndicate soon and the glider is fitted out with oxygen. Next time I will not have to break off the climb."

"I had better warn you Harry, you may not be so lucky with the weather next time. Many other times, I have sat in the clubhouse all week, waiting for a break in the weather that never came. So, consider yourself lucky this time!"

LEE WAVE. AIRFLOW CAN "BOUNCE" IN THE LEE OF A MOUNTAIN AND MAINTAIN A STANDING WAVE MANY TIMES HIGHER THAN THE MOUNTAIN ITSELF



CHAPTER ELEVEN

"Boss, let's have a chat while we take another cup of coffee again."

"That is alright by me, what do you want to talk about?"

"Well, I feel I have come a long way since we first met, but I always seem to learn something when we talk."

"Nice of you to say so."

"Oh, that's alright! Tell me Boss, have you ever had to land up a steep slope, because there was no other choice?"

"Yes, I have."

"Did you pull it off O.K.?"

"Yes I did. But let me tell you of what you have to be fully awake to. Obviously, if you are going to land in such a field you are not exactly spoilt for choice. However, obstructions on the approach are not likely to cause much of a problem, because of the angle of your glide to the field during the approach. I will try to explain. When making a normal approach into a nice flat field, which of course, is placed in a large flat area, your approach angle to the field will be about 20° and is easy to read when looking at your aiming point. And should you look, you will be able to see as far ahead as the horizon. Any obstructions there may be close to the approach boundary, needs to be lower than any part of the projected 20° glidepath line. Hence, since they are beneath the glide path, they are not really obstructions. Also, the 20° glide angle will give the pilot all the speed he will need. Now Harry, let us change that field into a hill. If there is no flat field in the area, the hill will most likely reach to quite a height and will be one of many. When you turn in for the approach, the crest of the hill may be higher than yourself. The horizon is now hidden behind the hill. With the crest of the hill well above you, there is now a danger that you will make the landing surface appear as it has always appeared, by approaching down a 20° angle relative to its surface. Should you do that, not only will your landing field be pitched upward, above the true horizon, your glider will be also. Albeit at 20° less than the field. Imagine Harry, if at that moment you could suddenly flatten the hill, you would then see the glider's nose above the horizon. What comes next Harry?"

"The stall, Boss."

"Indeed."

"How do I get it right then?"

"By the approach speed Harry. The speed at which you will approach, is the same as that you would use for an approach into a strong wind with its gradient at a flat field. This is because the round out is not going to be gradual, through 20°, but through a very much steeper angle. So you must be sure the glider has plenty of speed to enable the latter part of the round out to continue a short way up the hill."

"What will the approach angle to the hill be then?" Harry asked.

"I do not know. That is dictated by the hill. All you need to know is that your approach speed is correct. You must not try to control the angle. Only the speed, Harry. Certainly, you will seem to be high coming in over the boundary, if there is one. But that does not matter, so long as you see the aiming point remains constant. Now you can see why there is not too much to worry about approach obstacles. They would need to be very tall to be of any danger. If your speed is right, the angle you will get to the field will make it look as if you are diving the glider steeply. Especially if you have just turned off a normal base leg. But your ears and A.S.I. will tell you, you are not. It is true, Harry, after the round out, you do not want to hold off high, because the very quickly decaying speed as you fly up hill, will give very little time for correction. On the other hand, it is important not to round out late, because the sharp pull out from your approach line to the up hill hold off could mush the glider into the ground. Brakes, at this point will be closed, or nearly so."

"That was informative, Boss. Thanks a lot," said Harry.

"That's O.K. Now tell me something about down wind landings. What would you expect to be different?"

"Eh..... My ground speed would be faster."

"Faster than what?"

"Faster than my airspeed."

"Right! What else?"

"My ground speed at touch down would be high, and the ground run would be longer than normal."

"It would. Could you have a problem with the ground run?"

"No, not if I had plenty of room ahead of me."

"What about keeping the wings level until you were almost stationary, as normal?

"Oh yes, I see. The tail wind would catch me up as the ground run slowed, leaving me without aileron control."

"I did not think you would have forgotten that Harry. What else can you think of, concerning a down wind approach a landing?"

"I suppose the wind gradient must have some effect, Boss?"

"If the wind was strong enough, yes. But it would be unfortunate if it was necessary to make a down wind landing in a strong wind. Not very likely, I think! Anyway, even though you may have your hands full regarding space ahead, a gradient would work in your favour."

"How so?"

"Well, unlike landing into wind and through a gradient, where it is necessary to have extra approach speed to allow for the suddenly decaying wind strength near the ground which also reduces the gliders airspeed, the tail wind gradient works in our favour.

"How come?" Harry asked.

"Remember the gradient, which is caused by friction, slows the movement of air near the ground. It follows then, that during a down wind landing, the glider is flying through a decreasing tail wind, making a stall less likely for the glider with a constant glide angle, even if flying only a little above the stall. During the last few feet the pilot need not lower the nose for fear of a gradient stall. So, although the glider's ground speed will be fast, the gradient does not create the need for it to become faster. This is especially so, if the air is not turbulent."

"There is more to it than meets the eye, Boss."

"Do you think there are more considerations for a downwind landing?" The instructor continued.

"I'm sure there will be, but I don't know what they are."

"What about the angle of the approach?"

"What about it?"

"Come on Harry, think! With a tail wind the glider covers more ground from a given height, therefore the approach will be flatter than an into wind approach."

"Ah yes, of course."

"So, what about obstacles?"

"Obstacles. Let me think. Yes, I've got it. An obstacle which wasn't one, during the higher angled into wind approach, may become one, during the much flatter down wind approach."

"Now you are thinking, Harry. So, we have got:

a. Flatter approach.
b. Obstacles which were not a problem, may become one.
c. No need for extra speed for flying through the gradient.
d. Little or no aileron control during the landing run. Much more space required for the landing run.

Now tell me, on landing out, when would we land up a slope with the wind, rather than down a slope into wind? You may have to think very carefully before making your decision, because much will depend on the strength of the wind and the degree of slope of the field. I mean, Harry, if the wind is strong and the slope is slight, you would then land into wind. The effect of the air brakes, when flying into wind, would easily counter a slight slope. It would simply make a full brake landing similar to that of a half brake landing on a flat field. But given a light wind, it is best to land up the slope, even if the slope is slight. However, much care would be required for the circuit plan, since a slight slope may go unrecognised before leaving the high key position. However Harry, a good rule of thumb is: if you can detect a slope at all from a height of 1500' or more, then do not land down it. It is too steep. You will keep flying until you hit something."

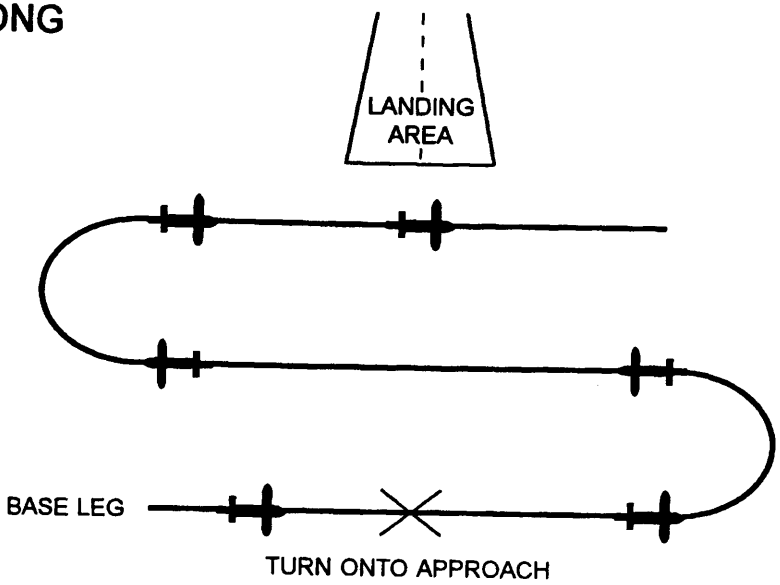
"I am enjoying our little talk, Boss. Another cup of coffee?"

"Thanking you Harry. To continue: If, when on the bass leg, the glider is too high, you can make use of the air brakes to lose height. But height may also be lost by flying 'S' turns. I think Harry, I will be able to explain better with the use of a diagram.

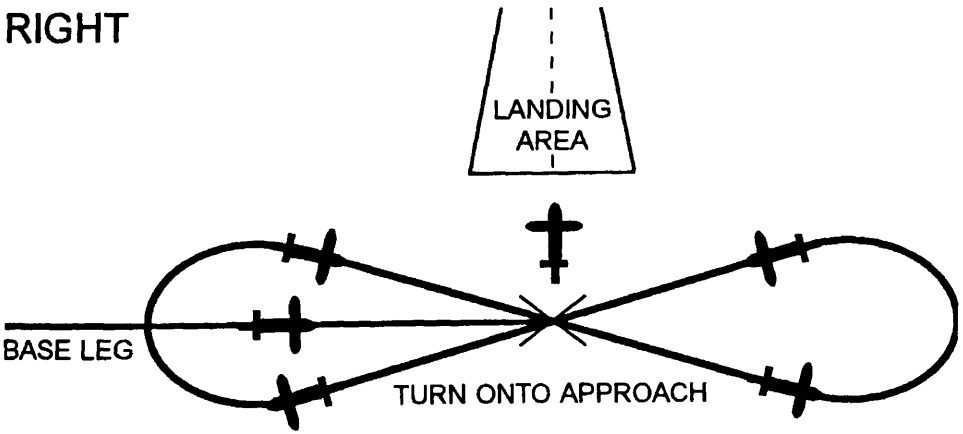
* (See page 17)

Recently the launching procedure has been changed in Britain. Now, once the pilot has indicated he is ready for take off, all commands are to be given by a person outside the glider. Of course, the emergency stop can still be ordered by anyone, including the pilot.

WRONG



RIGHT



Point over the ground where the glider normally turns from the base leg onto the approach. Always pass over 'turn in' point until height is correct to make approach. When making these 'S' turns, the pilot never has his back fully to the landing area. Of course Harry, if the air is rather buoyant, a number

of S' turns may be required before you achieve your required height. Therefore should the circuit be busy, another method of losing height would be preferable so as not to hog the approach area. We will move on to something else.

"Supposing one has been careless when flying in windy conditions, so that when one turns in for the approach, one has really serious doubts about getting back to the landing field. Is there anything at all which may help the situation?

" Should one be so unfortunate, or silly, the best action is certainly to land at once in a safe field. However Harry, if there is no place to land before reaching the normal landing field, then there is one way by which one may get back home. It was the wind, plus one's own carelessness, that placed one in such a predicament. Now we must find a way to handle the wind! Because the airfield is far away, one must resist the temptation of taking up a flat attitude by flying slowly, hoping to 'stretch' the glide. All that will do, is to give a slower ground speed, making the situation worse. What one must do, is use the wind gradient by diving steeply towards the ground and build up as much airspeed as possible, within safety limits. One will pull out of the dive as close to the ground as one's competence will permit. After which one will be under the wind gradient. Instead of flying at 40 kts against, say, a 25 kts wind, giving a groundspeed of only 15 kts., one is now flying with an initial airspeed of, say, 100 kts into a wind of, say, only 10 kts now, giving a ground speed of 90 kts. Although the glider's speed will constantly diminish, it is surprising how far the glider's kinetic energy will take the glider forward, before reaching the stall. Also, the glider receives some lift from what is known as 'ground effect': A sort of cushion of air between the under surface of the wing and the ground. Perhaps the cushion increases the air pressure under the wing. If this technique does not get one back against an otherwise strong wind, nothing will!"

"Brilliant, Boss. I do love our talks!"

"Spare my blushes. A little more Harry, about the angle of attack and the stall. For instance, when landing, especially on a windless day, some pilots roll or fly the glider on its wheel, so that if they were to bring the stick back immediately after touch down, the glider would lift off and fly again. That is not good. If the glider can still fly, then it should not be on the ground. I must clarify that last statement Harry. Should there be a strong crosswind, then, after kicking the glider straight with rudder from its angled approach, it should be 'placed' on the ground while it still has a little flying speed, in order to stop the drift starting up again. It would not be kind to the wheel, when it made contact with the ground.

"What do you think happens to the angle of attack as the glider is slowing down towards the stall, while flying close to the ground for landing?"

"The angle of attack gradually increases, as the stick comes back during the hold off. The lift lost from the decreasing airspeed, is replaced by the increasing angle."

"Good boy. Now answer this Harry. When flying into rising air, what happens, if anything, to the angle of attack?"

"It increases."

"Why?"

"Because the airflow now strikes the wing at a more positive angle to the cord, which increases the lift."

"So, would this effect the stall?"

"Yes, the stall would occur at a slightly reduced speed."

"Correct. What about flying into sinking air?"

"The airflow now reduces the angle of attack, resulting in reduced lift, so the stalling speed is increased."

"Good Harry. So, if you were climbing in a strong thermal, with other gliders nearby, do you think it would be a good idea to fly near the now reduced stalling speed in order to achieve a little more lift?"

"No, it would not be a good idea, Boss."

"Why not?"

"Because I might fly quite suddenly from rising air into a strong downward gust, changing the angle of attack to a point where a stall may occur. More speed would lessen the effect of the downdraft. To stall amongst other gliders would not increase one's popularity stakes."

"Thank you Harry. No more questions. I must be on my way. Happy landings, old son."

A car drove out from the airfield. From the window Harry saw a hand wave. The instructor was gone.

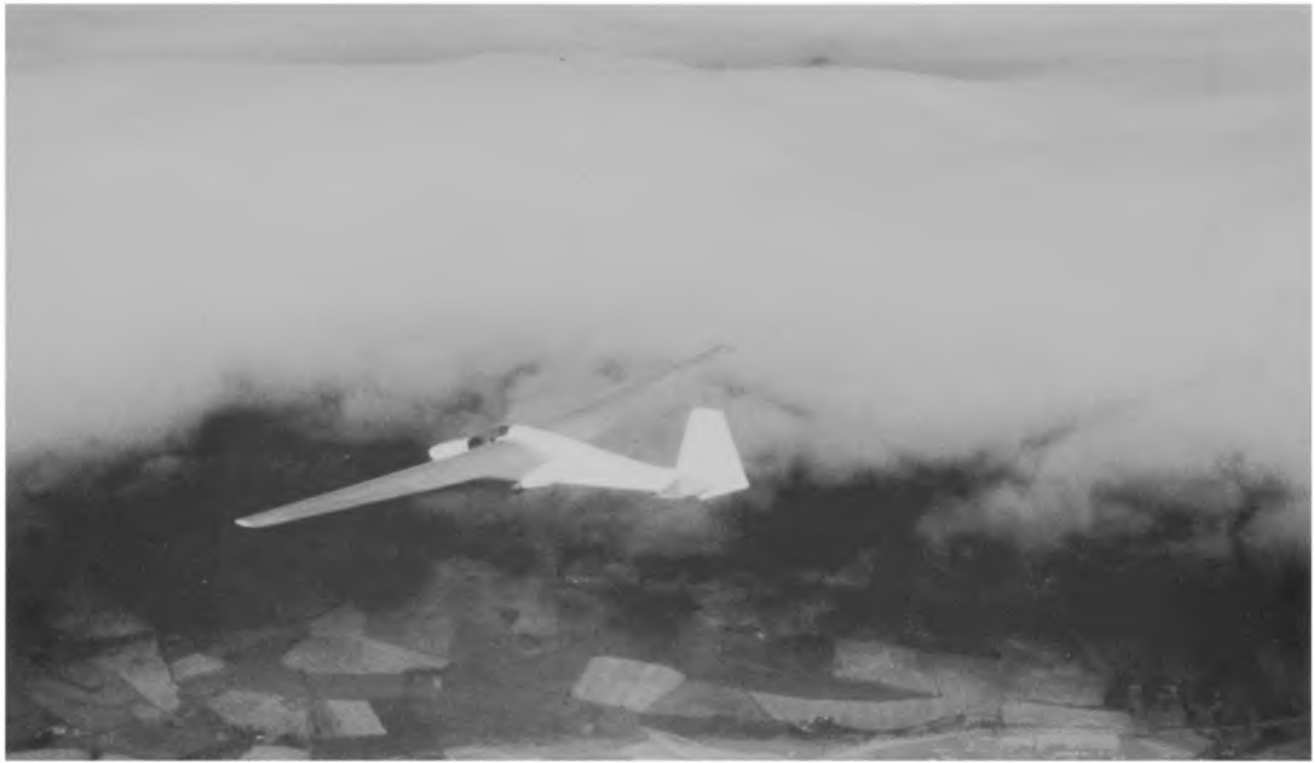
Hill Soaring in Scotland

Photo by Mike Richardson

Peter Craven, from The Lakes School, in Wave

A High Flight by a member of the Lakes G.C.

Photo by Peter Craven



The Author in Wave over Perth, Scotland.

Photo by Neville Allcoat

The Author about to take flight in the OLY 463
from the Bowland Forest Club

David Millett first stepped into a glider with the Lakes Gliding Club during the 1950's. The club at that time was situated on the fells above the village of Tebay in Westmoreland, now Cumbria. In 1965 David became a professional instructor. A job which he continued to do until 1981, when he retired from full time instructing, having knocked up 20000 launches and close on 4000 hours in gliders. He flew the wooden Skylark 3 to obtain the Gold certificate with a Diamond Goal. David still enjoys a few hours each year in his old Olympia 463 and usually instructs a couple of holiday courses during the season with the Derbyshire and Lancashire Gliding Club.